Physics & Engineering Service Learning Resource Sheet

Definition and examples of service learning by Project Ignition: "Service-learning is education in action."
--Holding a mock crash on campus is **service**.
--Sitting in a science classroom analyzing velocity, the laws of physics including bodies in motion and bodies at rest, is **learning**.
--Taking lessons learned in a physics course regarding laws of motion, inertia, velocity, and energy, and using this knowledge to predict and understand the danger of auto accidents is **service-learning**.
--Exploring theories through a mock crash and sharing what is now understood about impact at varying speeds is **service-learning**.
--Sharing that information so others understand laws of physics and the dangers of auto accidents is **service-learning**.

Table of Contents:

A) General Info

1) Intro to Course-Bases Service-Learning in Physics and Engineering
by CU-Boulder College of Engineering and Applied Science
http://engineering.colorado.edu/downloads/CourseBasedSL.pdf
This article contains many successful examples of service learning engineering projects at the CU-Boulder College of Engineering and a variety of other institutions. It also defines service-learning from an engineering perspective.

2) Accreditation Board for Engineering and Technology. (1998). *Engineering Criteria 2000*.
**Available at the ABET website at <http://www.abet.org>.
Engineering Criteria 2000… formalized the incorporation of "softer" skills to complement the traditional engineering knowledge and skills in preparing graduates for the 21st century. … The softer skills identified in ABETS's Criterion 3, "Program Outcomes and Assessment," include "an ability to function on multidisciplinary teams," "an understanding of professional and ethical responsibility," "an ability to communicate effectively," "the broad education necessary to understand the impact of engineering solutions in a global and societal context," a recognition of the need for , and an ability to engage in lifelong learning," and " a knowledge of contemporary issues." Service learning can be an effective pedagogy to meet these program outcomes. Engineering faculty members interested in integrating service-learning into their course would keep these students outcomes in mind as they prepare learning objectives, course materials, and assessment instruments" (Tsang, 2007).

3) Assessment of outcomes of Physics service-learning programs @ Weber State University
http://programs.weber.edu/assessment/participants/results_of_assessment/physics20062007results.htm
** focus on student's perception of the impact of planetary program service learning.

4) American Institute of Physics: Public Policy Center
AIP's Public Policy Center programs keep you in touch with information that matters on science policy and legislation.
http://www.aip.org/gov/

5) Modeling Instruction Program
http://modeling.asu.edu/

Modeling instruction in the sciences at the University level "emphasizes active learning through a wide variety of short experiments (often computer-based), pencil-and paper exercises and discussion questions" (according to Dr. David Hestenes).

Though modeling instruction is not the same as service learning instruction; service learning instruction is similar in that it often incorporates a problem or project-based applied learning techniques.

Please see the page specifically on re-modeling University Physics:
http://modeling.asu.edu/rup_workshop/

Any Questions? Prof. Kathy Harper (Visiting Assistant Physics Professor;harperk@denison.edu) directs the Ohio workshops in Modeling Instruction. Please contact her with questions about up-coming workshops. Inquisitive visitors are always welcome.

6) Research Based Instructional Strategies for Physics
http://homepages.wmich.edu/~chenders/rbis.htm
Dr. Charles Henderson (Associate Professor of Physics @ Western Michigan University)
Alternative, experiential and problem based methods of physics instruction. May of these methods could be expanded into a service learning if they are given a clear societal goal.

The list below includes instructional strategies for introductory quantitative (i.e., algebra- and calculus-based) physics courses that are based on research into teaching and learning. Most have also been shown to be significantly more effective in promoting student learning than traditional physics instruction.

B) Syllabi and Model Programs

1) Physics Service Learning @ Purdue

A) Cosmic Ray Detector S.L.
http://www.physics.purdue.edu/academic_programs/courses/phys290Mmajors/

Purdue has been involved in the QuarkNet program for several years and has recently acquired cosmic ray detector hardware from Fermilab that regional high school teachers helped assemble and operate during the summer of 2006. One goal of the QuarkNet program is to have several of these detectors, or ones that are similar, located in high schools across the country. . . . Physics 290M . . . trains undergraduates in the set up and use of this equipment and in the development of demonstrations and activities based on the goals of the QuarkNet

program that fit in with the Indiana high school physics curriculum. . . . [T]hese students can provide the expertise needed to work with the high school teachers.
**QuarkNet Center @ Purdue: http://www.physics.purdue.edu/outreach/quarknet/

B) Cosmology S.L.
http://www.servicelearning.org/etrcncs-link/?popup_id=1404

This course is designed for students with an interest in helping develop curriculum related to the national science standard: The Physical World—The Universe. The project is being developed in response to a grant received by Professor Laura Cayon, continuing lecturer for Intermediate Astronomy and Cosmology. The goal is to include science and science education majors interested in applying the Understanding by Design and 5E Learning Models to develop curriculum that can be used in high school classrooms.

2) Engineering Projects in Community Service (EPICS)
https://engineering.purdue.edu/EPICSNational/About/Overview
"EPICS" stands for Engineering Projects in Community Service. In the program, teams of undergraduates earn academic credit with multiyear, multidisciplinary projects that solve engineering and technology-based problems with community service and education organizations. This partnership provides many benefits to the students and the community alike. For example, EPICS teams have developed projects ranging from homelessness prevention to environmental protection to creating toys for children with disabilities.

A) EPICS @ Purdue University
http://epics.ecn.purdue.edu/about/overview.php
On February 23, 2005, the founders of the EPICS program at Purdue University were awarded one of the engineering profession's highest honors, the Bernard M. Gordon Prize for Innovation in Engineering Technology Education.

EPICS is a unique program in which teams of undergraduates are designing, building, and deploying real systems to solve engineering-based problems for local community service and education organizations. EPICS was founded at Purdue University in Fall 1995.

B) EPICS at Worcester Polytechnic Institute
http://www.wpi.edu/Academics/EPICS/
Welcome to the WPI site for EPICS - Engineering Projects in Community Service. WPI is in its second year as part of this nationally recognized program. Our focus at WPI is on Accessibility and Assistive Technology.

3) Foster Family Center for Engineering Service Learning @ U. California
Summary of the Engineering Service Learning projects Carried out by each team in the course:
https://eng.ucmerced.edu/slp/portal/teamsJournals

In the 2007-2008 academic year, approximately 120 University of California Merced School of Engineering students are participating on 10 multidisciplinary teams. Each team of 8 to 10 students includes freshmen, sophomores, juniors, and seniors, and each team has a multi-year partnership with a community service or education organization. Projects are in four broad areas: human services, access and abilities, education and outreach, and the environment.

4) Duke's Pratt School of Engineering Service Learning Opportunities
http://www.pratt.duke.edu/outreach-service-learning

*Site includes great inter-departmental engineering course descriptions and in-depth web-pages about each of Duke's outreach programs teaching science and engineering to K-12 children/youth.

*Research oriented opportunities allow undergraduates from colleges and universities across the nation to spend the summer researching at Duke.

*Outreach programs offer an opportunity for Duke students interested in participating in K-12 outreach and in engineering and science education to gain hands-on mentoring and teaching experience with local K-12th grade students.

5) Science, Technology, Engineering, and Mathematics (STEM) Education Coalition
http://www.stemedcoalition.org
"The Science, Technology, Engineering, and Mathematics (STEM) Education Coalition works to support STEM programs for teachers and students at the U. S. Department of Education, the National Science Foundation, and other agencies that offer STEM related programs.
The STEM Education Coalition is composed of advocates from over 600 diverse groups representing all sectors of the technological workforce – from knowledge workers, to educators, to scientists, engineers, and technicians."

One of the main goals to STEM is to support partnerships that will support engaging and effective education of all people in Science, Technology, Engineering, and Math: "Support new and innovative initiatives that encourage partnerships between state and local educators, colleges, universities, museums, science centers and the business, science, and technology communities that will improve STEM education."

(The Coalition is co-chaired by the American Chemical Society and the National Science Teachers Association. Meetings are held monthly at the American Chemical Society, 1155 16th Street, NW, Washington, DC.)

***Also see a Fact Sheet that summarizes all of the STEM related sites:
<http://www.servicelearning.org/instant_info/fact_sheets/he_facts/stem/>

6) **ProCEED (Program for Community Engagement in Engineering Design)**—University of Michigan
http://www.engin.umich.edu/soc/pts/ProCEED/
ProCEED is a student organized program that brings together community based projects with engineering students. Through design courses, small groups of 3 to 5 engineering students work closely with community organizations and faculty on individual projects and take them from design through implementation. "As a result, community service organizations are provided with alternatives for solving important technical problems."

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7) Engineers Without Borders - USA
http://www.ewb-usa.org/

EWB-USA is a non-profit humanitarian organization established to partner with developing communities worldwide in order to improve their quality of life. This partnership involves the implementation of sustainable engineering projects, while involving and training internationally responsible
engineers and engineering students.
**Example college branch of Engineers Without Borers at University of Colorado at Bolder:
http://www.ewbcu.org/
**Example of successful student research that comes from EWB:
http://www.lafayette.edu/news.php/view/10461/

8) Community Outreach and Service Learning Activities @ U. Penn. School of Engineering and Applied Science (SEAS)
http://www.seas.upenn.edu/under/studenta_slo.html
Including Engineers Without Borders Program, Global Bio-Medical Service Program, a Computer outreach program, InnoWorks middles school science and Tech outreach, and Engineering K-12 outreach.

9) Engineering and Community Engagement at Penn State University
Humanitarian Engineering challenges students and faculty from **all academic disciplines** to apply their training to assist and empower underserved individuals and communities in addressing engineering-related problems that directly impact their lives.
http://www.engr.psu.edu/ece/index.htm

10) Klein Institute for Undergraduate Engineering Life
http://viterbi.usc.edu/students/undergrad/kiuel/service-learning-globalization/

11) Engineering for Developing Communities (EDC) at University of Colorado at Boulder
http://www.edc-cu.org/
The Engineering for Developing Communities (EDC) program educates globally responsible engineering students and professionals who can offer sustainable and appropriate solutions to the endemic problems faced by developing communities worldwide.

12) Office of Engineering and Public Service @ Stanford University
http://och.stanford.edu/
Based in the School of Engineering, the Office of Engineering and Public Service (OEPS) supports the efforts of Stanford engineering faculty and students to engage in public service with the local and global community.

13) The Fu Foundation School of Engineering & Applied Science @ Columbia University
http://www.engineering.columbia.edu/overview-pages/community/index.html
"Columbia Engineering puts the creative minds of every first-year student to the task of finding ways to solve or ameliorate these real-world problems. From designing and building a wheelchair swing for a playground to constructing a greenhouse for a high school, our students experience the satisfaction of helping others while learning the basics of design, collaboration, communication, problem solving and project management."

C) Individual Physics S.L. Courses

1) Campus Compact Physics Syllabi
http://www.compact.org/syllabi/
**Under "discipline," See "physics" and "engineering"
Physics examples include a "Solar Powered Vehicle Project" and an environmental physics project.

2) Service Learning Courses in Physics and Engineering @ Century College
http://centuryservicelearning.project.mnscu.edu/index.asp?Type=B_BASIC&SEC={869871AA-2CEE-45D7-95B7-A02CFEB43FC1}&DE={65C19B33-0507-422C-9ED3-0494B4B14CC7}

3) Environmental Physics Service Learning @ Clarion University
**Includes Appropedia pages about each student's service learning report.
http://www.appropedia.org/Portal:Service_learning

4) Medical Physics Course @ Carleton College
http://apps.carleton.edu/collab/civic/courses/past/commonlyoffered/MedicalPhysics/

5) Intro to Physics Pedagogy
http://tulane.edu/cps/students/upload/Fall-08-Courses.pdf
The objective of this course is to introduce Tulane students, specifically science majors, who have experience in the field of physics (at least a full year of introductory college physics) to the art of teaching science courses while providing scientific support and added instruction for local K-12 teachers and students. The Tulane students in this class will learn the pedagogy of physics instruction.

6) The Energy Retrofit of a Building: A Journey through Bloom's Learning Domains
By Morgenstern, M., Meyer, S., Whitten, B., and Reuer, M. @ Colorado College.
http://learningcenter.nsta.org/product_detail.aspx?id=10.2505/4/jcst08_037_05_16
The energy retrofit of a building is used as a service-learning research project to teach physics and chemistry in a variety of courses. In introductory courses for non-science majors, the project helps students appreciate the scientific method and quantitative reasoning. Within the physical-chemistry course, students see that the abstract science of thermodynamics has very real applications to life. The energy retrofit project successfully teaches inquiry-based science and effectively takes students through all of Bloom's learning domains: cognitive, affective, and psychomotor. The most dramatic impact on students is in the affective domain as indicated by student actions following the conclusion of the project and the constant demand for the project offering.

D) Undergraduate S.L. w/ K-12

1) InnoWorks
http://www.innoworks.org/newinno/
InnoWorks is a non-profit organization founded, developed, and conducted by volunteer college students, and is devoted to designing and implementing innovative programs guided by the latest neuroscience-based educational methodologies to stimulate interest in science, technology, and engineering among middle school students from disadvantaged backgrounds, with particular emphasis placed on targeting underrepresented minorities and females. Penn InnoWorks targets middle school students from three areas in the City of Philadelphia area - West, North and Chinatown. Penn InnoWorks will also provide bi-monthly scientific demonstrations at local middle schools.

2) Vanderbilt Student Volunteers for Science (VSVS)
http://studentorgs.vanderbilt.edu/vsvs/New%20VSVS%20Site/lessons.htm
"VSVS is a service organization composed of undergraduate, graduate, and medical students who are committed to bringing inquiry-based, hands-on science lessons to middle-school students." This Program began in 1994 and has grown from serving 8 classes per semester to 121 classes per semester. **Site includes Lessons for over 50 chemistry, physics, and biology/environmental activities to do with 5th and 6th graders. "Lessons include: Cryogenics, iron in cereal, polymers, rates of chemical reactions, light, UV light, and dry ice."

3) Joseph A. Gardella's K-16 Interdisciplinary Science and Engineering Partnership
http://www.acsu.buffalo.edu/~gardella/k16.htm
Professor Gardella is Professor of Chemistry at SUNY Buffalo. His research interests are in quantitative analysis and surface chemistry, broadly applied to the study of environmental effects at polymer surfaces and tissue engineering with synthetic biomaterials, and have resulted in some 220 publications and a similar number of invited talks worldwide.

4) Penn Engineering Outreach Project for Livelihood and Education (PEOPLE)
PEOPLE is an organization designed to unite the Penn Engineering community in order to raise awareness of engineering as a possible career path for students in greater Philadelphia. Students work with engineering faculty, graduate students and staff to organize interactive presentations about all types of engineering for elementary through high school students. PEOPLE also serves the humanitarian community through fundraising efforts for SEAS community outreach projects and relief organizations.

5) Physics & Engineering Activities with Children and Youth @ Northern Illinois University

A) Get Wise Clubs and Summer Camp @ Northern Illinois University
http://www.niu.edu/getwise/index.shtml
"Engineering clubs, an extra-curricular activity, exist in six middle schools in Aurora District 129 and Rockford District 205. Funded by the E.E. Carter Foundation and led by NIU faculty, staff, and students, these clubs motivate young people to prepare for college and to consider careers in engineering. A popular summer camp at NIU provides in-depth, hands-on experiences with engineering."

B) Girl Scouts – Enhancing Engineering Pathways
http://www.niu.edu/eep/about/index.shtml
"This Saturday program for 48 middle school and high school girls provides hands-on engineering activities and information on engineering careers. Located at NIU Naperville, the program is funded Motorola and led by NIU engineering faculty and NIU student mentors."

C) STEM Physics Activities
http://www.outreach.niu.edu/stem/index.shtml
--Haunted Physics Lab: Spooky Science Saturday
http://www.niu.edu/PubAffairs/RELEASES/2008/oct/spooky.shtml

D) Cosmic Ray Detectors
http://www.niu.edu/PubAffairs/RELEASES/2008/june/quarknet.shtml
"A group of high school students and teachers spent a week at the QuarkNet center jointly run by NIU and Argonne National Laboratory. Detecting and measuring cosmic rays was part of developing cutting-edge research into high school science curriculum."

E) Researching Mars with High School Students @ N. Illinois U.
http://www.niu.edu/PubAffairs/RELEASES/2008/jan/mars.shtml

6) Physics and Astronomy Outreach @ University of Minnesota
http://www.physics.umn.edu/outreach/

A)Physics Force is a group of Physics and Astronomy professors and high school teachers who put on a physics circus of dynamic and entertaining demonstrations for area school children and the general public.
http://www.physics.umn.edu/outreach/pforce/index.html

B) Research Opportunities for Undergraduates (REU) is a ten-week summer research program for physics undergraduates open to students from around the country as well as Minnesota.

C) Research Experience for Teachers (RET) is a program designed to help high school teachers participate in cutting edge physics with our research groups.

D) QuarkNet is a five-day workshop for physical science teachers designed to help bring the world of particle physics into high schools.

E) PACES is a program designed to promote science education in under-represented communities in a format where parents model learning for their children. This format will allow young children (pre-k through 3rd grade) to see their own parent valuing an educational experience and finding that science is fun and exciting.

F) PhysTEC Physics Teacher Education Coalition is a program designed to enhance recruitment of college students to become high school physics teachers and to improve their training and early career mentoring.

G) Soudan Mine Tour The Soudan State Park Underground Mine tour includes a stop at the MINOS far detector.

7) Engineering Outreach Corps at University of Colorado Boulder
http://itll.colorado.edu/GEEN4100/
In this service-learning technical elective, students use engineering as a vehicle for the advancement of K-12 math and science. Students teach hands-on engineering in elementary or middle school classrooms, develop a lesson for the TeachEngineering digital library and explore relevant literature.

II. Partners/Grant-making Organizations

A) Ohio Resources

1) Alford Center for Service Learning at Denison University
http://www.denison.edu/campuslife/servicelearning/

2) Ohio Campus Compact: Supports Academic Service Learning in all disciplines.
http://www.ohiocampuscompact.org/

B) National Resources

1) American Society for Engineering Education
Founded in 1893, the American Society for Engineering Education is a nonprofit organization of individuals and institutions committed to furthering education in engineering and engineering technology.
http://www.asee.org/about/index.cfm

2) Science, Technology, Engineering, and Mathematics (STEM) Education Coalition
http://www.stemedcoalition.org
"The Science, Technology, Engineering, and Mathematics (STEM) Education Coalition works to support STEM programs for teachers and students at the U. S. Department of Education, the National Science Foundation, and other agencies that offer STEM related programs.

3) Merk/AAAS Undergraduate Science Research Program (USRP)
AAAS: Advancing Science, Serving Society
http://php.aaas.org/programs/education/merck/
"Since 1994 the Merck/AAAS Undergraduate Science Research Program (USRP) has awarded grants to support undergraduate interdisciplinary research in the sciences."
"The Program's support is provided by The Merck Company Foundation, which will have contributed over $11,500,000 when the grant term ends in 2011."

4) National Science Foundation
http://www.nsf.gov/funding/

III. Recommended Books and Journal Articles

BEST RESOURCES:

International Journal for Service Learning in Engineering (IJSLE)
http://www.engr.psu.edu/IJSLE/index.htm
IJSLE is a peer-reviewed electronic journal offered free, semi-annually, over the World Wide Web. The Journal welcomes manuscripts based on original work of students and researchers with a specific focus or implication for service learning in engineering, engineering entrepreneurship in service, or related service learning pedagogy.

Guerra, D.V. (2005) Service-learning in physics: The consultant model. *Journal of Higher Education Outreach and Engagement*, 10 (3), 143-152.
Problem solving, both theoretical and practical, is the underlying skill developed through the physics curriculum. Service-learning has been integrated into engineering curricula, but programs proposed for that field often do not fit well into the structure of physics departments.

A consultant-based approach to service-learning offers physics students the opportunity to apply their problem-solving skills for the benefit of others. As service-learning consultants, physics students provide technical and managerial support to groups that are participating in technically oriented educational enrichment activities.

<http://servicelearning.org/library/lib_cat/index.php?indexAll&library_id=7385&search_term=Service-Learning%20in%20Physics:%20The%20Consultant%20Model%20(site:www.servicelearning.org%20|%20site:servicelearning.org%20|%20site:www.Servicelearning.org%20|%20site:Servicelearning.org%20)>

Tsang, E. (Ed.). (2000). *Projects that matter: Concepts and models for service learning in engineering*, AAHE, Washington DC.

OTHER GREAT RESOURCES:

American Society for Engineering Education. (1994). *Engineering education for a changing world*. The Engineering Deans Council & the Corporate Roundtable of the American Society for Engineering Education .
This joint report cites the end of the Cold War, global economy, changing demographics, and information technology as driving forces to reform undergraduate engineering education for the 21st century. The report recommends that engineering colleges accelerate the integration of programs to help engineering undergraduates develop "softer" to complement traditional topics in the engineering curriculum" (Tsang , 2007).
**Available on the ASEE website at http://www.asee.org.

Duffy, J.J. (1998). *Using service-learning to promote solar learning*. Annual National Solar Conference Proceedings of the American Solar Energy Society.
Provides an example of a service-learning experience used to teach about solar design in an engineering course.

Finkelstein, N.D. (2004). *Teaching and learning physics: A model for coordinating physics instruction, outreach, and research*. University of Colorado Boulder: Department of Physics.
"This paper describes the development of a new university physics course designed to integrate physics, education, research, and community partnerships. The coordinated system of activities links the new course to local community efforts in pre-college education, university education, university outreach, and research on teaching and learning. As documented both by gains on conceptual surveys and by qualitative analyses of field-notes and audiotapes of class, the course facilitates student learning of physics, as well as student mastery of theories and practices of teaching and learning physics."
<http://www.colorado.edu/physics/EducationIssues/papers/JoSoTL_Finkelstein.pdf>

Jarvis, P.D., Humble, J.E., Watson, R.D., Newman, I.A., Chelkowska, E, & Stack, S. (2000). *Evaluation of improved outcomes in physics service courses*. Proceedings of evaluating the new teaching technologies workshop, Uniserve Connections.

Lima, M. and Oakes, W. (2005) *Service learning: Engineering in your community*. Great Lakes Press.

Martin, J.W., & Haque, M.E. (2001). *Service learning: Engineering, construction science and the experiential curriculum*. Paper presented at the ASEE/IEEE Frontiers in Education Conference. This paper examines the status of service-learning in the construction science curriculum at Texas A&M University and proposes a service-learning project for students in the construction science curriculum.
<http://www.fie-conference.org/fie2001/papers/1028.pdf>

Nagchaudhuri, A., & Eydgahi, A. *Infusing service-learning in science and engineering and its impact on pedagogy and retention*. Princess Anne, MD: University of Maryland Eastern Shore.
The acronym SLOPE - "Service Learning Opportunities in Physics and Engineering" has provided an umbrella for infusing "Service-Learning" seamlessly into a recently articulated collaborative engineering program between UMES (University of Maryland Eastern Shore) a Historically Black College and University (HBCU) and SSU (Salisbury State University). Since its inception in the fall of 1998, the SLOPE program has helped identify and serve specific needs in the Eastern Shore Community by way of faculty supervised student projects.
<http://facstaffwebs.umes.edu/anagchaudhuri/HBCU1.HTM>

Oakes, W., et al. (2002). *Service-learning in engineering*. Paper presented by at the ASEE/IEEE Frontiers in Education Conference.
The paper provides an overview of a panel discussion on several successful models of service-learning in engineering education, benefits and outcomes of service-learning in engineering, and how service-learning fits within the context of undergraduate engineering education.
<http://epics.ecn.purdue.edu/about/papers/FIE_2002_service_learning.pdf>

Pearce, J. M. (2007). Teaching physics using appropriate technology projects. *The Physics Teacher*, 45(3), 164-167.
"Appropriate technologies able to be easily and economically constructed from readily available materials by local craftspeople have a central role in the alleviation of poverty in the developing world. However, research and development of these technologies are generally apportioned relatively modest support by the developed world's institutions, in part because the operation of many of these appropriate technologies is dependent on relatively well-understood science accessible even to introductory college physics students. This paper describes a project-based assignment used to capitalize on this opportunity to motivate students to learn physics by offering them a chance to make concrete contributions to the optimization of appropriate technologies for sustainable development."
http://scitation.aip.org/getabs/servlet/GetabsServlet?prog=normal&id=PHTEAH000045000003000164000001&idtype=cvips&gifs=yes

Piket-May, M. & Avery, J. (2001). Service learning first year design retention results. *Proceedings from Frontiers in Education Conference of the Institute of Electrical and Electronics Engineers*, v 2, p F3C/19-F3C/22.
"The College of Engineering and Applied Science at the University of Colorado at Boulder has operated a first-year engineering design course for six years now. The course is required in some curricula in the college, recommended in others, and accepted for credit by all departments. The

course stresses teamwork and design, culminating in a 7-9 week team design project. The projects vary with instructor, and usually each of the 4-5 teams per class works on a different project. This paper will first discuss the service learning sections of the course. The paper will then discuss the results of statistical analysis regarding retention and major selection between students who took the first year design course compared with those who did not. We now have six years of experience with the course so we will present data from entry to graduation for the students who entered in the first two years. In addition we have included preliminary statistics to study the effect of using service learning projects as a part of the first year design experience. We will encourage the audience to make this an interactive oral presentation, and work with participants to help identify service learning possibilities in their environment."

Pinnell, M., Blust, R., Brahler, J., & Stevens, M. (2008, Oct.). *Can service-learning in K-12 math and science classes affect a student's perception of engineering and their career interests?* (38th ASEE). Proceedings from the IEEE Frontiers in Education Conference, Saratoga Springs, NY.

Pritchard, M.S. (1999, March). *Service-learning and engineering ethics*. Paper presented by at the International Conference on Ethics in Engineering and Computer Science, Case Western Reserve University, Cleveland, Ohio.
http://www.onlineethics.org/cms/12062.aspx
"Discusses accreditation requirements for engineering programs, including helping students acquire "an understanding of the ethical characteristics of the engineering profession and practice," and provides a context for linking a service-learning experience to the curriculum to meet current accreditation requirements" (from Learn & Serve America's NSLC Engineering and Service-Learning Fact Sheet).

Saha, S. (2003). Service learning experience: Design of devices to aid children with disabilities. *Proceedings at the annual International Conference of the IEEE Engineering in Medicine and Biology*, Institute of Electrical and Electronics Engineers, Inc. v 4, p 3469-3470.
"Service learning programs in Engineering Education are discussed in terms of how they meet educational and cognitive goals for students. These programs play a critical role in teaching students to conduct experiments, design a system, function on multi-disciplinary teams and broaden education necessary to understand the impact of engineering. (from Learn & Serve America's NSLC Engineering and Service-Learning Fact Sheet)."

Service-Learning in Engineering: A Resource Guidebook, Developed by William Oakes
http://www.compact.org/publications/downloads/SL_and_Engineering-WEB.pdf
This resource guidebook, published by Campus Compact, provides an introduction to service-learning in engineering education, and program models from the EPICS (Engineering Programs in Community Service) program. Sample syllabi, course descriptions, forms and evaluation tools are provided. The guidebook can be downloaded directly from the Campus Compact web site.

Ukens , L., Hein, W. W., Johnson, P. A., Layman, J. W. (2004). Powerful ideas in physical science. *Journal of College Science Teaching*.
Powerful Ideas in Physical Science (PIPS) is a pre-service curriculum that provides modules for physical science courses designed for elementary education majors. Because the courses are built on the learning cycle approach, students develop concepts from activities and then apply

this conceptual knowledge. A summative evaluation done by Horizon Research, Inc. looked at the implementation and institutionalization of PIPS. <http://learningcenter.nsta.org/product_detail.aspx?id=10.2505/4/jcst04_033_07_38>

Zitomer, D.H., Johnson, P. (2003). *International service learning in environmental engineering world water and environmental resources congress*, American Society of Civil Engineers, 1917-1924. Published Abstract: Educational experiences that relate social and technical subjects offer students the opportunity to reflect on the broad significance of environmental engineering. Although it is often difficult to join social and technical subjects in a classroom setting, the link may be more easily made through service learning projects in which students use classroom knowledge and hands-on service to implement solutions for a given community. As an example, a senior civil and environmental engineering student project to design a sanitary sewer for an in-need community in San Benito, Guatemala, is described. Students traveled to the site, performed a land survey, and gathered other design data while also learning about Guatemalan history and culture. The students apply knowledge from required courses and the humanities/social science class "Latin American Health, Infrastructure, and Environment" to arrive at an appropriate final design. The international design project is described as an approach to increase student appreciation of the engineering profession and support educational goals, such as increased understanding of engineering solutions in a societal context, and the ability to function on a multidisciplinary team.

IV. Future Social Justice Opportunities for Physics/Engineering Students:

1) Engineers Without Borders - USA
http://www.ewb-usa.org/
EWB-USA is a non-profit humanitarian organization established to partner with developing communities worldwide in order to improve their quality of life. This partnership involves the implementation of sustainable engineering projects, while involving and training internationally responsible
engineers and engineering students.
**Example college branch of Engineers Without Borders at University of Colorado at Boulder:
http://www.ewbcu.org/