

Promoting Interest in Engineering in the Local Community by “Walking On Water”

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Abstract

San Diego, California is home to many high-tech companies requiring the services of engineers. The engineering department at the University of San Diego (USD) has responded to the need to promote the field of Engineering and its importance in society through its annual Walk On Water (WOW) Competition. In this event, participants design, construct, and pilot their shoes across a 25-meter pool. WOW is organized by the engineering student societies at USD and sponsored by industry and businesses within the local community.

The WOW event is also used as a fun design project for teams of first-year engineering students at USD. Utilizing the engineering design process introduced in the classroom, student teams must consider three important design considerations: buoyancy, stability, and propulsion. In Fall 2002, the engineering students visited local high schools to present how they applied the engineering design process to design Walk On Water shoes. This service-learning project reinforces the USD students' comprehension of the design process and helps them develop their communication skills while encouraging younger students to consider engineering careers.

Walk On Water at USD is a great learning experience that serves several purposes. It is a design project for freshmen engineering majors at USD, a project for high school science classes, an event which creates awareness of engineering in the local community, a forum for interaction of high school and college students, and a vehicle for upper-class engineering students to develop skills in planning and executing an event including fundraising and publicity.

The paper will introduce the WOW event and then show how the competition provides a vessel to promote engineering and applied science throughout many areas within the local community.

Introduction

The annual Walk On Water (WOW) competition has been hosted and coordinated by the University of San Diego (USD) for 12 years. The competition's goal is to promote engineering and applied science in the local community. Participants design, construct, and pilot water shoes across a 25 meter swimming pool. They must consider three important design considerations: buoyancy, stability, and propulsion. The entire experience allows them to gain experience at applying the engineering design process and solving open-ended engineering problems.

The competition brings together competitors from local universities, colleges, and high schools. The college and university student competitors are from the University of San Diego (USD), San Diego State University (SDSU), the University of California at San Diego (UCSD) and Southwestern Community College. The high schools represented are located throughout southern California. La Jolla, Poway, and Eastlake high schools provide a large percentage of the competitors. Figure 1 shows spectators watching as students trek across the pool.



Figure 1: High school students racing across pool.

Original and innovative designs are encouraged for the Walk On Water contest. As such, minor modifications of items such as boats, surfboards, body boards, etc. are not within the spirit of the competition. There are several rules that confine the design so that the emphasis is on creativity. The main points of the rules are that each entry:

- Must consist of two separate and mirror image buoyancy shoes, not to exceed 8' in length
- External propulsion devices are prohibited. This is a human powered apparatus.
- Expenditures for each team shall be limited to \$100.00.

The complete rules for the WOW competition are listed in Appendix A.

The 12th Annual Walk On Water competition, held on December 7, 2002, was very successful by several measures. Attendance at the event was excellent including a record 48 participants, 30 of whom were high school students, many parents and friends of participants, and four local television stations. The industry sponsors donated a record amount of \$2500 for prizes. The prizes for the participants are listed in Table 1.

Table 1: Prizes for High School and College Competition in 2002 Walk On Water Event

High School 1 st Place	\$2000 scholarship, \$50 gift certificates, and WOW T-Shirts
High School 2 nd Place	\$25 gift certificates, and WOW T-Shirts
High School 3 rd Place	WOW T-Shirts
College 1 st Place	\$50 gift certificates, and WOW T-Shirts
College 2 nd Place	\$25 gift certificates, and WOW T-Shirts
College 3 rd Place	WOW T-Shirts

The results for the 2002 Walk On Water Competition are summarized in Table 2.

Table 2: Results of 2002 Walk On Water Competition

High School 1 st Place	La Jolla – Water Bears:	Time: 25.84 sec
High School 2 nd Place	Eastlake – USS Daralee	Time: 25.99 sec
High School 3 rd Place	Eastlake – HydroForce	Time: 32.49 sec
College 1 st Place	Hydro Runners	Time: 24.77 sec
College 2 nd Place	Seahorse Bandits	Time: 53.17 sec
College 3 rd Place	Archemedies	Time: 73.33 sec

For more information about the current and past competitions, please refer to the web site at <http://www.sandiego.edu/usdengr/WOW/index.html>.

What is Local Community?

One of the main objectives of the Walk On Water competition is to create an awareness of engineering and applied science in the local community. We define the local community as constituencies from San Diego County that include: University of San Diego, high schools, industry, small businesses, and the professional community. Walk On Water provides a value for each constituent and each constituent contributes to the success of the event.

USD Community

The Walk On Water competition encourages participation and support from all of the USD community: faculty, staff, and students. The 2002 competition received significant support from Engineering faculty, staff, and students. The School of Business Administration, Communications Department, and Facilities staff and administration also contributed to the success of the event.

Engineering

WOW has been a part of the USD engineering department for almost its entire existence. Thus it has become part of the department's culture. For the last several years, WOW has been directly incorporated into the Freshman Engineering course, ENGR5, as the primary design project. Although the event is overseen by a faculty member, the competition is organized, planned, and managed by upperclass engineering students. At the event, engineering students often bring friends and family which provides a venue for social interaction among engineering faculty, staff, and students.

Freshman Engineering

A freshman engineering student entering USD must enroll in ENGR5: Introduction to Engineering. The course includes students interested in Electrical, Industrial and Systems, and Mechanical Engineering. The catalog description for the course is

ENGR5 Introduction to Engineering (3 credits)

Introduction to the field of engineering. Exploration of problem solving using the engineering design process in lecture and laboratory projects. Introduction to engineering tools including spreadsheets and graphics. Intended for majors in engineering or those exploring careers in engineering.

The best way to learn about engineering design is to actually try it. At USD, we incorporate Walk On Water into ENGR5. The WOW experience provides engineering students an

opportunity to develop and implement a physical solution to a problem. This allows them to gain experience at applying the engineering design process to solve open-ended engineering problems. Such problems allow the students to be creative and require coordination between team members to develop team skills. The freshman engineering students use the engineering design process to develop an idea for WOW shoes, design the WOW shoes, create the WOW shoes, and test the WOW shoes in the final competition. The winning team, Hydrorunners is pictured in Figure 2.



Figure 2: USD engineering students racing across pool.

In Fall 2002, the WOW design project in ENGR5 began on the third week and culminated with the public competition held at the end of the semester. Teams of three or four persons are selected by the professor based on their schedules, student requests, and personality traits from Myers Brigg's exam. The students received a handout at the beginning of the semester outlining their schedule of events and deliverables. An overview of project tasks and approximate dates are listed in Table 3.

Table 3 Major Deliverables and due dates for WOW project in Engr 5

Task/Deliverable	Approximate Due Date
Sketches of shoes	Second week of Project
CAD Drawing of shoes	Fourth week of Project
Presentation to High School students	Fifth week of Project
Progress Reports	Weekly
Final Shoes to test at USD pool	One week prior to competition
WOW Competition	One week prior to final week
Final report	Final Week

The ENGR5 WOW design project schedule and outline can be seen in detail in Appendix B.

Service Learning, which involves matching a community need with academic goals, is becoming increasingly important in higher education [see for example 1 or 2] and USD has been nationally recognized for its leadership in this field. Over 70 faculty have integrated community service-learning into 130 courses at USD. The extension of service learning to engineering has been more recent [3, 4] but has been shown to be an effective pedagogy with particular application to design, communication, and teamwork which are also important for ABET accreditation under the Engineering Criteria 2000.[5]

To incorporate the service-learning component into our freshman engineering course in Fall 2002, the students were required to develop presentations to describe the engineering design process to high school students. The USD students also created in-class exercises to take the high school students through a small application of the engineering design process. Each student team visited a pre-engineering class at one of four local high schools.

Here is a brief overview of the goals, deliverables, and project parameters for the Walk On Water design project as given to the students.

Learning Goals

- To effectively communicate to a "real live" nontechnical audience
- To creatively design and implement an activity
- To effectively participate on a team
- To deepen students' understanding of engineering related topics

Deliverables

- Team Expectations Contract
- Powerpoint slides for presentation to high school students
- Materials for hands-on activity/contest with high school students
- Presentation in Engr 5 before going to the high school
- Peer review of presentation in Engr 5
- Presentation to high school students
- Evidence of mentoring of high school students (e.g. email)
- Documentation and Reflection - Discussion of your preparation, actual experience, and reflection on what you learned in this experience.
- Peer rating of team members

Project Parameters

- Presentation will cover topics such as "What is USD?", "Why major in engineering?" "What is the engineering design process?", and "What is Walk On Water (WOW)?"
- Project will be done in teams assigned by instructor
- Aimed at students in high school
- Educational and fun
- Presentation and activities should take about 45 minutes to complete

Junior/Senior Engineering

As engineering students enter the junior and senior years, they are looking for internships, projects, ways to apply concepts learned in prior courses, or other mechanisms for gaining some form of professional experience. Walk On Water provides an avenue for upper-class students to participate in event planning and management. The WOW committee consists of three

engineering students and one faculty advisor. The students are selected from the officers of the USD chapters of the IEEE, IIE, and SWE societies.

The 12th WOW competition was held at the end of the fall semester. However, the planning for the event began at the beginning of the fall semester. The WOW committee split tasks and responsibilities into three main areas: Event Operations, Public Relations, and Project Management. The faculty advisor acted as the Project Sponsor providing guidance and assistance throughout the entire semester. Each student was assigned one of the three areas with certain tasks and responsibilities. The responsibilities of Event Operations include determining the necessary materials and resources to make everything run smoothly the day of the event. The Public Relations responsibilities include contacting the local industry to request funding and donations and contacting local high schools and universities to encourage participation. The Project Manager is the overall organizer and coordinator of the event who checks that tasks are being completed, organizes finances, and serves as the point of contact for communication within committee. The students involved in the organization of the WOW event obtain hands-on experience to develop skills in a variety of areas including preparing status reports, planning, marketing, organization, project management, and communication.

Engineering Department Faculty and Staff

The USD Engineering department provides support in many ways. The faculty in the freshman engineering course, labs, and the Walk On Water faculty advisor coordinate tasks to ensure their timelines are in sync to meet the final competition deadline. Students in the freshmen course were required to test their shoes prior to the competition to ensure design revisions are incorporated into the final design. Fortunately, the Walk On Water faculty advisor was also one of the instructors for the freshman engineering course in Fall 2002. The staff were also instrumental in making the event a success. The Engineering administrative assistant assisted in distribution of mass mailings to the high schools and local industry using the central engineering database for the industry contacts which include many USD alumni. The ISE lab technician also provided assistance to the students in the design and construction of their shoes. The engineering manager helped with photography at the event.

High School Community

The USD engineering department promotes collaboration with high schools and Walk On Water is an event focused on creating and sustaining this partnership. It is an excellent way to create interest in engineering among high school students. This addresses a crucial need for more awareness of engineering in the community. ASEE President Jakubowski stated “if the United States does not start closing the gap in student achievement in science and mathematics, the country risks the danger of becoming disadvantaged.”.[6] San Diego has a large technology industry base with wireless telecommunications and biotechnology providing a large presence. The San Diego Science Alliance (SDSA), is a nonprofit consortium of businesses, institutions of research and higher education, and other organizations committed to foster K-12 science literacy and education in San Diego County. USD has worked with SDSA to promote the competition in the K-12 community by publicizing the event on their web site and at their sponsored science fairs.

USD Engineering faculty have met with members of the San Diego City Schools Pre-Engineering faculty to discuss participation with the Walk On Water competition. As discussed previously, USD engineering students gave presentations to high school students in Pre-Engineering classes to encourage participation at the WOW competitions. The high school

students were particularly excited by the hands-on activities that the college students did with them. One of the favorite activities was building boats out of aluminum foil and having a contest to see which could hold the most weight. Some High Schools use their Physics and Mathematics classes as a vessel for introducing engineering and the Walk On Water competition. Some teachers use extra credit as an incentive while others make it a requirement or assignment in class. A high school student team is displaying their finished shoes in Figure 3. At the event, the presence of teachers, students, and the many proud parents creates considerable excitement. Having competitors from high schools as well as colleges provides added incentive for each group. Over two hundred high school students in 2002 were impacted by the Walk On Water project either through visits to their high school by USD students or direct participation in the event. Such exposure to engineering and college students could have many benefits for enhancing the interest of these students in engineering and applied science.



Figure 3: High school students with their completed shoes.

Professional Community

The success of the Walk On Water event is enhanced by donations from industry sponsors which are primarily used to award prizes to the participants. In addition to funding, Walk On Water has led to other beneficial interactions with the local industry. In some years, teams from industry have participated in the contest. Since USD is a small private university, many businesses in the area are not aware of its engineering department. The dissemination of Walk On Water and department information improves awareness of USD. Offers for future collaborations and current job offerings and internships have resulted from contacts made with Walk On Water. The partnerships create a connection from industry to university to K-12 students with Walk On Water as the common theme.

The local media provides an excellent avenue to spread the news about engineering. Walk On Water spawns interest in a non-technical audience while still keeping the underlining theme of Engineering. The 2002 event received great coverage from television representatives from FOX, NBC, ABC, and KUSI, a local TV channel. Three news broadcasts contained varying coverage on the Walk On Water competition. They portrayed the event as fun for everyone in the family.

Summary

A Walk On Water (WOW) contest has been held annually for twelve years at the University of San Diego (USD). In this event, participants design, construct, and pilot their shoes across a 25-meter pool. WOW is organized by the engineering student societies at USD and sponsored by industry and businesses within the local community. The event promotes interest in engineering for several constituents in the local community. First-year engineering students use the WOW contest as the culmination of their design project for their introduction to engineering class. Upper class USD engineering students gain skills in project planning and execution. High school students also compete in the event. By designing and constructing their own shoes, they learn about engineering. In Fall 2002, the USD engineering freshmen visited local high schools to present how they applied the engineering design process to design Walk On Water shoes. This service-learning project has benefits for both the USD and high school students.

Appendix A: Walk On Water Competition Rules

The University of San Diego Walk-On-Water Competition is a design competition for self propelled buoyancy shoes. Original and innovative designs are encouraged. As such, minor modifications of items such as boats, surfboards, body boards, etc. are not within the spirit of the competition. The following rules govern the competition:

1. Each entry must consist of two separate and mirror image buoyancy shoes, not to exceed 8' in length, such that one person can operate and control the shoes using only his or her feet. External propulsion devices are prohibited. This is a human powered apparatus.
2. All materials are allowable; however, shoes designed from recyclable materials are encouraged. Acceptable recyclable items are defined as those items found in the "Recycling Guide" provided by Waste Management of San Diego for the City of San Diego Recycling Program.
3. Expenditures for each team shall be limited to \$100.00. Estimated value of donated materials shall be included in the total.
4. A slalom course must be traversed from one end of the pool to the other. The shoe pilot must maneuver around two floating "flags", placed at approximately 1/3 and 2/3 the length of the course.
5. The "shoe-pilot" will be required to maintain a vertical position above the shoes at all times.
6. No supports or secondary assist devices (poles, ropes, rods, etc.) may be used by the pilot to maintain the required vertical stance.
7. The shoes cannot in any way engage any part of the body above the knees.
8. The pilot will put the shoes on at the water's edge. A support team of up to six people may assist in the application of the shoes and in the transition from sitting to the officially sanctioned vertical position. Once vertical, no assistance may be offered until the pilot arrives at the far end of the swimming pool.
9. The starting line is either when the backs of the shoes are in contact with the starting edge of the pool or when the front of the shoes is 8' from the starting edge of the pool.
10. The competition is tentatively divided into the following categories:

High school students
College students
industry and other community participants
11. Each team will participate in a series of races within their division with the fastest crossing times used to determine the winning team of each category. Further guidelines concerning the advancement of teams will be presented on the day of the event.
12. All participants are required to fill out and complete an official entry form, which must be returned to Walk On Water, USD, Department of Engineering, 5998 Alcalá Park, San Diego, CA

92110 (FAX 260-2303) prior to 12:00 p.m. on Friday, November 30, 2002. The event will take place on Saturday, December 7, 2002 starting at 10:30 AM at the USD pool. industry participants and professional engineers must submit a twenty-five dollar entry fee along with their application form.

13. Safety guidelines will be provided to each entry. The guidelines must be strictly followed. Failure to comply with the safety guidelines may lead to disqualification. Lifeguards will be in the water at all times and will be available to assist "wet" shoe-pilots. A mechanism for quick release of the shoe pilot from the buoyancy shoes is mandatory.

14. Penalties for rule infractions include:

5 second penalty for every dollar over \$100 limit.

30 second penalty for every inch over 8'.

60 second penalty for safety violations.

60 second penalty for attaching buoyancy shoes together.

60 second penalty for not maneuvering around a flag.

60 second penalty for attachment above knees.

60 second penalty for secondary assist devices.

10 second penalty for touching shoe.

Disqualification for infraction of propulsion rule.

Disqualification for aid to shoe pilot while traversing the pool.

Disqualification for use of boats, surfboards, body boards, etc.

15. The rulings of the judges are final. There are no appeals.

Appendix B: Walk On Water Design Project Schedule and Outline

Walk On Water Schedule and Deliverables:

(Note that copies of all project deliverables should be kept in your Project Folder)

Week of September 30: Entire lab time for WOW

- Document how your team applied steps 1- 3 of the design process to this problem.
- A project schedule (Gantt chart) including assigning tasks to team members.
- Team Expectations Contract
- Status Report 1

Week of October 7: No lab time for WOW (CAD Lab 1)

- Document how your team applied steps 4-5 of the design process to this problem.
- Status Report 2

Week of October 14: Entire lab time for WOW (CAD Lab 2)

- Submit electronic and printed copy of PowerPoint slides for service-learning presentation to lab instructor at beginning of lab time
- Practice presentations to high school students (service-learning)
- Peer review of presentation
- DESIGN FREEZE: By the end of your lab time, you should have chosen your final design for your WOW shoes. Any subsequent changes must be approved by your lecture using a Change Request.
- Status Report 3

Week of October 21: No Official lab

- Monday October 21: Submit an electronic copy of your presentation to Dr. Lord (slord@sandiego.edu) by 2:00 pm. We will print out color viewgraphs for you and give them to the instructor who will accompany your team to the high school.
- Presentations to high school students (service-learning)
- Status Report 4

Week of October 28: Half of lab time for WOW (Half for EE Lab 1)

- Status Report 5

Week of November 4: Half of lab time for WOW (Half for ISE Lab 1)

- Status Report 6

Week of November 11: Half of lab time for WOW (Half for EE Lab 2)

- Status Report 7

Week of November 18: Half of lab time for WOW (Half for ISE Lab2)

- Finish construction in preparation for test at pool.
- Sign up for time to test shoes at the pool next week.
- Status Report 8

Week of November 25: No Thursday lab. Thanksgiving

- Tuesday November 26 or Wednesday November 27 (lab times): Test shoes at the pool!

Week of December 2: Entire lab time for WOW

- Improvements to shoe design based upon pool testing.
- Status Report 9

Saturday, December 7:

- 9am - 2 pm: Engr 5 Walk On Water Competition at the USD Pool (all 3 lab sections)

Week of December 9: Entire lab time for WOW

- Complete team evaluations (Team Developer)
- Post web pages for your design project. Page should include a report how your team arrived at your design including how you followed the engineering design process. Also include pictures of your shoes, data from the competition (testing), and suggestions for improvements as a result of your testing.
- Submit final report
- Submit project folder

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