Fountains, Golf Courses and Music: Design Projects in Water Resources Engineering Education

Thomas C. Piechota[1]

[1]Department of Civil and Environmental Engineering, University of Nevada, Las Vegas, 4505 Maryland Parkway, Box 454015, Las Vegas, NV 89154-4015, P: 702-895-4412; F: 702-895-3936; email: piechota@unlv.edu

Abstract
The following is a summary of design projects that have been included in a Junior Level Water Resources Engineering course that is required for all Civil and Environmental Engineering majors. The projects are structured to encompass the fundamentals of applied fluid mechanics, while at the same time, providing the students an opportunity to be creative and bring water resources engineering “to life.” The students (working in groups of 3) designed a water feature (fountain) and a golf course water system for the proposed resort, “Le Reve”, on the Las Vegas strip. A field trip to the Bellagio resort provided students the opportunity to see the components of a world class water feature. The students acquired information from local sources such as water requirements from the Las Vegas Valley Water District, sprinkler and nozzle capacity from manufacturers, and evaporation rates from the National Weather Service. The phasing of the project throughout the semester provided each student an opportunity to be “Lead Engineer.” The Lead Engineer responsibilities included the delegation of work on each Phase, and preparation of the progress report. The public domain software, EPANet, was the tool used for analysis of the water distribution systems and ensuring that all pressure requirements were met. Course assessments show improved student knowledge in the design of water resource systems. Lastly, the incorporation of “water themed” music into the classroom creates an active learning environment in the classroom.

Introduction

The role of project(problem)-based learning in engineering education has expanded in the past decade and now undergraduate courses at all levels are utilizing this teaching pedagogy to enhance student learning (Birch, 1986). The premise of PBL is that the problem drives the learning. The students are asked to determine the information needed to solve the problem and/or project. PBL also allows the students to participate in active, integrated, and team learning using open-ended or poorly-defined problems. There is a plethora of information in the literature and on the internet (e.g., http://cleo.eng.monash.edu.au/teaching/pbl-list) which has made it easier for more institutions to implement PBL.

The study presented here focuses on the use of PBL in a design project for a Civil and Environmental Engineering undergraduate course in Water Resources Engineering. In addition, the use of music to provide an active classroom environment is discussed.

Course and Project Description
PBL was used in the course CEG 403: Water Resources Engineering. This is a required course for all undergraduate civil and environmental engineering majors and is the next course after fluid mechanics. The overall course objectives are to quantify the components of the hydrologic cycle and to apply the principles of fluid mechanics to design pipe and open channel systems. The students spend approximately five weeks studying surface and subsurface hydrology, and 10 weeks on pipe and open channel hydraulics. The book used in the course is Water Resources Engineering by Mays (2001).

In the second part of the course, a design project is assigned where students work in three or four person teams to design a water distribution system. The projects are structured to encompass the fundamentals of applied fluid mechanics, while at the same time, providing the students an opportunity to be creative and bring water resources engineering "to life." In the past year, the students were assigned the task of designing a water feature (fountain) and a golf course water system for the proposed resort, "Le Reve", on the Las Vegas Strip. Le Reve will be the next megaresort on the Strip and provides some unique engineering design problems. A field trip to the Bellagio resort provided students the opportunity to see the components of a world class water feature (See Figure 1).

Figure 1: Photographs of field trip to the Bellagio water feature.

Project Description
As noted earlier, one of the final assessments in the course is a group design project. The following **project description** was provided to the students.

> A new resort "Le Reve," is proposed to be built on the old site of the Desert Inn. Steve Wynn (developer of the Bellagio and Mirage) has proposed that the 1.63 billion dollar project have a water-theme with a constructed lake and a world-class golf course. Mr. Wynn is looking for ideas for the water feature and golf course that will be the centerpiece of the resort. **It is the objective of your design team to design the water system for the world-class golf course and the water feature.**

The **background information** provided to the students included:

- Site location bordered by Las Vegas Boulevard (on the west), Paradise Road (on the east), Desert Inn (on the north), and Spring Mountain (on the south).
- Water Supply:
  - Golf Course: reuse water from hotel, and a water reuse line on Paradise that has a static pressure of 60 psi.
  - Water Feature: from groundwater pumping of deep aquifer that is approximately 300 feet below the surface.
- Hotel will have 2455 rooms

The **design requirements** included:

<u>Golf Course</u>

- Schematic of a world class resort golf course.
- Assume reuse water from hotel has been treated to acceptable level.
- Main water supply lines only (e.g., line for each golf course hole)
- Minimum pressure = 20 psi.
- Maximum pressure = 80 psi.
- Need to store one summer days worth of water in lakes (separate from water feature) throughout the golf course
- Obtain typical water schedule from Southern Nevada Water Authority
- Obtain sprinkler ratings for demand.
- Calculations:
  a. Water requirement per typical day for all four seasons.
  b. Determine how much water is lost due to evaporation from the lakes.
  c. Total water requirement for year.
  d. Size pipes, pumps, and check pressure requirements at all nodes for peak demand during all four seasons (See EPANet section for water distribution calculations)

<u>Water Feature</u>

- Five of the fountains must shoot at least 50 feet high.
- Do not have to treated the groundwater
- Can not have drawdown in the aquifer that impacts area outside of property.
- Will need to make reasonable assumptions of aquifer properties.

<u>Calculations:</u>

- Determine how much water is lost due to evaporation.
- Total water requirement for year.
- Size pipes, pumps, and check pressure requirements for peak demand during all four seasons (see EPANet section for water distribution calculations)

The **timeline** for submitting the project was as follows:

- Phase 1: Background and Conceptual Layout – Thursday, March 21st (Report Sections 1.0, 2.0, and 3.0)
- Phase 2: Preliminary Analysis – Thursday, April 18th (Report Sections 1.0, 2.0, 3.0, and 4.0)
- Phase 3: Final Report and Presentation – Thursday, May 2nd (entire report)

The phasing of the project throughout the semester provided each student an opportunity to be "Lead Engineer." The Lead Engineer responsibilities included the delegation of work on each Phase, and preparation of the progress report. The public domain water distribution software, EPANet, was the tool used for analysis of the water distribution systems and ensuring that all pressure requirements were met.

Example Projects

Figure 2, 3, 4 are examples of the fountain and golf course systems designed for Le Reve. The water distribution systems for the golf course and water features were designed separately to meet the design constraints. The design group Moody Mad Men designed a water feature that had fountains, misters, and lasers (Figure 2). The extensive water distribution system for the water feature designed by the SCLM design group is shown in Figure 3. The students used EPANet to ensure that the fountain heights were at least 50 feet. Figure 4 presents the golf course and water system designed by BB&H. The coverage area for each demand node was determined from Theissen polygons.

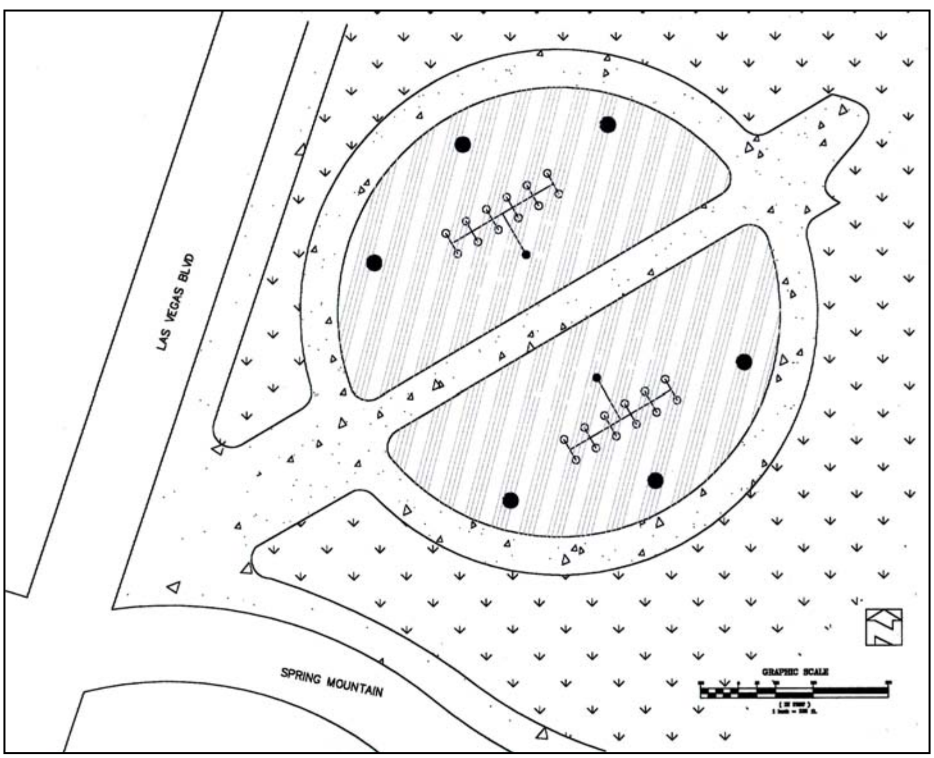

Figure 2: Schematic of the Le Reve Laser show water feature as designed by Moody Mad Men (Spring 2002).

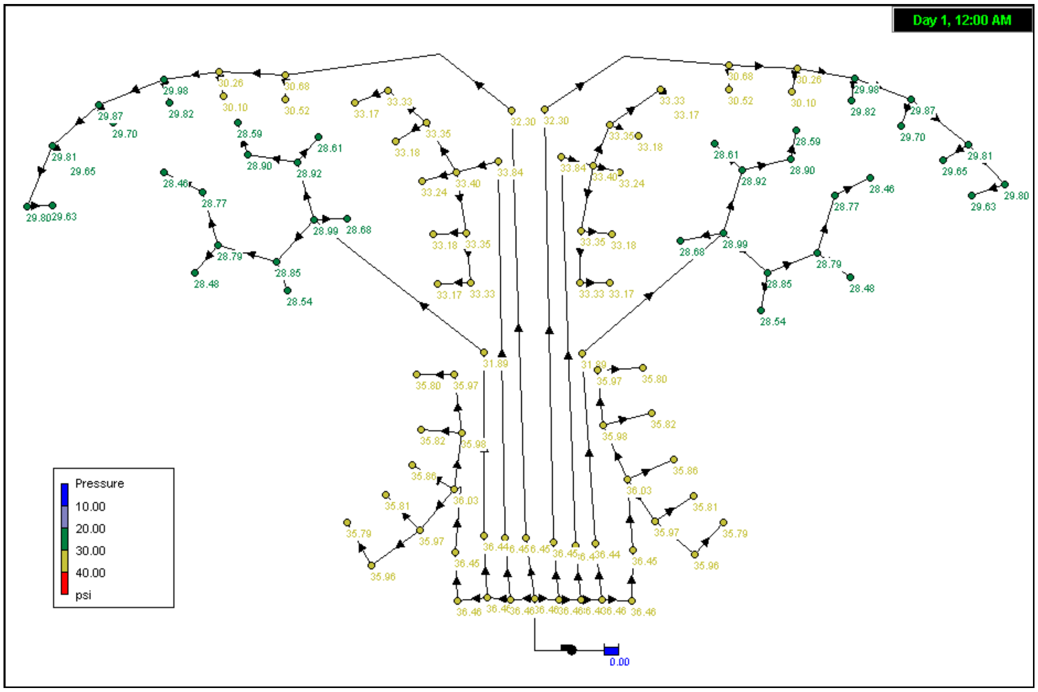

Figure 3: Schematic of the water distribution system and pressure nodes for the water feature as designed by SCLM (Spring 2002).

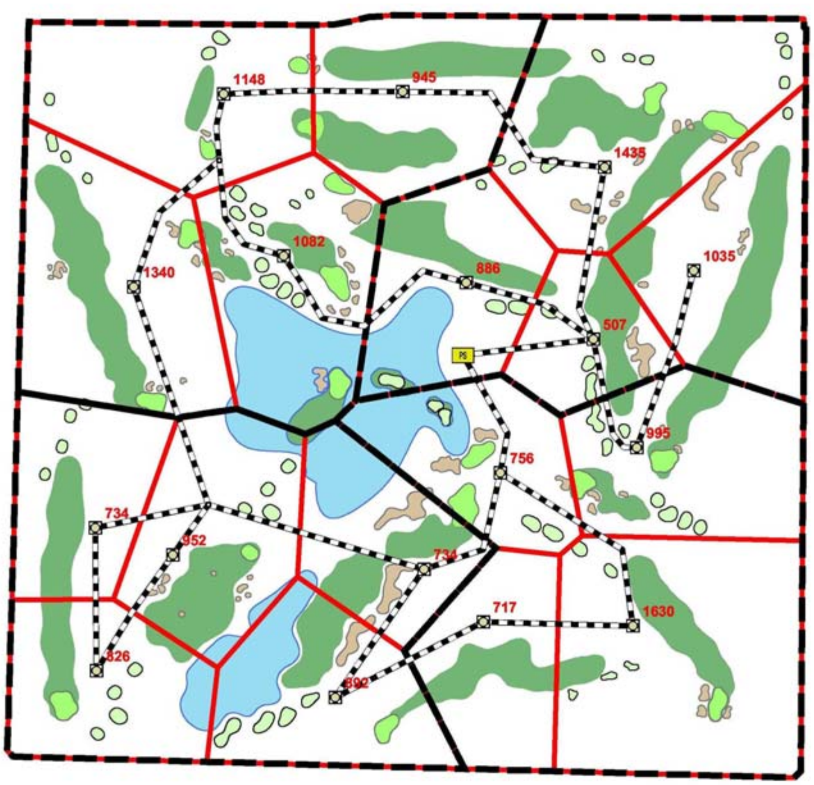

Figure 4: Schematic of the water distribution system for the golf course designed by BB&H (Fall 2002).

Assessment

The individual performance of students was assessed using a strategy developed by Felder and Brent (2001). Students are asked to provide ratings of their own individual performance and also the performance of the other team members. This provides a mechanism to assign students higher grades to students that did much of the work, and lower grades to students that did not provide satisfactory input. Figure 5 is the peer rating evaluation form used for the design project.

CEG 403
Peer Rating of Design Group Members

Name______________________________ Group Name________________

Please write the names of all your design group members, INCLUDING YOURSELF, and rate the degree to which each member fulfilled his/her responsibilities in completing the design project. **Remember to rate yourself**. The possible ratings are:

EXCELLENT:	Consistently went above and beyond — carried more than his/her fair share of the load and had to help group members.
VERY GOOD:	Consistently did what he/she was suppose to do, very well prepared and cooperative.
SATISFACTORY:	Usually did what he/she was supposed to do, acceptably prepared and cooperative.
ORDINARY:	Often did what he/she was supposed to do, minimally prepared and cooperative.
MARGINAL:	Sometimes failed to show up or complete designated work, rarely prepared.
DEFICIENT:	Often failed to show up or complete designated work, rarely prepared.
NO SHOW:	No participation at all

These ratings should reflect each individual's level of participation and effort and sense of responsibility, not his or her academic ability.

Name of Team Member	Rating
___________________	____________
___________________	____________
___________________	____________
___________________	____________

Your signature:____

Adapted from Felder and Brent (2001)

Figure 5: Peer rating form used for individual assessment of student performance on the design project.

Music and Water Resources Engineering

A final strategy in this class is the use of music at the beginning of class. The music is played while the students are entering the room and the selection corresponds to the topic of the day. In addition, music is played while the students are working in teams during class. Table 1 presents examples of the selections for this course and the related topics. The use of music is not only fun, but also creates an active classroom and a certain sense of drama to the classroom (Daniel, 2002). Student feedback has been very positive and extra credit homework points are provided if a student suggests a song that is relevant to the course topics.

Table 1: Examples of music used at the beginning and during class.

Topic	Song	Singer/Group
First day of class	"Start me up"	Rolling Stones
	"Get this Party Started"	Pink
Groundwater Hydrology	"Wishing Well"	Free
	"Poison in the Well"	10,000 Maniacs
Precipitation	"Rainy Days"	Carpenters
	"Rain Drops Keep Fallin on my Head"	Burt Bacharach
Flood Frequency	"Here Comes the Flood"	Peter Gabriel
	"Flood"	Tori Amos
Pipe Flow	"Under Pressure"	David Bowie
	"Got me under Pressure"	ZZ Top
Open channel flow	"River"	Bruce Springsteen
	"River of Dreams"	Billy Joel
Hydraulic Jump	"Jump"	Van Halen
	"Jump"	Pointer Sisters
Pumps	"Pump up the Volume"	Marss

Acknowledgements

This work is supported by the National Science Foundation award CMS-0239334 and the College of Engineering at the University of Nevada, Las Vegas. The students of CEG 403 are thanked for their dedicated efforts in the Spring & Fall 2002 semesters.

References

Birch, S., 1986. Towards a Model for Problem-based Learning. *Studies in Higher Education,* 11(1), 73-82.

Daniel, 2002. Staging Your Classes. *ASEE Prism*, 12(3), 40-42.

Felder, R.M. and R. Brent, 2001. Effective Strategies for Cooperative Learning. *Journal of Cooperation & Collaboration in College Teaching*, 10(2), 69-75.

Mays, 2001. *Water Resource Engineering.* First Edition, John Wiley and Sons, Inc. New York.