# AC 2008-1521: ENGINEERING FACULTY ATTITUDES TOWARD SERVICE-LEARNING

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Engineering Faculty Attitudes toward Service-Learning


## Abstract

SLICE is a multi-year initiative at the University of Massachusetts Lowell (UML) that is designed to embed service-learning opportunities for students throughout the undergraduate curriculum in the College of Engineering, with the ultimate goal that each student would have at least one course every semester with a service-learning project. Since it began in 2004, thirty-seven full-time faculty members in the engineering college at UML have tried service-learning (S-L) in at least one of their courses over the last three years, out of an average of 70 faculty members who taught undergraduate courses. In 2003 there was one full-time faculty member engaged in S-L. As a result of SLICE, a total of 52 courses (35 of them required core undergraduate courses) taken by engineering students have had S-L integrated into them, with a total of over 700 student-courses each semester. This group of faculty members is perhaps the largest associated with a single engineering college using S-L. They were recruited in part by the principle of "start small rather than not at all." The program has a combination of grass-roots initiative and administration support.

As part an ongoing evaluation, in depth interviews with fourteen faculty members who had tried SLICE were undertaken by experienced assessors of S-L projects from an outside university. All of the faculty members interviewed indicated that they saw SLICE as a valuable element in the engineering program, based on their own experience. All saw it as adding important dimensions to the learning experience that were not available through traditional classroom exercises, and all believed that it was consistent with efforts to broaden students' understanding of both engineering and their role in society. Finally, though all noted challenges with regard to implementation, they also indicated that the integration of S-L was worth the extra effort that it often involved. One faculty member even said, "It will change the way we think about engineering. It adds an additional dimension." One area in which the SLICE experience itself can be strengthened is through increased community partner involvement and exploration of ways to help students (and faculty) make the connection between SLICE projects and the broad social context. Presently most faculty and students seem to view the community agencies being served in a typical engineer-client relationship, which does have limitations compared to viewing the community agencies as equal partners and as capable of teaching the students at least about the social impact of their technical projects.

Annual surveys of the engineering faculty members (averaging approximately 40 responses or about two-thirds of the faculty) also found broad support for S-L, with nearly 70% agreeing in principle to the idea of integration of service and academic coursework by 2006. Faculty responding to the survey ranked time as the biggest barrier to trying S-L, their own time, course time, and student time. One of program stated goals, however, is to not add extra work for the students but to replace existing "paper" projects with S-L projects.

## Introduction

"It [service-learning] will change the way we think about engineering. It adds an additional dimension." (Anonymous faculty member)

SLICE is a multi-year NSF funded initiative at the University of Massachusetts Lowell (UML) that is designed to embed service-learning opportunities for students throughout the undergraduate curriculum in the College of Engineering so that every student would have at least one courses every semester with S-L. The related goals of the project so far have been to recruit enough faculty to integrate S-L into at least one of their courses, to develop partnerships with community groups to generate meaningful projects matching with the courses, to recruit and retain underrepresented groups in engineering, to assess the impacts of the program on faculty, students, community, and the institution. This paper addresses the impacts on faculty.

SLICE defines service-learning as a hands-on learning approach in which students achieve academic objectives in a credit-bearing course by meeting real community needs. In engineering the students become better professionals and better citizens while the community benefits. There are many other definitions in the literature, for example, service-learning is the integration of academic subject matter with service to the community in credit-bearing courses, with key elements including reciprocity, reflection, coaching, and community voice in projects (Jacoby, 1996)[1]. Service-learning (S-L) has been shown to be effective in a large number of cognitive and affective measures, including critical thinking and tolerance for diversity, and leads to better knowledge of course subject matter in such classic studies as Eyler and Giles (1999)[2] and Astin et al. (2000)[3].

Service-learning in engineering has been a little slower to take hold. There were just a few faculty, courses, and institutions using S-L a decade ago (Tsang, 2000)[4]. S-L in engineering has been gaining more acceptance as times goes on. Oakes[5], Coyle et al.[6], and Lima and Oakes[7] discuss S-L in engineering in general and the EPICS model in particular.

The approach of SLICE to integrate S-L into existing core courses rather than adding courses (as in the EPICS approach) is common to the approach used in most other disciplines. It appears to have begun in engineering by Duffy (2000)[8] in eleven different courses. More details about SLICE are discussed in prior papers[9,10,11,12].

The effect of S-L on faculty was identified by Giles and Eyler[13] as an area needing more research. Holland[14] discusses factors influencing faculty involvement in public service. Hesser[15] surveyed 48 faculty in a variety of disciplines and institutions and found a shift in attitude from skeptical to accepting of S-L. Bauer et al.[16] compared faculty and student attitudes toward community service before "intervention" of a program in humanitarian engineering at Colorado School of Mines and found more positive attitudes in faculty compared to students. It appears that there is no other study of such a large number of faculty in engineering who have actually tried service-learning at least once.

Critical to the success of service-learning in general and SLICE in particular is, of course, the adoption by members of the faculty. Perhaps the most important outcome of the SLICE project so far is that almost half of the faculty have tried service-learning since the project began. In 2003-04, only one full-time faculty member and five part-time faculty members were using service-learning in their courses. By the following year (2004-05), 25 faculty members implemented service-learning into at least one of their courses, and in 2005-06, 32 of 68 full time faculty members tried service-learning. In 2005-06 over the two semesters, an average of 700 undergraduate students participated in service-learning projects in 52 courses, some with required projects and others elective. In 2006-07, 26 tenure-track college full-time faculty members out of 78 (31 including part-timers) had service-learning projects in their courses, several had more than one course. Thirty-seven full-time engineering faculty members have tried service-learning at least once so far, just about half the faculty.

Faculty were recruited via personal contacts and through workshops offered in the summer and fall of 2004. All engineering faculty were invited. The summer workshop was an all day affair with presentations by Dwight Giles as well as community partners and breakout discussions; Dwight Giles is a well-known researcher in service-learning[9] and was a consultant on the project. A second workshop was about 3 hours and focused on assessment, and again Dwight Giles presented. A planning grant from NSF allowed faculty to develop S-L courses through minigrants and graduate student support, and a part-time S-L coordinator was hired to provide an easier link to community partners for faculty new to S-L. A motto for the faculty has been: "Start small rather than not at all."

An implementation grant from NSF in early fall 2005 allowed the continuation of minigrants, more graduate student assistants, and the hiring of a full-time S-L coordinator (Linda Barrington). Concurrently, the university matched resources to provide course release time for faculty members who serve as department coordinators as well as a course release for one faculty member in each department to develop significant, high quality S-L projects in a course or courses. We are presently having biweekly community of practice meetings of faculty with a few invited students and occasional outside presenters and community partners to discuss objectives, techniques, problems, solutions with improving the S-L projects in our courses.

Other goals of the SLICE program with regard to faculty are to:

- study the art and science of service-learning and form a community of practice ,
- create a formal program to connect faculty to community groups (local and international) ,
- develop appropriate projects/experiments for integration of S-L into at least forty core courses in the undergraduate engineering curriculum at UML ,
- develop assessment tools to gauge the impact of this integration on students, faculty, institution, and community ,
- become an engaged college—engaged with the students, each other as faculty across departments, and with the community.

The anticipated outcomes for the faculty are:

- revitalization in teaching and service ,
- coincidental generation of ideas for research and service through course projects,
- enhanced cooperation and unity among departments.

## Data Sources

As part of the ongoing evaluation of the SLICE initiative, project staff at UML and their outside evaluation partners (Cathy Burack and Alan Melchior) at Brandeis University conducted two major forms of data collection aimed at assessing faculty attitudes and concerns about service-learning and the SLICE program: interviews with a sample of faculty members from various departments in the College of Engineering and an annual survey of faculty that is conducted by SLICE staff at the annual faculty retreat in December. (The project also conducts an annual survey of College of Engineering students in the spring, which are reported on elsewhere[12]). The results of the interviews and faculty surveys are reported here.

### *Interviews*

External evaluators set up interviews with selected faculty members who had used service-learning in at least one of their courses. This resulted in a convenience sample of 14 faculty members from five departments at the College: Mechanical, Civil, Plastics, Electrical and Chemical. Interviews were conducted in March and April 2007 during the third year of the project. The evaluators each interviewed individual faculty members who were assured that their responses would be confidential with no attribution in reporting. The interviewers used an interview protocol that asked about the faculty member's particular experience with using service-learning, the challenges and supports associated with using service-learning, impact of service-learning, and any additional comments or recommendations they might want to offer. All interviews lasted from thirty minutes to an hour.

### *Surveys*

Surveys were distributed to all the college's faculty at the annual retreat during each of the past three years (2004, 2005, and 2006). Results are analyzed by SLICE project staff, and include comparisons by year. Questions address faculty openness to using service-learning, perceived benefits to students, and the impact of adopting service-learning on the faculty member.

## Types of Service-Learning Projects

In the interviews conducted for the study, faculty were asked about the ways in which they integrated service-learning opportunities (e.g. duration, requirements, focus) into their class(es). Through the interviews faculty reported on a wide variety of projects in terms of scope and structure. For instance, across all departments, in different courses service-learning was:

- Voluntary and required;
- Extra credit and a part of the regular grade;
- Had students out in the field and had students carry out and complete project entirely at the College;
- Team based and individual;
- Involved a non-university contact such as a professional engineer or client representative and provided contact only with university students and faculty; and
- Week-long and semester-long.

In other words, the design of service-learning experiences for students was as varied as the courses themselves. Each faculty member, in effect, worked to integrate the service-learning into his/her class in the way that best seemed to fit, given the type of project and the time and resources they had available.

The majority of the projects were designed to benefit some entity associated with the city in which the university resides – public utilities, the park, museum, public schools and the like. Sample projects included:

- Working with the city to design a system to open and close the gates on the locks of the canal;
- Surveying and mapping trails for the Conservation Commission;
- Identifying methods of increasing the energy efficiency of the building used by the community food bank;
- Tracking potential sources of water pollution affecting the wells of a nearby community;
- Designing plastic grave vaults; and
- Designing exhibits on technology for the local museum.

In each case, an effort was made to identify a project that addressed an evident community need, though a number of faculty noted that it was sometimes difficult to identify potential projects (the SLICE coordinator was seen as a major aid for this), or to identify projects that would have a significant impact that could be completed in the time available for the class. Examples of projects and courses for the 2006-07 academic year are tabulated in the appendix. Also there are more complete descriptions of more S-L projects and courses at the SLICE web site[17].

While community focused, more often than not projects were identified and developed by faculty working with community partners or by the service-learning coordinators involved in the program. Given the need to link projects with the engineering curriculum, in only a few instances were students able to take the lead in identifying the need to be addressed or the service to be provided. Perhaps more important, in only a few instances did students meet with the community members impacted by the project, and this was generally in the form of a presentation at the end. One result was that there were relatively few opportunities for students to talk directly with community representatives about the work of the agencies they were assisting or the broader social needs or benefits associated with their projects. As discussed further below, one of the challenges running through these service-learning efforts was that of making the connection between the "service" and the broad needs or issues it was designed to address.

Finally, projects were generally bounded by the course in which they occurred; that is, there was no formal connection to other courses or departments. The two exceptions to this are the Assistive Technologies Program[18], which involves staff and students from electrical engineering mainly and the Village Empowerment Program[19], which has involved students and faculty from mechanical engineering as well as a number of other departments in several colleges at UML and other universities. These two programs had the highest visibility among the faculty interviewees, transcended departmental boundaries, and offered multiple avenues for contributing to the projects (e.g. from developing a plan for later implementation to fabricating an actual part).

**Impact of Service-Learning**

Faculty in their interviews readily discussed the positive benefits of using service-learning with their students. These benefits most often occurred within the context of service-learning as a form of experiential learning. One faculty member stated service-learning "gives students a grounding in the practical applications" of what they are learning. Another faculty member noted that introducing "human elements" makes a project more complex, allowing students to both apply knowledge to the real world while providing a service to the community. Involvement in a service-learning project provides students with the "opportunity to learn how to interact with the client" and "learn lots about relationships and how to deal with clients." Some service-learning projects can be more complex and undefined, so students are required to do their own analysis, create their own specs, and meet client expectations. All the faculty members who were interviewed saw service-learning as an effective "hands-on," project-based pedagogy for students that enabled them to better learn class content and as a means to develop professional/personal skills. One faculty member also noted that service-learning projects provide an avenue for meeting ABET requirements and were helpful when the school was undergoing its ABET review.

Almost all the faculty members noted that an additional benefit of these projects was being able to do something positive for the community. "Students are motivated and engaged in the project because they know this isn't just an exercise, it can potentially help someone." They also saw service-learning as a way of reinforcing the idea that engineering (and engineers) can contribute to the solution of social problems in the community. However, these benefits were generally framed as coincidental outcomes rather than as an intentional, integrated part of the community-based learning experience for students. One faculty member noted that it is "difficult to focus on social implications. In the capstone, we do ask students to think about environmental and social issues as part of review questions. But we don't have significant discussions on social connections as part of projects." Another faculty member in a different department said, "We don't talk about social impacts much. We should be doing more reflection." One faculty member who was very supportive of using service-learning responded with surprise when asked if s/he talked with students about the impact of the project on the community. S/he noted that s/he had never considered having the discussion but thought it would be beneficial.

A number of faculty members acknowledged that the impact of a service-learning project on student learning varies greatly depending on the scope of the project. The perceived impact is greatest where students are able to go out into the community, work on a project over the course of several weeks, and see the results of their project. It is also easier for students in these types of service-learning experiences to see the social benefits. However, faculty also noted that short, campus-based, applied projects had benefits with regard to student understanding of the consequences of plans/products, or in demonstrating that engineers can serve communities in multiple ways.

Three faculty members noted that they think service-learning will help attract and engage female students in the engineering program. "The benefits to humanity will get them involved, help increase the number of women in engineering majors." A faculty member also added that s/he thinks service-learning at the College will attract students who are interested in doing "social good." In that regard, service-learning was seen as strengthening the recruitment efforts at the College of Engineering, noting that SLICE and service-learning were featured at the various open-house events for prospective students.

Ultimately, all of the faculty interviewed indicated that they saw service-learning as a valuable element in UMass-Lowell's engineering program, based on their own experience using service-learning in their courses. All saw it as adding important dimensions to the learning experience that were not available through traditional classroom exercises, and all believed that it was consistent with efforts to broaden students' understanding of both engineering and their role in society. Finally, though all noted challenges with regard to implementation, they also indicated that the integration of service-learning was worth the extra effort that it often involved.

**Challenges**

In their interviews, faculty, while generally positive about their experience with using service learning, also indicated that there were challenges. The primary challenges included time constraints, the skills faculty need to do these projects, finding appropriate projects, reward and recognition, and lack of clarity about the definition of service. These challenges parallel those that were found in the early development of the S-L initiative.

***Time and Effort***

Time and the extra effort involved in service-learning continues to be a frequently discussed challenge for faculty. Service-learning projects simply require a greater time commitment on the part of faculty and in many cases, on the part of students as well. As several faculty noted, service-learning projects tend to be more demanding on teaching. "A traditional class project or exercise is easier – you know the answers; it is easier to grade. Service-learning is more open-ended, new to both students and faculty, so it takes more work." Faculty also worried about adding extra assignments for students on top of regular class exercises. "Teachers are worried about burden" for their students and have to figure out what to substitute or cut.

***Skills Required***

Some faculty members expressed concerns about their own ability to incorporate service-learning strategies into their course. "An adjunct is more prepared to do this" said one faculty member. "I'm an academic, I don't have those skills." Similarly, some faculty noted that they were not really prepared to talk about the broader social issues involved in the service-learning projects, noting that this was an argument for designing service-learning courses as multidisciplinary efforts that link, for example, courses in sociology with service-learning projects in engineering.

***Appropriate projects***

Matching projects with the level of the class content and the amount of time students have to complete a project presents a challenge for some faculty. One faculty member worried in particular about service-learning in a capstone course preventing students from getting experience in an industrial setting. "The service-learning projects afford the student the design experience, but deny them the edge and taking advantage of the demand of industry."

Another faculty member indicated that matching suitable service-learning projects in upper level classes with the complexity of difficulty required to teach the content and that could occur in the class time frame was a challenge.

More generally, faculty noted the challenge of integrating service-learning projects into a relatively full curriculum – trying to define projects that were sufficiently challenging and complex to provide a rich learning experience given the limited time available in a class over a semester. As one faculty noted, "good projects take time, and students do not always have a chance to play the projects out to their finish." Others noted the difficulty of tying projects directly to a single module or set of lessons in the course and the challenge of trying to scale projects up or down to fit the available time.

It is worth noting that one faculty member addressed that challenge by running the service-learning project for his class as a semester-long effort that "floated" in parallel over the course curriculum. Rather than tie the project to a specific lesson or module, he had his students work on the project throughout the semester, incorporating new information and refining their plans as new material was covered in the course. The result, he argued, was that it allowed students to incorporate learning as it happened, and avoided the problems of trying to directly link project work to daily classroom activities.

***Recognition***
A Chair noted that in order for this to be sustained faculty have to get recognition. This Chair felt that the University Rank and Tenure Committee was "iffy" around service-learning and this type of community based work, even though the College committee was supportive. Another faculty member stressed the importance of being able to publish and get grants. One senior faculty member said s/he advises younger faculty NOT to do this because it puts their tenure at risk and there are few incentives. Since a number of faculty said they thought younger faculty were more inclined to adopt service-learning as a pedagogy, the lack of recognition in the review and reward system is an important challenge with regard to program sustainability.

***Definition/Purpose***
There is some concern about service-learning and its role in engineering education, even among these faculty members who embrace it. One faculty member said, "It is a good construct. But I want to make sure we are not harming what we are fundamentally trying to do – produce skilled engineers for the local economy. The primary goal is not to make social activists." This faculty member does see service-learning as a way to educate students *and* get environmentally and socially conscious graduates.

Another faculty member asked "why teach service? We all know that project-based learning is better, but I'm not convinced on the service-learning part."

In each case, the apparent message was that even supporters of service-learning still had some doubts about the value-added of service-learning. While most were clear about the benefits of project-based or experiential learning – of involving students in real-world projects outside of the classroom -- the role and value of "service" and how it fits into an engineering curriculum often seemed less clear.

In many ways, this represents one of the more difficult challenges in integrating service-learning into the College of Engineering, and into engineering programs generally. As suggested earlier, one of the more difficult challenges for faculty involved in service-learning at UMLwas in making the connections between the specific service-learning projects and the broader social context and issues that would make the idea of "service" meaningful. As noted by several of the faculty interviewed, few of the service-learning courses built in opportunities for student reflection on their service projects beyond their engineering implications, and the lack of direct contact with community partners in many projects meant that students in those projects learned relatively little about the social or policy implications of their work. To the extent that service-learning is intended to make those connections, this is an area that likely needs additional work.

**SLICE Project and the Growth of Service-Learning**

The SLICE project and the support it offers faculty was seen positively by all those interviewed. The project Service Learning Coordinator is an important resource for faculty. "Linda Barrington is doing a fantastic job." Coordination is an important issue and "Linda Barrington is helpful in organizing meetings within the university and with outside partners." The role of the Coordinator is seen as vital to the institutionalization of these efforts. A faculty member noted that the coordinator can help find projects, help faculty figure out how to incorporate projects into classes, serve as a liaison to the community and manage the expectations of the faculty. Sometimes it is simply a challenge to come up with ideas. Faculty want someone who can say "here is a project you can do," who also knows the curriculum and can identity a project in the community. A coordinator is the key person who can address these challenges.

Based on the comments in the interviews and the survey data, SLICE has been able to raise the visibility of service-learning at the college. As discussed further below, faculty surveys found that the majority of faculty agreed to the goal of the project, with only about 15% percent indicating they were not planning to try service-learning. With regard to students, one faculty member said that students are hearing more about opportunities to work on community based projects. S/he said, "Two years ago there was not much discussion; now newer students are more aware. Not all of my students are doing service-learning projects, but everyone is hearing about those projects and learning about them." Another faculty member noted that the Dean frequently mentions service-learning. A third also argued that that S-L has had an impact on faculty attitudes and thinking. S/he thinks service-learning is "an idea that has taken hold" and that most faculty in his/her department are thinking about service-learning and willing to give it a try.

At the same time, all of those interviewed also saw substantial challenges to continued growth, noting that the effort is still in its early stages. As one faculty noted, "this is a slow, steady process. There are 3 groups of faculty: the converted, the reluctant, and the resistant. SLICE has involved the first and is working on the second."

The challenge, as the quotation suggests, is in convincing additional faculty to integrate service-learning into their courses. For the most part, the faculty interviewed see this as requiring a continued effort to raise awareness and to make clear the extent that service-learning is taking place and has been successful.

Others, however, also argue that for service-learning to grow, it has to move towards a more systematic approach, rather than the course-by-course expansion that has taken place thus far. For those faculty, the ideal would be to look at ways of creating a clear sequence of courses that include service-learning and that involve students in a single project each year at the school. To do that, they note, would require a stronger push by department chairs and the dean, as well as an investment in multi-disciplinary/cross-department courses.

**Faculty Survey Data**

The data from the annual surveys of faculty at the College of Engineering tend to reinforce the interview data. As noted above, in each year faculty were asked to complete a survey at the annual faculty retreat with questions on their attitudes towards S-L and the impact of the SLICE project. On average, approximately 40 of the 70 College of Engineering faculty responded each year.

As Table 1 shows, in each of the three years, faculty members were generally supportive of the integration of service-learning into the engineering program, with scores significantly higher than "Neutral" on all but one of the items. (Faculty were neutral on the statement that service-learning could be integrated into a class without increasing student workload). On four of the eight items assessing attitudes towards service-learning, faculty support appears to have increased over the years (thought the differences were generally not significant), with scores on questions related to the quality of student learning, the attraction of service-learning to female students; the idea that service-learning courses could be academically rigorous; and the idea that service-learning could be beneficial to students rising in each of the three years of the survey. By the most recent year of the survey (2006) roughly 70% of the faculty or more agreed that it was possible to meet course objectives, improve student learning, and maintain academic rigor while integrating service-learning into College of Engineering courses. Overall, 69% of the faculty agreed in principle with the goal of having at least one S-L course a semester for every undergraduate in the college. There were few differences in the survey results between male and female faculty, or between tenured and non-tenured faculty, though female faculty were more likely to think that service-learning could be incorporated into the curriculum without major impacts on student workload.

Based on the most recent (2006) faculty survey, faculty also attributed their increased use of service-learning and shifts towards increased use of community resources to their involvement in the SLICE program. Table 2 shows faculty response to a number of questions about the impact of the SLICE program. On almost every item, faculty report that SLICE had a positive impact, and that on a scale from "Strongly decreased" to "No Change" to "Strongly Increased," the average response positive and significantly different from "No Change." On average across all of the items, nearly half (49%) of the faculty respondents reported that SLICE had a positive effect on their teaching; over 70% indicated that it had changed their understanding of what their students could accomplish, as well as their own commitment to improving their community. More than 60% of faculty indicated that involvement in SLICE had increased:

- their knowledge of issues and resources in the community;

- their emphasis on community issues in the classroom;
- the existence of partnerships between the College and area community organizations;
- their sense of pride and satisfaction with the UML engineering program; and
- their ability to address ABET outcomes in their teaching.

**Table 1: 2004-2006 Faculty Survey, Attitudes Towards Service-Learning**

| | 2004 Faculty Survey | | | 2005 Faculty Survey | | | 2006 Faculty Survey | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Mean responses to Likert scale of 1 (disagree) to 5 (neutral) to 9 (agree) | **2004 N** | **Mean (2004)** | **Significantly Different from "Neutral"** | **2005 N** | **Mean (2005)** | **Significantly Different from "Neutral"** | **2006 N** | **Mean (2006)** | **Significantly Different from "Neutral"** | **Percent "Agree" (6-9)** |
| a. With service learning, it is possible to meet course learning objectives in a credit-bearing course while also meeting real community needs. | 44 | 6.43 | * | 45 | 6.07 | * | 38 | 6.50 | * | 73.7% |
| b. When service-learning is done well, students learn the subject matter better than in a traditional classroom. | 45 | 6.36 | | 44 | 6.57 | * | 38 | 6.71 | * | 76.3% |
| c. With service-learning, students become better citizens. | 46 | 6.28 | * | 45 | 6.73 | * | 36 | 6.50 | * | 69.4% |
| d. Service-learning can be an effective way to increase the involvement of women and other underrepresented groups in engineering. | 46 | 6.13 | * | 45 | 6.36 | * | 38 | 6.55 | * | 63.2% |
| e. Service-learning courses can be academically rigorous. | 46 | 6.2 | * | 45 | 6.22 | * | 38 | 6.45 | * | 71.1% |
| f. In principle, service-learning would be beneficial to the students in the courses I teach. | 46 | 6.3 | * | 45 | 6.33 | * | 38 | 6.42 | * | 73.7% |
| g. I agree in principle with the goal of having at least one service-learning course available every semester for every undergraduate in our college of engineering. | 46 | 6.26 | * | 44 | 6.86 | * | 36 | 6.44 | * | 69.4% |
| h. It is possible to integrate service-learning into existing engineering courses without adding to the overall workload of students by replacing existing homework, projects, lab experiments, lectures, etc. with similar activities solving real problems in the community. | 47 | 5.04 | | 45 | 5.64 | | 36 | 5.31 | | 73.7% |

**Table 2: 2006 Faculty Survey, Impact of S-L Program on Teaching**

| **How has S-L affected the following:** ( -4 = Strongly Decreased, 0 = No Change or don't know, +4 = Strongly Increased) | **N** | **Mean** | **Significantly Different from "No Change" (0)** | **Percent Reporting an Increase (+1-4)** |
|---|---|---|---|---|
| a. My knowledge of issues and resources in the community | 30 | 1.23 | * | 63.3% |
| b. My emphasis on community issue/problems in my class or program | 29 | 1.34 | * | 62.1% |
| c. My use of community issues and resources in my class or program | 30 | 0.97 | * | 56.7% |
| d. My use of information about Lowell in teaching about community issues in my class | 30 | 0.67 | * | 40.0% |
| e. My emphasis on the importance of examining public policy in teaching about community issues in my class | 30 | 0.33 | * | 26.7% |
| f. My use of student-led projects in my teaching | 31 | 0.74 | * | 38.7% |
| g. The amount of discussion of controversial /community issues in my class or program | 30 | 0.27 | * | 20.0% |
| h. The amount of time I spend lecturing in my class | 30 | 0.30 | | 23.3% |
| i. My belief that students can make a difference in their communities | 30 | 1.70 | * | 73.3% |
| j. My personal commitment to improving the community | 30 | 1.50 | * | 70.0% |
| k. My enjoyment or satisfaction with teaching | 31 | 1.06 | * | 51.6% |
| l. My ability to address ABET outcomes in my teaching | 30 | 1.53 | * | 60.0% |
| m. My day-to-day workload | 31 | 0.97 | * | 54.8% |
| n. My access to resources and people (materials, grants, professional development) that help me improve the quality of my work with students. | 32 | 0.59 | * | 40.6% |
| o. The existence of partnerships between my College or program and other organizations in the community | 31 | 1.19 | * | 67.7% |
| p. The use of community issues in the class or program by other faculty in the College or community organization | 32 | 0.72 | * | 43.8% |
| q. My role as a resource for colleagues in my College or program | 32 | 0.69 | * | 46.9% |
| r. My connections with other engineers who share my interests and ideals | 32 | 0.63 | * | 46.9% |
| s. My sense that I am confident and capable as an educator | 32 | 0.66 | ** | 31.3% |
| t. My sense of pride and satisfaction with the University of ----- engineering program. | 32 | 1.41 | | 62.5% |

The surveys also included questions about barriers to integrating service-learning, and the responses reflected those in the faculty interviews. The barriers to integrating S-L into courses ranked highest were faculty time, class time, student workload, community coordination, and lack of information (with the order determined by a weighting of 7 for the first ranked, 6 for the second, etc.). In answer to the open-ended question about the main reasons "you have, or have not, tried service-learning in your courses," some representative responses were: "Introducing real-world problems makes the course more interesting and lively for the students and myself," "Students learn certain course materials better," "Important (teachers and students) to apply knowledge and skills acquired to serve community," "Ability to show how engineering can assist with the solution of community/social problems," "Provide real-world problems or project to students that are open-ended," "Not applicable to course content," and "Takes too much time from the teaching of basic fundamentals."

## Recommendations

The SLICE project employs a problem-based model (Heffernan, 2001)[20] of service-learning. In this model students relate to the community much as consultants working for a client. Students work with community members to understand a particular community problem or need. This model presumes that the students will have some knowledge they can draw upon to make recommendations to the community or develop a solution to the problem. Heffernan notes that caution is needed when using this model of service-learning. Although it can be very effective, it can also promote the idea of students as "experts" and communities as "clients" thus re-emphasizing the disparities between universities and communities, and underestimating the social capital of communities. One way to offset this risk is to have students either engage with the community more, reflect, think about social implications of projects. Successful implementation of this model argues for ongoing partnerships with community agencies rather than single random projects.

This was echoed in the suggestions of a number of faculty members who argued for more integration and coordination of the service-learning opportunities available to students. Faculty commented on how service-learning is "bits of things" across courses. A related concern was expressed by a faculty member who is concerned that students are "OD'ing" (overdosing) on service learning projects. This faculty member thinks there should be a maximum of one service-learning project per semester. Another faculty member would prefer to see service-learning set up as a theme across courses, or as a broad based project, such as a freshman project.

Across the board, faculty members involved in service-learning saw a need to move towards a more systemic approach to integrating service-learning in the curriculum. One faculty member suggested that service-learning was a way to bring together multi-disciplinary teams (e.g. civil and mechanical). This approach would help meet ABET[21] requirements and enable students to work in a "real world" context. Another faculty member suggested that one way to combine engineering classes with social issues might be to use a multidisciplinary approach and tie into a humanities course on "social factors in engineering use," something jointly taught with ethics for example. However, working across departmental lines was cited by one faculty member as one of the biggest challenges at the college. Whatever specific approach is ultimately adopted, there is an interest in exploring how service-learning can more fully integrated into the curriculum. As such, it may be time for S-L to begin to bring faculty together to explore those options.

In a similar vein, there is concern among some of the faculty regarding the extent of the institutionalization of S-L. One faculty member expressed concern that SLICE is still primarily associated with the leader of the SLICE initiative. Another faculty member was concerned that when the funding for SLICE ended so would increased implementation of service-learning. In that regard, several faculty members recommended broadening the efforts to market service-learning and to work to make other faculty and projects more visible. As one step, one faculty member wanted colleagues to see how much service-learning is occurring at the College. S/he suggested that different faculty be asked to present their work. Another noted that the acceptance of service-learning is slow, but is facilitated by faculty hearing from other faculty about how they have incorporated it into their class. A third noted suggested seeking grant funds and generating articles based on existing service-learning efforts as a way of building visibility and legitimacy. Another also suggested collecting feedback from and data on graduating students. The common message from all, however, was to continue to look at new ways to spread the work, and to work to expand the group of faculty and students who can talk about the value of their service-learning experience.

Finally, as suggested in several places, one area in which the service-learning experience itself can be strengthened is through increased community partner involvement and exploration of ways to help students (and faculty) make the connection between service-learning projects and the broad social context. One of the suggested approaches was to work towards more interdisciplinary courses, with links between engineering and social science disciplines that can address social issues and needs; in the meantime, S-L staff and faculty may want to look at how to expand the direct involvement of community partners with students in service-learning projects and to draw on partners' expertise to help students reflect on the meaning and value of their service to the community.

In sum, service-learning has made significant inroads into the engineering program at the University of ___ and the SLICE program enjoys support from faculty who are using service-learning. Faculty involved in service-learning see clear benefits from involving students in community-based programs and, while they have identified a number of ongoing challenges, believe that service-learning is worth the effort required. As such SLICE stands as a model for other Colleges of Engineering to explore and is beginning to reinforce the evidence of other programs that service-learning can be practically implemented into an engineering curriculum. With this model, any individual faculty member can integrate S-L into any course he or she teaches without a formal program at little or no cost.

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## Appendix

| **Service-Learning in Courses 2006-2007** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| **Yr** | **Course #** | **F, S** | **Cr** | **Course Title** | **Professor** | **Activities** | **S-L stu** | **# stu** |
| **Common First Year Course** | | | | | | | | |
| Fr | 25.107 | F 06 | 2 | Intro. to Engineering I | Dave Kazmer | Tsongas Industrial History Center exhibits for K-12 illustrating "energy around us" principles of engineering; | 354 | 354 |
| | | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| CORE REQUIRED COURSES | | | | | | | | |
| **CHEMICAL ENGINEERING** | | | | | | | | |
| Jr | 10.304 | S 07 | 3 | Heat Transfer | Al Donatelli | Winter heat loss/alterations analysis for Mental Health Assoc of Greater Lowell (MHA) | 18 | 18 |
| | | | | | | | | |
| **CIVIL ENGINEERING** | | | | | | | | |
| Fr | 25.108 | S 07 | 2 | Intro. To Eng. II - CEE | Jackie Zhang | Parking lot re-design: UML Smith & Eames | 35 | 35 |
| So | 14.286 | F 06 | 3 | Probability & Statistics for Engineers | Oz Gunes | Statistical analysis of water samples from Town of Dunstable wells | 21 | 35 |
| Jr | 14.310 | F 06 | 3 | Engineering Materials | Krishna Vedula | Analysis of possible materials for Lawrence alleyways with Lawrence Community Works (LCW) and Groundwork Lawrence (GL) | 10 | 31 |
| Jr | 14.332 | S 07 | 3 | Environmental Eng. Lab | Cliff Bruell | Town of Dunstable road salt/chem analysis | 27 | 27 |
| Sr | 14.460 | F 06 | 3 | Water Resources Engineering | Jackie Zhang | Follow up on spring soils project: Using hydrology to gain insight on chloride levels in the Town of Dunstable wells | 39 | 39 |
| | | | | | | | | |
| **ELECTRICAL ENGINEERING** | | | | | | | | |
| So | 16.208 | S 07 | 3 | Basic EE Lab II | Alan Rux | LED analysis for headlamp design for Peru | 36 | 36 |
| Jr | 16.317 | F 06 | 3 | Microprocessors Systems Design I | Yan Luo | PIC micro controllers to build monitors for human voice volume for LifeLinks (North Chelmsford) | 33 | 33 |
| Jr | 16.317 | S 07 | 3 | Microprocessors Systems Design I | Yan Luo | World's Largest Book page-turner control design for Groton-Dunstable Regional Middle School | 44 | 44 |
| Jr | 16.365 | F 06 | 3 | Electronics I | Joel Therrien | Designed and built circuits for measuring and displaying the power generation of various water wheels for the Tsongas Industrial History Center | 50 | 50 |
| Sr | 16.399 | F 06 | 3 | Capstone I (Proposal) | Alan Rux, Donn Clark, Senait Haileselassie | Develop a business plan to fund the design and development of a product which would be considered an "Assistive Technology" device. Students work with a specific client and identify Capstone Assistive Technology project to be accomplished in 16.499. | 44 | 44 |
| Sr | 16.399 | S 07 | 3 | Capstone I (Proposal) | Donn Clark | Business plan to fund the design & development of Assistive Technology device; incl. client | 20 | 20 |
| Sr | 16.499 | F 06 | 3 | Capstone II (Project) | Alan Rux | Students are required to design, test and deliver a device that would enhance the quality of life for a disadvantaged person. Students are required to have direct contact with | 41 | 41 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | their client throughout the project. | | |
| Sr | 16.499 | S 07 | 3 | Capstone II (Project) | Alan Rux, Jay Fu, Senait Haileselassie, Chuck Maffeo | Design, test and deliver a device that would enhance the quality of life for a disadvantaged person; including direct contact with client | 50 | 50 |
| | | | | | | | | |
| **MECHANICAL ENGINEERING** | | | | | | | | |
| Fr | 25.108 | S 07 | 2 | Intro. To Eng. II - ME | Sammy Shina | Renewable energy application for Greater Lowell Technical HS (GLTHS) | 9 | 108 |
| So | 22.202 | S 07 | 2 | Design Lab II | Bob Parkin, Byungki Kim | Design/manufacture of assistive tech devices - for the Bill Kelly Assistive Technology center at the Hogan Regional Center, Hathorne, MA | 53 | 60 |
| So | 22.213 | S 07 | 3 | Dynamics | Faize Jamil | Analyze playgrounds for City of Lawrence, Department of Parks and Recreation (and other playgrounds) | 24 | 43 |
| So | 22.296 | S 07 | 3 | Mechanical Behavior of Materials | Emmanuelle Reynaud | Mounted posters and annotated bibliographies for the American Textile History Museum (ATHM) | 18 | 18 |
| Jr | 22.341 | S 07 | 3 | Conduction & Radiation | Hongwei Sun | Winter heat loss/alterations analysis for the JFK Civic Center, City of Lowell, Division of Planning and Development | 48 | 48 |
| Sr | 22.342 | F 06 | 3 | Convective Processes | Gene Niemi | Piping design of water supply system for Yanacaca village, Peru | 47 | 47 |
| Jr | 22.361 | F 06 | 3 | Mathematical Methods for Mechanical Engineers | John McKelliget | statistical analysis of Company survey for SLICE | 61 | 61 |
| Jr | 22.381 | F 06 | 3 | Fluids | Majid Charmchi | Canal locks wicket gate - hydrostatic analysis for NPS | 11 | 48 |
| Sr | 22.403 | F 06 | 3 | Mechanical Engineering Lab II: Measurement Engineering | Majid Charmchi | playground materials analysis for safety | 10 | 43 |
| Sr | 22.423 | F 06 | 3 | Capstone | Sammy Shina | Design, build, test, re-design wicket gates for remote lock for the Lowell National Historical Park (LNHP). | 2 | 3 |
| Sr | 22.423 | S 07 | 3 | Capstone | John Duffy | 2 groups for Village Empowerment Peru project: Hand-powered swing (3) and Composting solar toilet (2) | 5 | 5 |
| Sr | 22.423 | S 07 | 3 | Capstone | Sammy Shina | Large gate hydraulic lock opener | 4 | 39 |

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|---|---|---|---|---|---|---|---|---|
| Sr | 22.425 | F 06 | 3 | Design of Machine Elements | Chris Niezrecki | Water tower designs (2) and motorcycle ambulance connection for Peru; wicket gate mechanism for the NPS; gym mat roller for UML Athletics Dept. | 19 | 49 |
| Sr | 22.441 | S 07 | 3 | Analysis of Thermo-Fluid Processes | Majid Charmchi | Analyze heat exchanger possibilities for the JFK Civic Center, City of Lowell, Division of Planning and Development | 7 | 48 |
| | | | | | | | | |
| **PLASTICS ENGINEERING** | | | | | | | | |
| Fr | 25.108 | S 07 | 2 | Intro. To Eng. II - PE | Carol Barry, Nick Schott | Teaching modules for CHN Outreach program in Lowell schools | 28 | 28 |
| So | 26.215 | F 06 | 1 | Plastics Process Lab I | Carol Barry | Plasticizer leaching from PVC testing for Peru | 21 | 21 |
| So | 26.218 | S 07 | 2 | Intro. to Design | Steve Orroth, Nick Schott | Design and manufacture of animal guards for high voltage transformers for National Grid customers | 22 | 22 |
| Jr | 26.348 | S 07 | 3 | Heat Transfer | "Jim" Jan Chan Huang | Plastic insulation analysis for Mental Health Assoc of Greater Lowell (MHA) | 21 | 21 |
| | | | | | | | | |
| **ELECTIVE/GRADUATE COURSES** | | | | | | | | |
| **CIVIL ENGINEERING** | | | | | | | | |
| Gr Sr | 14.570 | S 07 | 3 | Water Resources Assessment | Bill Moeller | Water resource analysis for the National College of Forestry in Honduras for the Mesoamerican Development Institute (MDI) | 3 | 3 |
| Gr | 14.733 | S 07 | 3 | MS Project in Civil Eng Lab | Susan Faraji | Initial analysis of historical footbridge design for the Architectural Heritage Foundation site at 165 Jackson St. Lowell, MA | 1 | 1 |
| Gr | 18.584 | S 07 | 3 | Sustainable Infrastructure Practicum | Bill Moeller | Coffee waste composting for organic farmers in Honduras with MDI | 1 | 1 |
| | | | | | | | | |
| **ELECTRICAL ENGINEERING** | | | | | | | | |
| Gr Sr | 16.541 | S 07 | 3 | Introduction to Biosensors | Xingwei Wang | Lowell HS education modules, presentation and mentoring. | 8 | 8 |
| | | | | | | | | |
| **MECHANICAL ENGINEERING** | | | | | | | | |
| Gr | 22.504 | F 06 | 3 | Energy Engineering Workshop | John Duffy | Green building upgrades for North American Indian Coalition of Boston | 3 | 3 |
| Gr | 22.504 | S 07 | 3 | Energy Engineering Workshop | John Duffy | Solar water pumping system design and installation for Laguna, Peru | 2 | 2 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| GrSr | 22.521 | F 06 | 3 | Solar Fundamentals | John Duffy | Estimate solar irradiation and optimal tilt for a solar collector and install in Yanacaca in Peru; design a solar hot water batch collector for a village biogas system; design and build for Yanacaca a solar herb crop dryer. | 10 | 10 |
| GrSr | 22.527 | S 07 | 3 | Solar Systems Engineering | John Duffy | Carbon displacement credit assessment of PV systems in Peruvian villages with Staples; solar water pumping system data acquisition design and installation for Huayash, Peru | 8 | 8 |
| | | | | | | | | |
| **INTERCOLLEGIATE ENGINEERING** | | | | | | | | |
| Jr | 25.300 | S 07 | 1 | Community-based Engineering Design Project II | Bob Parkin | W/C transfer board | 1 | 1 |
| Jr | 25.300 | F 06 | 1 | Community-based Engineering Design Project II | John Duffy | Lowell canals trash remover | 1 | 1 |
| Sr | 25.400 | S 07 | 1 | Community-based Engineering Design Project III | John Duffy | Lowell canals trash remover | 1 | 1 |
| Sr | 25.401 | S 07 | 3 | Intercollegiate Engineering Capstone Design Project | John Duffy | WiFi system design for Huarmey Valley village in the dept. of Ancash, Peru | 1 | 1 |
| Sr | 25.401 | S 07 | 3 | Intercollegiate Engineering Capstone Design Project | Jim Sherwood | Page turner prototype for World's Largest Book for Groton Dunstable Regional Middle School | 4 | 4 |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | **2006-07 Total S-L Student-Courses:** | 1276 | 1613 |
| | | | | | | **Total enrollment full time (ABET report)*2:** | | 2154 |
| | | | | | | Total full-time regular faculty with S-L: | 26 | |
| | | | | | | Total faculty with S-L incl part-time: | 31 | |
| | | | | | | Total faculty full-time who have ever tried S-L: | 37 | |
| | | | | | | Total full-time faculty in entire college: | 78 | |
| | | | | | | Total courses with students engaged in S-L : | 46 | |
| | | | | | | Total required courses with S-L (unique, not counting sections): | 28 | |