

# Integration of Service-Learning into Civil and Environmental Engineering Curriculum

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## Introduction

Service-learning is defined as integrating the community service experience of students with their academic study so that learning is enhanced<sup>1</sup>. The level of student participation in community service is at an all time high as students feel the need to confront today's technical and societal problems<sup>2</sup>. However, service-learning is more than community service or volunteerism. Service-learning as defined above, integrates the community service experience with the student's academic study (note the hyphen in "service-learning" means that both are considered equal). This enhances learning which is a fundamental goal of colleges and universities. Boyer<sup>3</sup> highlights the need for service-learning stating that "At no time in our history has the need been greater for connecting the work of the academy to the social and environmental changes beyond the campus." Service-learning is a campus wide learning pedagogy including a range of disciplines and has been implemented at over 600 institutions<sup>1</sup>; however, not as widely implemented in engineering and science. A noteworthy contribution in the engineering education, is the Engineering Projects in Community Service (EPICS) program at Purdue University (<http://epics.ecn.purdue.edu>) that partners undergraduate students and local community not-for-profit organizations to solve engineering-based problems in the community

Service-learning is a type of experiential education where the students learn through "real-world" experiences that meet a community's needs<sup>4</sup>. In the engineering curriculum, other forms of experiential learning include projects, clinics, internships, laboratory classes, field trips. Moreover, service-learning promotes student understanding of the impact of engineering solutions in a global/societal context, a requirement in the Accreditation Board of Engineering and Technology (ABET) new Engineering Criteria (EC) 2000 ([www.abet.org](http://www.abet.org)). Through service-learning, students experience the greater sense of belonging and responsibility to a larger community. Other features of EC 2000 that service-learning addresses are: the ability to function in multidisciplinary teams; an understanding of professional and ethical responsibility; and an ability to communicate effectively<sup>4</sup>. Service-learning projects should be selected so that a community need is met for groups with specific needs pertinent to the desired learning experiences. Such groups include community organizations, public schools (K-12), or local and state agencies. The feeling of being empowered to address issues of concern and relevance to society, and being responsible for the same, enhances the students' perception of the value (and significance / relevance) of applying their knowledge and expertise. In turn, this promotes better learning and understanding of information from their other curricular activities. This paper

presents information related to attempts of incorporating service-learning into the civil and environmental curriculum at the University of Nevada, Las Vegas (UNLV).

### **UNLV Curriculum**

UNLV has a total enrollment of approximately 27,000 students (undergraduate and graduate) and is primarily a commuter campus. The Howard R. Hughes College of Engineering provides education to approximately 1,300 undergraduate and 250 graduate students with about 60 full time faculty members. Within the College of Engineering, the Department of Civil and Environmental Engineering has 16 full time faculty members and offers degrees at the bachelors, masters, and doctoral levels. The civil and environmental engineering program is ABET accredited and requires students to earn a total of 132 credits leading to the degree of Bachelor of Science in Engineering with a major in Civil engineering.

There are various opportunities at all levels to integrate service learning into the civil engineering curriculum. For instance, students in the Introduction to Civil Engineering course are exposed to the design process and prepare group projects that demonstrate their understanding. A service learning project could have the students develop educational tools for high school students that demonstrate fundamental concepts of science and/or engineering. Junior and senior level courses such as Water Resources Engineering, Transportation Engineering, and Senior Design (I and II) require design projects. These projects have generally focused on specific community needs.

The integration of service learning into the curriculum is also consistent with the Educational Objectives of the program. More specifically, service learning addresses the objectives that the students will have: “participated in a strong design experience throughout the professional component of the civil engineering curriculum and have the ability to identify, formulate, and solve open-ended civil engineering problems,” “the ability to function on multi-disciplinary teams,” and “an awareness of social and contemporary issues as related to civil engineering practice.”

### **Community Partners**

An essential element to successfully integrating service learning into the curriculum is having the buy in, cooperation, and support of community partners. Community partnerships can benefit student learning by exposing them to diverse settings and realistic problems. As noted earlier, service learning is a balance of community service and student learning, so these expectations must be clearly stated to the community partners. In addition, other expectations such as time expectations, accessibility, information that will be required, and review of student work must be clearly communicated to the community partners. Examples of community partners include education (K-12, museums), human services (United Way, Habitat for Humanity), and non-profit (local government, neighborhood associations). The specific examples that will be discussed in the following section include three community partnerships (Project Green, Kyle Canyon Gateway Development, and the redesign of the intersection of College Drive and Mission Drive in Henderson, Nevada).

### **Example from a Senior Design Course: Project GREEN (Spring/Summer 2004)**

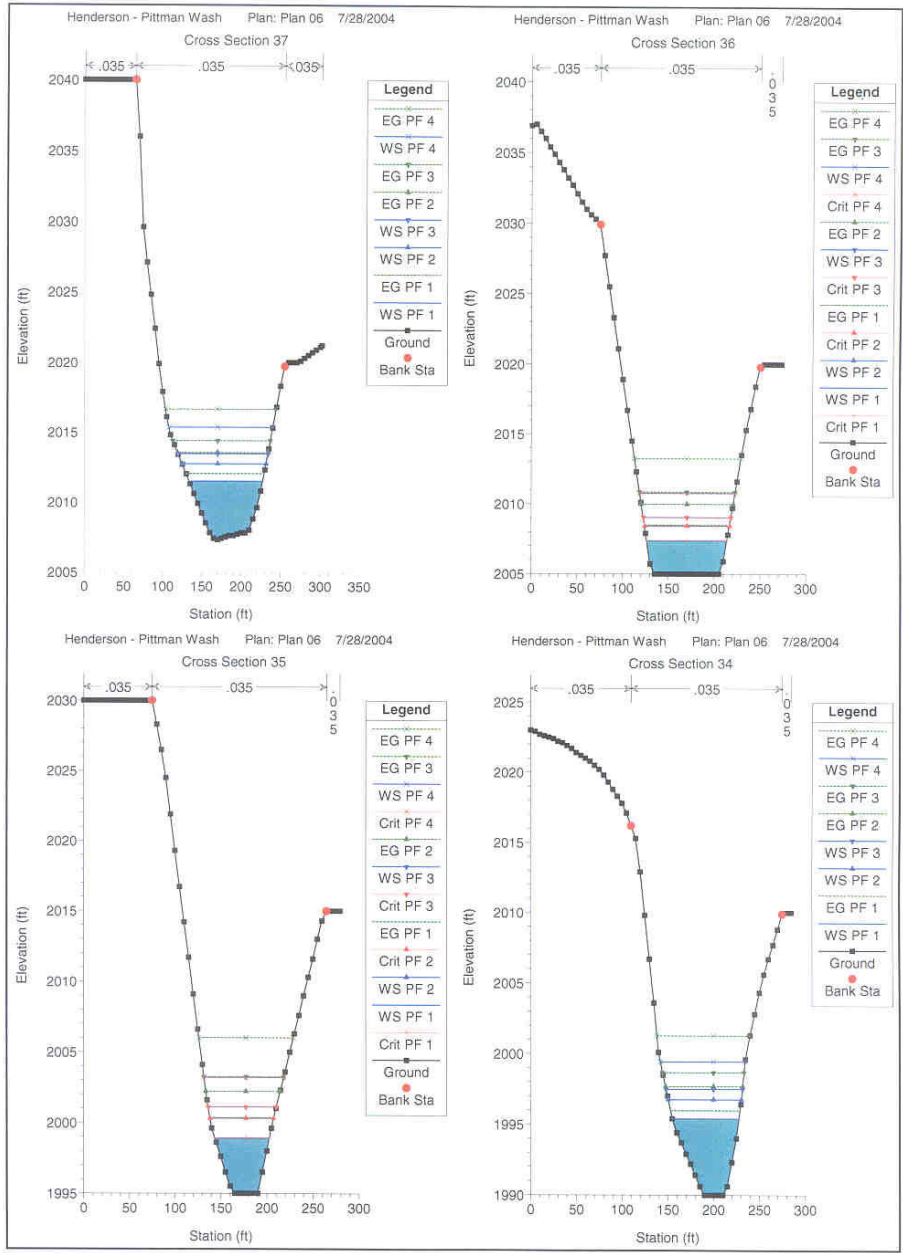
Project Green (Green Valley Ecology, Environment, and Nature) is a habitat restoration and protection project in the City of Henderson, Nevada with an overall goal of restoration of the

Pittman Wash as a valuable resource to the entire community (See Figure 1). Planning for this project is coordinated between a citizens group (Project Green Steering Committee), the City of Henderson Public Works Department, and Harris and Associates. The technical needs are largely being met by Harris and Associates; however, there is a limited budget and specific studies are required to make a complete assessment of the project impacts on flood control and water use. The specific technical studies required were a conceptual hydraulic model of the Pittman Wash and design of a temporary irrigation system for plant restoration. These specific technical needs were communicated to UNLV and a senior design group in the Spring and Summer of 2004 worked on the project with the Doug Blatchford, Harris and Associates, as the client mentor.

The hydraulic model (see Figure 2) provided the client with information regarding the flood elevations during various storms (e.g., 2, 5, 10, and 100 year) which will be used to plan the location of the tree plantings and trails. The design of the irrigation system provided the client with two alternatives for temporarily irrigating the trees that will be planted as part of the restoration. The cost analysis of these alternatives suggested that it would be best to deploy a pump-powered system instead of a multi-reservoir system. These recommendations were presented to the City of Henderson and Harris and Associates. It is noteworthy, that this is an ongoing project and currently another group of senior design students will be continuing the technical analysis and working with the Project Green Steering Committee.



**Figure 1: Location map for Project Green (source: Proposal submitted by DWD Senior Design Group)**



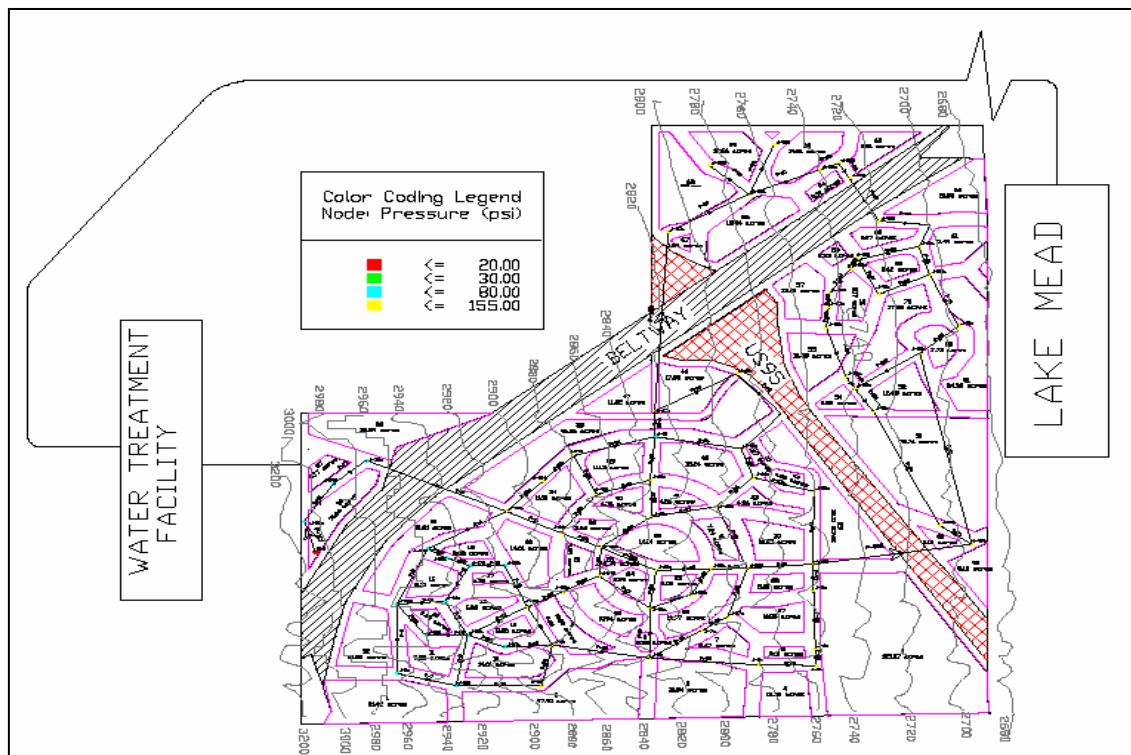
**Figure 2: Example of HEC-RAS Hydraulic model for Pittman Wash showing flood elevations in the channel cross sections (source: Project Green Draft Conceptual Plan from Senior Design group SJA Engineers).**

**Example from Water Resources Engineering (CEE 413, Spring 2004)**

Service learning was also integrated into a junior level course (CEE 413: Water Resources Engineering) in the Spring of 2004. This course is the required water resources course for all civil and environmental engineering majors and introduces the students to hydrology and applied hydraulics. A group design project is required during the second half of the course that has the students perform hydraulic analysis of water supply systems.

In the Spring 2004, the City of Las Vegas agreed to serve as a community partner and have the students perform technical analysis on a sustainable water system for the Kyle Canyon Gateway Development. The City of Las Vegas would like this development to demonstrate sustainable design concepts for resources (energy, water, transportation). The specific technical need that fit with the core objectives of the course included the design of a recycled water system. The class had 37 students that were divided into groups of 4-5. Thus, there was a total of 9 groups. It is noteworthy, that the instructor assigned the groups based on ranking of the students in the course and to avoid women being a minority in a group. Since there were nine groups, the technical needs were divided into three tasks (A, B, C) and three groups (1, 2, 3) worked simultaneously on each task. In addition, each group had to coordinate with the other groups in their “SuperGroup.” This was particularly challenging for students since coordination had to take place at the group level, and also amongst other groups.

Task A included the design of a sustainable water system, Task B included the design of the sewer collection system and water redistribution system of treated wastewater, and Task C included the design of a traditional water system and comparison to the sustainable system from Task A. An example of a sustainable water system is show in Figure 3.



**Figure 3: Example of sustainable water system for Kyle Canyon Gateway Development (source: Design group, Prat Water Co.)**

**Example from a Transportation Engineering Course (CEG 362, Spring 2004)**

The redesign of the intersection of College Drive and Mission Drive in Henderson, Nevada was incorporated as a service-learning project in CEE 362: Transportation Engineering. This is a junior level that is required in the department’s ABET accredited undergraduate curriculum. The Las Vegas metropolitan area, which includes the city of Henderson, has consistently experienced

the highest population growth rate in the nation over the past decade. This has led to the rapid development of numerous residential communities in previously uninhabited areas. In turn, this has led to significant public infrastructure challenges. Challenges in the transportation system and road network are often the ones most visible to the community and elected officials. The intersection of College Drive and Mission Drive is a location that was of concern to the Public Works Department officials in the City of Henderson. The community proximate to the intersection consists of the following land uses (Figure 4):

- J. Marlan Walker International Elementary School
- Foothills High School
- Community College of Southern Nevada
- Single family residential homes

Key characteristics of the intersection are as follows:

- The intersection is controlled by a 4 way stop.
- Posted approach speeds are 35 mph on each leg.
- On and Off Ramps to US 95 are located about 200 feet North of the intersection.
- Mission Hills Park and the J. Marlan Walker Elementary School occupy the Southeast corner of the intersection
- The US 95 and a flood control drainage area occupy the area immediately to the North of the intersection.
- The Southwest corner of the intersection is undeveloped at this time

Shital Patel, P.E., a traffic engineer with the city, identified issues related to safety of the intersection, and the level of service afforded to users of this intersection as items of key concern to the city of Henderson. He served as the community liaison / client for the project. He provided the students information on traffic counts and engineering drawings of the existing intersection. He was available (on a limited basis – typically for one meeting of about 2 hours per month) for discussions with the students throughout the semester. The students were charged with proposing designs that would address the problem on a short term basis (design year 2007 or so), and long term (for the design year 2015 to 2020). To do so they were required to validate existing conditions, obtain additional data, estimate the design year demands, identify potential alternatives, develop criteria to evaluate alternatives, select a preferred alternative, and develop as detailed a design document as possible for the preferred alternative. Safety, operational efficiency, and cost were required to be considered, and other elements that were candidates for consideration in comparing alternatives included environmental impacts, aesthetics, maintenance requirements, and user friendliness.

The students in the class were divided into 4 teams of three students each, and one team of two students. The teams were selected by the instructor based on their stated Grade Point Average (GPA), schedules, and considerations of gender and race. Teams were constituted based on the following general criteria:

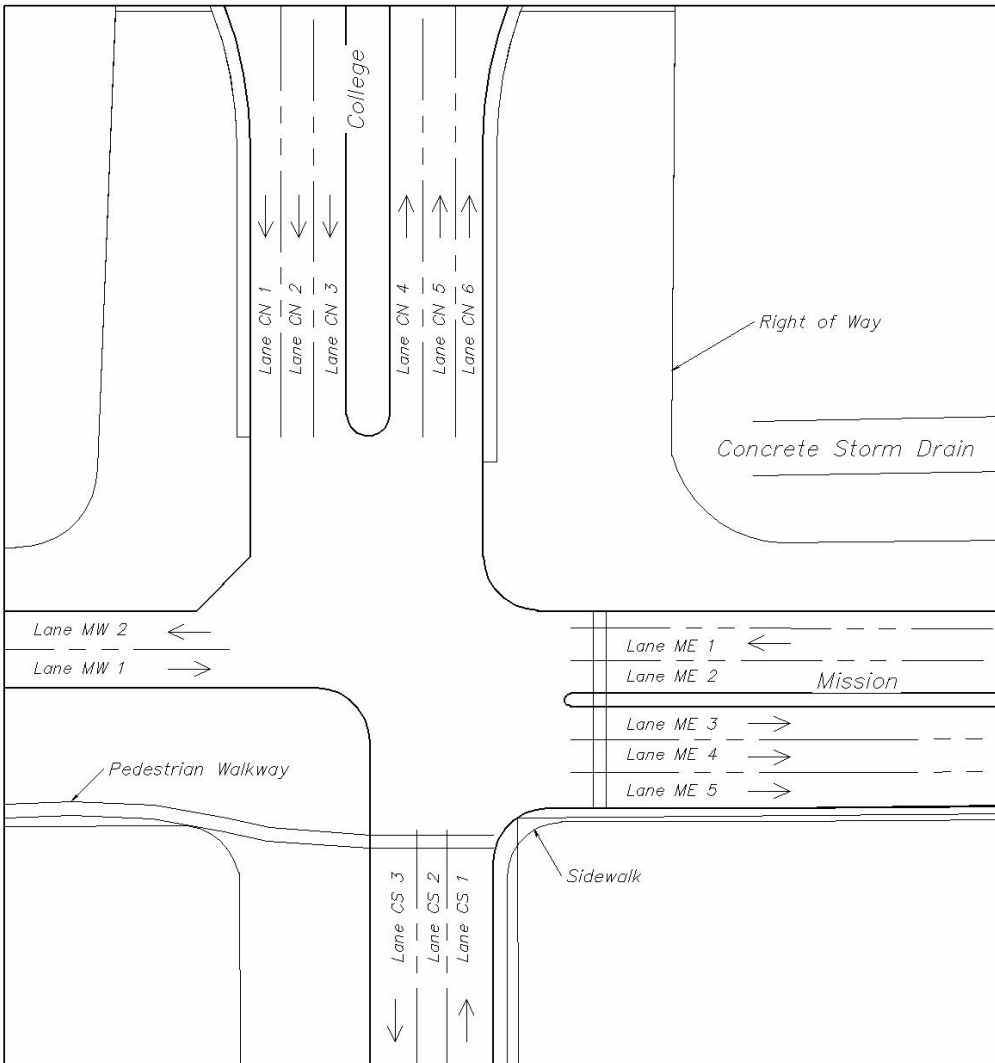
- The average GPA of each team was close to the average GPA of the class as a whole
- Women and members of minority populations would not be a minority on a team
- Ensure that all the members of each team had at least 6 hours of “available” time per week (outside of class hours) to meet on this course related efforts

These teams were also utilized for other assignments in the course that were to “team” efforts (as opposed to individual efforts).

Examples of the outcomes of the student efforts of one team are presented next. Figure 5 shows the existing geometric conditions around the subject intersection.



**Figure 4: Vicinity Map of the Intersection of College Drive and Mission Drive, Henderson, Nevada (Source: Project Report Submitted by Carter, Hales, and Hills, Spring 2004)**



*Not To Scale*

**Figure 5: Existing Geometrics at the Intersection of College Drive and Mission Drive, Henderson, Nevada (Source: Project Report Submitted by Carter, Hales, and Hills, Spring 2004)**

The following were the alternatives identified by the team:

**Alternative A:** Do Nothing

**Alternative B:** Retrofit to 4-lane per Approach

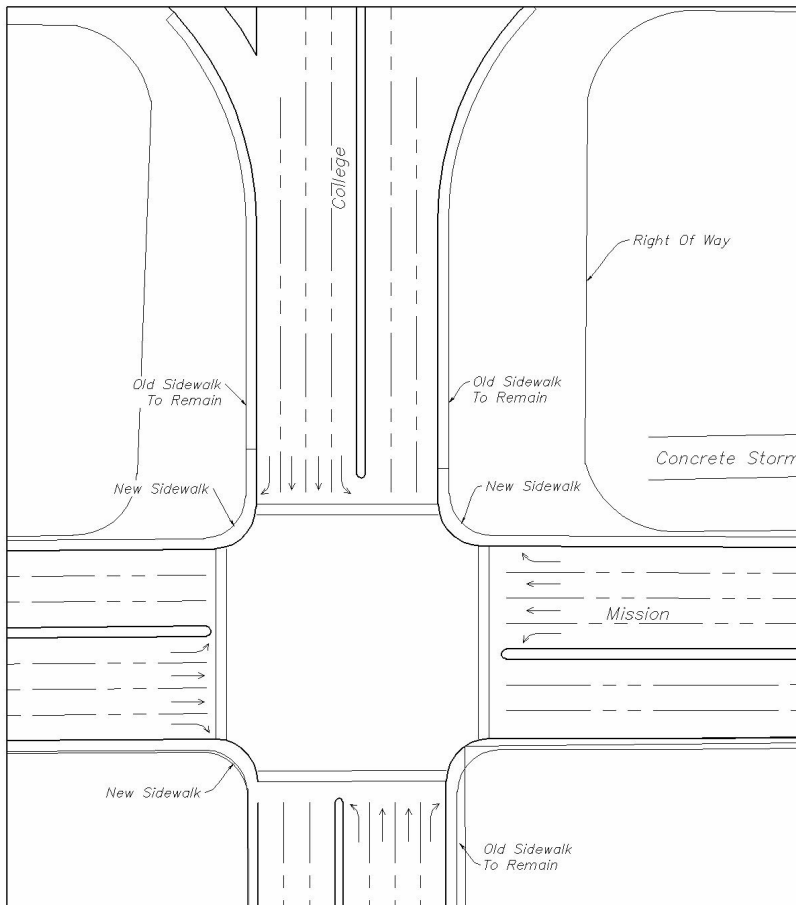
- All Way Stop Control (AWSC)
- Two exclusive through lanes
- Permitted Right/Left Turn Lanes
- 12' wide cross walks



**Alternative C: Retrofit to 4-lane per Approach**

- Two-Cycle Signalized Intersection
- Two Exclusive Through Lanes
- Permitted Right/Left Turn Lanes
- 12' wide cross walks

*New Design Intersection*



*Not To Scale*

**Figure 6: Alternative “C” - Intersection of College Drive and Mission Drive, Henderson, Nevada: Modified Geometry and Signal Control (Source: Project Report Submitted by Carter, Hales and Hills, Spring 2004)**

**Assessment**

The assessment of student performance in design groups is always a challenge and an assessment tool is needed that allows the students to perform peer evaluations. The individual performance of students was assessed using a strategy developed by Felder and Brent<sup>5</sup>. Students were 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 who did more than an equal share of the work, and lower grades to students who did less than an equal share of

the work. Figure 7 is the peer rating evaluation form used for the design project in CEE 413. Table 1 summarizes the results from nine (9) student groups. The results of the evaluations were used by the instructor to adjust the student grades. It is noteworthy that in all groups grade adjustments were needed. A maximum of 3% adjustment was used to avoid excessive adjustments that may not reflect the true contribution of the students.

<b>CEE 413</b>	
<b>Peer Rating of Design Group Members</b>	
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. <b>Remember to rate yourself.</b> The possible ratings are:	
EXCELLENT (6):	Consistently went above and beyond — carried more than his/her fair share of the load and had to help group members.
VERY GOOD (5):	Consistently did what he/she was suppose to do, very well prepared and cooperative.
SATISFACTORY(4):	Usually did what he/she was supposed to do, acceptably prepared and cooperative.
ORDINARY (3):	Often did what he/she was supposed to do, minimally prepared and cooperative.
MARGINAL (2):	Sometimes failed to show up or complete designated work, rarely prepared.
DEFICIENT (1):	Often failed to show up or complete designated work, rarely prepared.
NO SHOW (0):	No participation at all
<i>These ratings should reflect each individual's level of participation and effort and sense of responsibility, not his or her academic ability.</i>	
<u>Name of Team Member</u>	<u>Rating</u>
_____	_____
_____	_____
_____	_____
_____	_____
Your signature: _____	

**Figure 7: Peer rating form used for individual assessment of student performance on the design project in CEE 413 (adapted from Felder and Brent<sup>5</sup>).**

Similar instruments were used in CEG 362 as were those used by Nambisan in other courses<sup>6</sup>. Other means to assess the student performance in CEG 362 included their submission of a proposal, two interim reports, a final report, and an oral presentation. The “client” was provided a copy of the final report. He attends the final presentation and he provides comments / critiques of the team presentations, and a numerical score for each team and each team member. The score provided by the client was used along with peer evaluations by the students, and the instructor’s

evaluation to determine each individual's score for the project. The client, peer, and instructor evaluations for the presentations resulted in the grades of 5 students being lower than their respective team average grades, the grades of 6 students being the same as their respective team average grades, and the grades of 3 students being lower than their respective team average grades.

**Table 1: Summary of the peer evaluations for CEG 403 design project. The number of students whose grades adjusted lower or higher are noted in addition to the number of students with no grade change.**

Team #	# of Students with a Lower Grade	# of Students with No Grade Change	# of Students with a Higher Grade
A1	1	-	3
A2	2	-	2
A3	1	-	3
B1	2	-	2
B2	1	-	3
B3	1	1	2
C1	-	3	1
C2	-	3	1
C3	1	3	-
<b>TOTAL</b>	<b>9</b>	<b>10</b>	<b>17</b>

Indicators of the client buy-in, and value of the outcomes of the projects to the client include their continued participation in such efforts over time (they “sponsor” projects each semester), and more importantly their use of the “preliminary designs” provided by the student teams as starting points to actually develop and deploy design changes. Over the past four or five years every project worked on by the students in CEG 362 (renumbered as CEE 362 in 2004) has eventually been adopted and implemented by the sponsor. This not only validates the value of the students’ work, but also gave a tremendous boost to the morale of the students when they see their “ideas” and “concepts” turning into reality. However, it is recognized that more formal assessment mechanisms need to be pursued to quantify and qualify the clients experiences and satisfaction with the projects.

### **Conclusions and Instructor Observations**

The integration of service learning has been demonstrated for two courses in a civil and environmental engineering curriculum. These examples were performed with no institutional support and community partners were identified with the knowledge of the course instructors. A complete assessment of student learning was not performed; however, informal student feedback is that they enjoy working on community projects and interacting with community partners. They also indicated that coordinating schedules and resolving conflicts were often difficult. Several students expressed a desire to have “self selected” teams rather than being forced to work on teams assigned by the instructor. To fully integrate service learning into the curriculum, additional education resources are needed to coordinate the efforts. For instance, a central service learning facility that would coordinate community partnerships would make it easier for faculty across campus to experiment with service learning.

## **Bibliography**

1. Decker, 1998. Introduction. in *When Community Enters the Equation: Enhancing Science, Mathematics, and Engineering Education Through Service-Learning*, Ritter-Smith and Saltmarsh, editors. pgs. 9-12.
2. Jacoby, B. editor, 1996. *Service-Learning in Today's Higher Education*, in *Service-Learning in Higher Education: Concepts and Practices*, Jossey-Bass, p. 3-25.
3. Boyer, E.L., 1990. *Scholarship Reconsidered: Priorities of the Professoriate*, The Carnegie Foundation for the Advancement of Teaching. Princeton University Press.
4. Tsang, E., 1998. Why Service-Learning? in *When Community Enters the Equation: Enhancing Science, Mathematics, and Engineering Education Through Service-Learning*, Ritter-Smith and Saltmarsh, editors. pgs. 13-28.
5. Felder, R.M. and R. Brent, 2001. Effective Strategies for Cooperative Learning. *Journal of Cooperation & Collaboration in College Teaching*, 10(2), 69-75.
6. Nambisan, Shashi S. 2002. A Team Oriented, Case-based Approach for a Transportation Engineering Course. Paper Number 2002-1350, Session 2215. *Proceedings of the American Society for Engineering Education Annual Conference*, Montreal, Canada. June 18. (on CD-ROM)

## **Biographical Information**

THOMAS PIECHOTA, PhD, PE: Assistant Professor at the University of Nevada, Las Vegas, Department of Civil and Environmental Engineering since 1999. Areas of teaching/research interest include service-learning, water resources engineering, surface water hydrology, Geographic Information Systems (GIS), and climate variability.

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