Faculty Views of Service Learning in Mechanical Engineering at MIT

Amy Banzaert, Sumi Ariely, David Wallace, Barbara Masi

Massachusetts Institute of Technology

Abstract

An initial effort is being made in MIT's undergraduate mechanical engineering curriculum to develop archetypes and resources for using service learning broadly in different types of engineering classes: design, analysis-based engineering science, and experimental lab courses. As a preliminary step, departmental faculty were surveyed on their attitudes about service learning to assure that implementation efforts fit the department's needs: 72% of the department (N=54) responded, a representative group in terms of research focus, gender, and tenure level, indicating that 80% of faculty are open to the use of service learning. However, 52% expressed concerns about time constraints and 56% needed support finding suitable projects for technical classes. If this type of support, including methods to mitigate time constraints, were available, faculty were interested in the practice. Surveyed faculty considered service learning most appropriate for design classes, but were open to the practice in other classes if suitable projects were available.

Introduction

Service learning is a teaching method that integrates academically-appropriate community service projects into the curriculum of a class. Service learning research shows that it can offer a wide variety of pedagogical benefits, including improved understanding of course material, increased motivation for learning subject material, and enhanced appreciation for the ethical role and implications of their profession[1].

At MIT, service learning was first used deliberately in a mechanical engineering class in the spring of 2002, and since then has been implemented in a few mechanical engineering subjects, all in design and manufacturing subject areas. Written post-surveys given to students following three of the classes and informal conversations show mixed success. On average, students reported that they found service learning worthwhile, and benefited through improved interactions with their peers and instructors, motivation toward the class, and interest in community service. In terms of learning gains, on four different scaled questions about direct academic benefit, responses were mixed: students were mildly positive for two questions and mildly negative on two other questions. Additionally, there were wide ranges in student responses, with many extremely positive toward service learning, and a few extremely negative. Faculty attitudes were measured informally: we found that when the project matched the class curriculum well and the community partnership was strong, the faculty were very pleased with service learning; when either or both of these criteria were not met, faculty were understandably much less enthusiastic.

Therefore, as part of a planning process to develop an infrastructure and curriculum for the broader integration of service learning in the mechanical engineering department, we sought to better understand faculty knowledge of, enthusiasm for, and concerns about service learning. In part, we needed this information to create a tailored educational workshop on service learning for the faculty. To this end, structured interviews were conducted to gain insight into MIT mechanical engineering faculty's perception of service learning.

Background

Studies of faculty attitudes about service learning are reasonably rare; Driscoll suggests the significant need for such studies in order to increase the use of service learning[2]. A small number of studies examine the reasons that faculty elect to employ service learning as part of students' curricular educational experiences. Hammond completed one of the most comprehensive studies that focused solely on faculty who were already using service learning; the study found that faculty are motivated primarily to use service learning in order to improve student learning[3]. Hesser[4], as well as McKay and Rozee[5], completed similar surveys of faculty, finding similar results. However, only Hammond's study includes research-focused institutions, and the study does not address similarities or differences between those schools and other types of universities. Further, it is not clear if these studies include surveys of engineering faculty.

It is not necessarily the case that general findings are applicable to engineering programs or research-focused Institutions. Abes et al. completed a more recent, comprehensive study that also included research universities (N=86, 40% of the study) and "math, engineering, computer sciences" faculty (N=5, 18% of the study) and found significant differences between these variables on certain measures[6]. This study also found that faculty adopted service learning primarily because of student educational benefits, and secondarily for benefiting the communities served. Faculty who did not use service learning reported that "time, funding, and logistical concerns" were most critical, followed by "curricular and pedagogical concerns."

While a number of studies survey engineering faculty exclusively, none includes questions about service learning that focus on more general education topics, such as ability to teach engineering teams[7], teaching styles[8], and time spent on improving teaching[9]. As the Abes et al. study has such a small engineering sample size, there is a clear need to study engineering faculty's interest in service learning given the paucity of data that exists currently.

Despite the limited data on faculty using service learning in engineering classes, the practice is slowly increasing in engineering educational settings, in part because it can help instructors meet many of ABET's EC 2000 Criterion 3 accreditation requirements[10]. The literature published thus far focuses on implementation methods for service learning in engineering education rather than on faculty attitudes[11,12,13,14,15]. These papers provide mainly anecdotal evidence that engineering service learning activities have been well-accepted by students and faculty alike. Based on the positive educational experiences described, many authors propose the implementation of service learning in other engineering educational programs. Yet, adoption is slow and it is suggested that faculty attitudes and perceptions about, and lack of support infrastructure for, service learning in engineering education may be one important factor in adoption rates. Hence, this study of such attitudes is an appropriate one since it expands knowledge of factors that might facilitate or hinder adoption.

Method

Faculty were surveyed using a brief (ten minute), structured, one-on-one interview. This method was chosen because faculty have been far more willing to take ten minutes to be interviewed in person than to respond to a paper or an electronic survey, especially because many were unaware of service learning and were less likely to comment on an unfamiliar practice in writing. Previous paper service learning surveys given to MIT mechanical engineering faculty for gauging interest and for evaluation following service learning classes resulted in a typical response rate of under 5%, but through a variety of in-person interactions, it was clear that faculty were generally interested in service learning. While issues of demand characteristics and good subject biases can be pronounced for interview formats particularly,[16] care was taken to encourage all responses and minimize social desirability effects. Interview instructions indicated that the interview was not only trying to gauge knowledge about and interest in service learning but also to understand concerns about and limitations of the practice. The open-ended format of questions and structured probes for both positive and negative aspects of service learning were used to encourage expression of all attitudes. Additionally, the method was deemed necessary in order to get feedback from as many of the faculty as possible.

Considerable persistence was required to reach most of the 75 faculty members in the department at the time of the study. Half of the interviewees, 27 (36%), were reached after one or two emails requesting interviews; another 27 were reached by subsequent emails, phone calls, and unscheduled visits to their offices. Four faculty (5%) requested interview times far in the future. Six (8%) declined to be interviewed explicitly, and 11 (15%) were never reached. In total, 64 faculty (85%) were contacted, and 54 (72%) were interviewed at the time of the study.

Because of scheduling constraints, seven people were involved in carrying out the 54 interviews, though the majority were given by two primary interviewers. All interviewers were instructed on how to perform the interviews, and all used structured interview questions to standardize the interview procedure. While interviewers took hand-written notes, audio-tapes of the interviews ensured comprehensive collection of interview data.

The interview questions were organized into a number of parts. First, faculty's awareness and general impressions of service learning were ascertained. Then, the interviewer defined service learning, giving some examples specifically appropriate for engineering classes. Next, faculty were asked to discuss in more details what they liked and disliked about the practice, their openness to trying service learning in classes they teach, and what classes in the department they believed were most appropriate for service learning. Then, in preparation for a workshop in service learning for the mechanical engineering department, faculty were asked to explain what they'd like to see covered in such a workshop, and any logistical preferences, such as time of day, time of year, and length. At the conclusion of the interview, handouts on service learning at MIT and the associated service learning grants program were given to increase faculty awareness of the resources available at MIT for such work.

Most of the questions allowed for an open-ended response; however, a quantitative scale was used for two questions targeting faculty's future behavior: "On a scale of 1-10, with 1 being not at all open, and 10 being completely open, how open are you to trying service learning in classes

you teach?" and "Assuming the [service learning] workshop was reasonably similar to what you described, how likely is it that you would attend, on a scale of 1-10, where 1 means you definitely wouldn't go, 10 means you definitely would go?"

Results and Discussion

The 54 faculty interviewed for the project were a representative sample of the 75 faculty in the MIT mechanical engineering department based on three factors: tenure status, gender, and department division (faculty in the department are divided into three divisions: I - mechanics and materials; II - fluids, energy, and transport; and III - design, manufacturing, systems, controls, and information). Figure 1 compares demographics for all faculty in the department to their interview status.

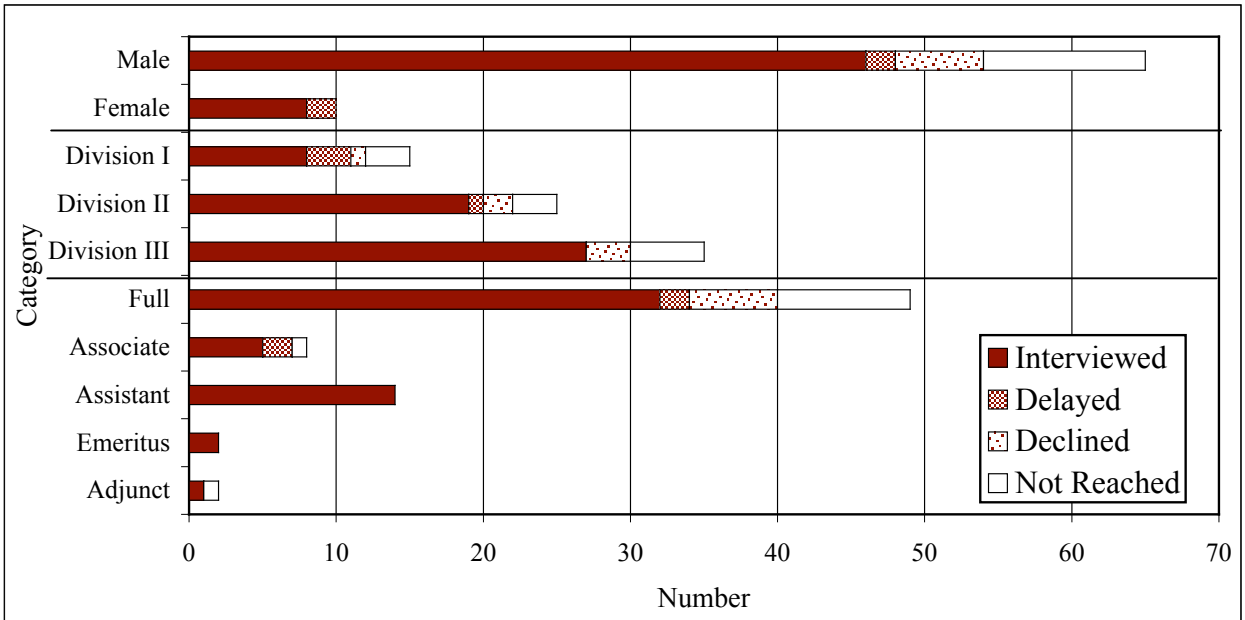

Figure 1: Faculty Demographics for Interview Option

We hypothesized that tenure status, gender, and departmental division might be influences on whether a faculty member agreed to be interviewed, especially because the principal investigator on the grant funding this study is in the design division (III), and because the most well-known service learning class in the department is a design class. We considered the four who delayed their interview to be part of the interviewee group for this analysis because they were willing to be interviewed. We grouped those whom we were unable to reach into the "declined" group: since we tried multiple methods of reaching them repeatedly, it is likely that they would decline to be interviewed were we able to reach them.

To test the relationship between tenure status and whether a faculty member agreed to be interviewed, a Yates chi-squared test was performed, comparing full professors to all others. The difference was barely significant, with $p=0.049$. We hypothesize that perhaps professors still working toward full tenure might be more interested in new teaching methods and/or more

willing to collaborate to build relationships. For gender, a one-tailed Fischer exact probability test was performed because the number of women was not high enough to use a chi-squared test. The t-test showed no significant difference, with p=0.085. For division, faculty in division III were compared to those in either divisions I or II, using a Yates chi-squared test, with p=1.0, showing no significant difference between the groups.

The faculty interviewed were evenly divided as to whether they had heard of service learning previously: 28 (52%) had heard of the practice, 22 (41%) had not heard of it, and four (7%) were not sure whether they had heard of it. All but one of those who had heard of the practice was aware of it through MIT – either colleagues had mentioned it, service learning staff had reached them directly or indirectly, or they were aware of a service learning class in the department.

All 54 interviewees were asked to define the term, "service learning," regardless of their familiarity with it. As shown in Figure 2, 23 (42.5%) said they were not sure, ten (18.5%) gave a definition quite different from how it is generally used[10], 16 (30%) were generally able to define it, but did not emphasize the criticality of both service and learning, and five (9%) defined it in a way that it aligned well with the definition given in the introduction of this paper, the one used by MIT's service learning program. Following that question, all interviewees were told the definition used by MIT's service learning program and were told to consider the remaining survey questions using the given definition.

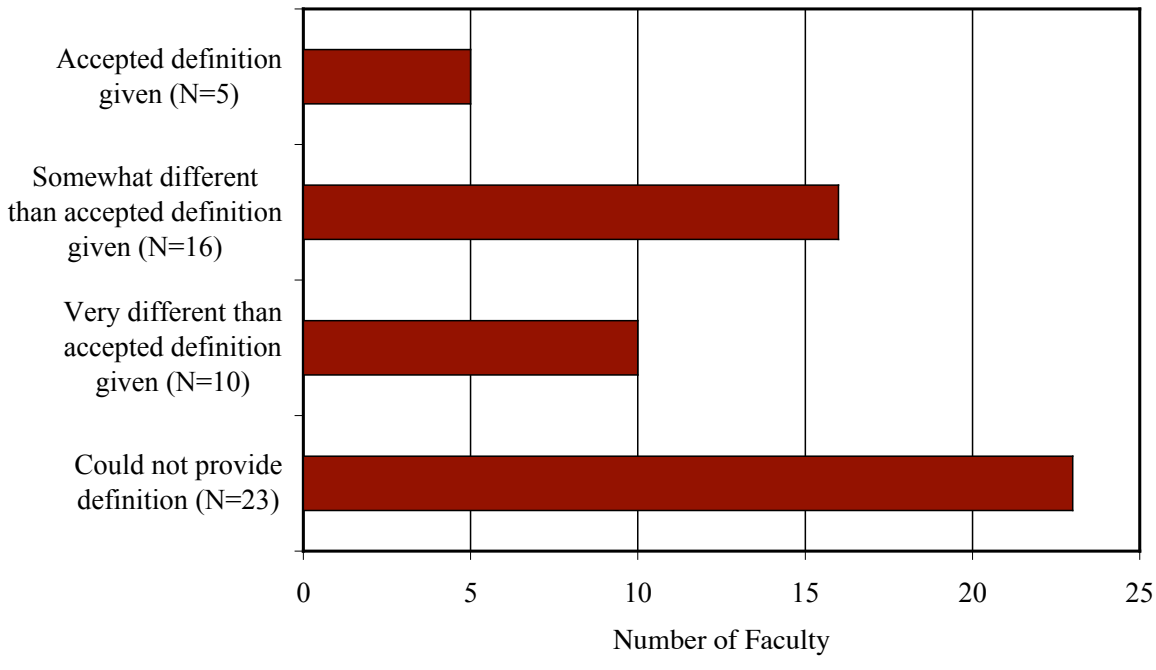

Figure 2: Faculty Definitions of "Service Learning"

Of the 28 faculty familiar with service learning, 18 (64%) had a "good" impression of it, 1 (4%) had a "bad" impression of it, and 5 (18%) had "mixed" impressions of it. The remaining 4

faculty (14%) did not report an impression. Faculty were asked to provide a rationale for their positive or negative impressions in terms of the possible benefits or concerns for service learning implementation in the mechanical engineering curriculum. Tables 1 and 2 present these results.

Table 1: Faculty beliefs about the benefits of service learning (N=54)

Benefit of Service Learning	N	%
Provides service to a community	29	53.7
Motivates students	19	35.2
Helps students develop experience and skills to help society	16	29.6
Helps students contextualize their learning	13	24.1
Helps students understand course material	9	16.7
Is an efficient, good use of student time	6	11.1
Helps MIT's reputation	4	7.4
Helps students consider the ethical issues of engineering	3	5.6
No Benefit	2	3.7

A majority of faculty interviewed considered service learning beneficial because it provides service to a community, and many believed that it motivates students and helps them develop skills that will allow them to help a community. A quarter believed it could help students to contextualize their learning. These findings do not align well with earlier published faculty studies described in the background section, in which faculty adopt service learning primarily because of student educational benefit. A key difference in these studies may explain the contradiction: the vast majority of the faculty surveyed here have never tried service learning, whereas the faculty documented in the other surveys were ones using service learning.

Table 2 displays the logistical and pedagogical concerns about the concept of service learning.

Table 2: Faculty concerns about the practice of service learning (N=54)

Concerns	N	%
Difficult to find an appropriate project	30	55.6
Class curriculum too tight to fit in service learning	28	51.9
Possible conflict between service and learning goals, leading to negative effect on academic rigor	22	40.7
Time-intensive to revise the course curriculum	18	33.3
Challenges of working with off-campus community partner	14	25.9
Potential harm to or disappointing community partners	9	16.7
Logistical headaches	8	14.8
Need training to do service learning well	8	14.8
(Some) students don't like service learning, especially if done poorly	5	9.3
Liability and safety concerns for the student and/or community partner	3	5.6
Not efficient use of student's time or way to provide service	2	3.7
Service could distract to students from course material	2	3.7
Against MIT entrepreneurial spirit	1	1.9
No concerns	1	1.9

The top concern faculty had about service learning was finding an appropriate project, followed closely by class curriculum constraints. Faculty also worried that the service would negatively affect academic rigor. These concerns are highly understandable: finding appropriate service learning projects for engineering classes is challenging, as we found in previous MIT pilot projects and, without an appropriate project, it is very likely that the service project goals and a subject's learning goals will conflict. Concerns about the effort to revise the course curriculum and interact with an off-campus community partner were also commonly cited. Many of the concerns mentioned by faculty aligned well with results published in the service learning literature, and our own prior interactions with MIT faculty. Additionally, it is no surprise that MIT faculty face serious constraints on their own time and on the course content.

Figure 3 displays how faculty responded to the question, "On a scale of 1-10, with 1 being not at all open, and 10 being completely open, how open are you to trying service learning in classes you teach?" Two sets of data are shown, since 18 faculty (33%) gave two responses to the question – a lower response for a worst-case scenario, and a higher response for a best-case scenario. For faculty who gave a single response, that response is included in both categories.

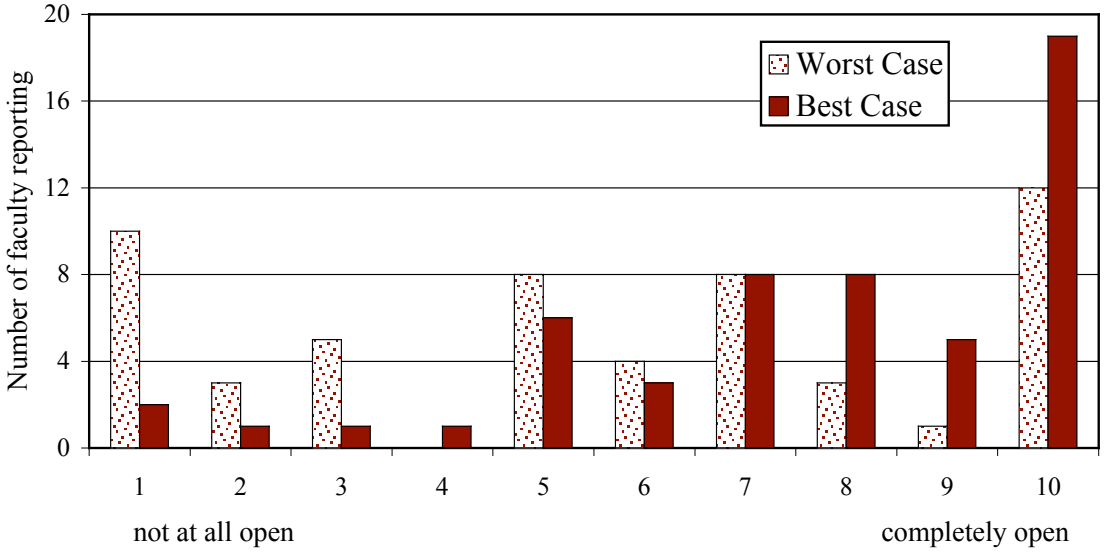

Figure 3: Openness of faculty to trying service learning in classes they teach, N=54

The worst-case scenarios discussed included not having enough time, not finding the right project, or teaching a class particularly ill-suited to service learning. The best-case scenarios included teaching an appropriate class, having a highly appropriate project, and receiving sufficient support from the service learning staff at MIT (despite outreach efforts, few faculty were aware of the available support). For the worst-case scenario, faculty's average response was 5.6 (scale 1=not at all open, 10=completely open, standard deviation +/- 3.3). For the best-case scenario, the average was 7.61 (standard deviation +/- 2.5). Overall, the average was 6.6 (standard deviation +/- 3.1).

As shown in Figure 4, dividing the responses into three categories – scores of 1-3, 4-7, and 8-10 – it becomes clear that given the worst-case scenario, faculty are evenly split in their openness to service learning (18 not open versus 16 highly open), and in the best-case scenario, the majority (32) are open to the practice. While there are four faculty who are clearly not interested in the practice, and for some faculty their worst-case scenario is the most realistic, many are open to the practice regardless of the challenges.

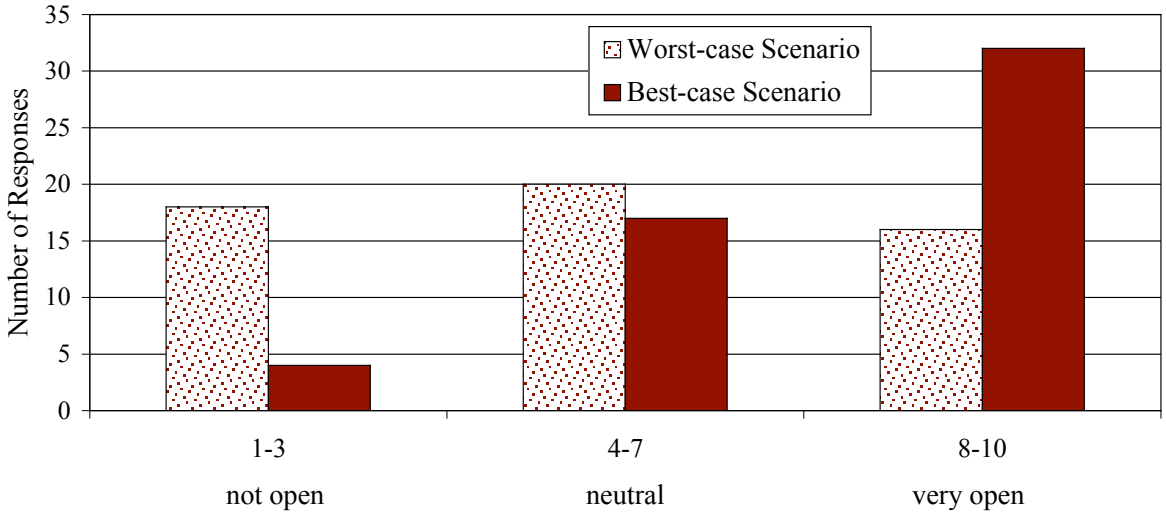

Figure 4: Lumped Faculty Openness to Using Service Learning (N=54)

Table 3 shows the list of undergraduate classes that faculty believe are best-suited to service learning. By far, most faculty consider design-focused classes to be most suitable, with the top four most-suggested classes being design classes. While part of this overall effort is to integrate service learning into more theory-focused classes, this finding is entirely unsurprising. 2.009, the class that 94% of the faculty mentioned as being appropriate for service learning, is the mechanical engineering class at MIT that has done the most service learning, so it is what most faculty are aware of when they think of the practice. The majority of service learning engineering classes that have been written about and cited in the background section of this paper, focus on engineering design. Further, it is likely that the survey itself caused faculty to think of design as most appropriate, since the service learning examples given were primarily design examples, an unfortunate error in survey design. However, faculty mentioned other classes and many were open to using service learning in classes they teach, even though they do not teach design classes.

Faculty were also asked questions about their interest in and availability for a workshop on service learning. While many of their responses for this topic are likely less generalizable than their beliefs about service learning, the responses most likely to be helpful are presented.

Table 3: Faculty Beliefs of MIT Classes Most Suited to Service Learning (N=54)

Class Number	Class Name	Div	# Faculty Mentioned	% Faculty Mentioned
2.009	The Product Engineering Process	III	45	94%
2.007	Design & Manufacturing I	III	32	67%
2.008	Design & Manufacturing II	III	21	44%
2.72	Elements of Mechanical Design	III	16	33%
2.006	Thermal-Fluids Engineering II	II	12	25%
2.005	Thermal-Fluids Engineering I	II	9	19%
2.002	Mechanics & Materials II	I	7	15%
2.001	Mechanics & Materials I	I	6	13%
2.670	Mechanical Engineering Tools	N/A	6	13%
2.671	Measurement & Instrumentation	N/A	6	13%
2.672	Project Laboratory	N/A	6	13%
2.THU	Thesis	N/A	6	13%
2.003	Systems, Modeling & Dynamics I	III	3	6%
2.004	Systems, Modeling & Dynamics II	III	3	6%
2.41	Advanced Thermal-Fluids Engineering	II	3	6%
2.14	Analysis & Design of Feedback Control Systems	III	3	6%

Finding a time that most faculty were free for a workshop was predictably difficult – their preferences and availability varied widely. Most suggested a one-hour workshop as the appropriate length, with two hours being the second choice. While not mentioned by the interviewer, four specifically mentioned that serving food would increase attendance. The vast majority of faculty prefer email as the primary mode of contact, although some strongly prefer paper mail, and a few prefer drop-in visits. None wanted to be contacted by phone.

In terms of workshop topics, Table 4 lists those that were suggested, in order of preference.

Table 4: Preferred Workshop Topics (N=54)

Topic	N	%
Successful examples	34	63.0
Information about projects/partners	25	46.3
Best practices	20	37.0
Learning from other faculty	14	25.9
Lessons learned	14	25.9
Hearing experts	11	20.4
Resources for service learning	4	7.4
How to work with community partners	1	1.9

The preferred topics align well with faculty concerns: helping them to understand how service learning could be appropriate for their classes through successful examples; helping them find appropriate projects; and helping them better understand how to do service learning well. Faculty were also quite open to attending the workshop, given the caveat of their availability.

Nine (19%) said they were unlikely to attend; 17 (31%) were somewhat likely to attend, and 21 (44%) were likely to attend. This level of interest matches the numbers of faculty who expressed "best-case scenario" interest in service learning: for the number of faculty who responded to both questions (N=47), $p<0.0001$ for a linear correlation and regression analysis.

Conclusions

A survey of 72% of the MIT mechanical engineering department showed a moderate level of awareness of service learning and inconsistent views of the definition of service learning. However, after hearing an accurate definition, most faculty expressed interest in using service learning, regardless of their gender, position, or research discipline. Key hesitations about the pedagogy included finding appropriate service projects and service learning limiting the number of curriculum objectives they could fulfill.

The results of this survey also suggest that faculty understanding of service learning pedagogy and its benefits is highly varied and incomplete. Faculty saw the value of service learning primarily as a way to provide service, and were less aware of how service learning can improve student learning, a key difference from other studies of faculty interest in service learning. To improve faculty awareness of service learning benefits and best practices, the survey results are being used to develop workshops about service learning, and to propose an infrastructure to support a broader application of service learning concepts. Faculty are interested in using service learning in their classes, but they need significant support in terms of training, curriculum development, and project identification. We encourage both the mechanical engineering department and the service learning program at MIT to increase the level of support they provide in these areas.

The one-on-one, comprehensive interview approach was time-intensive, but we recommend that other universities perform similar interviews if they are trying to establish similar departmental-level integration of service learning, since such knowledge of a large department's interest in a teaching practice is quite rare. While many of the concerns we found were similar to those found in other surveys of faculty, some differences were evident, and having this confirmation of interest is highly encouraging, especially given the conventional wisdom that engineering faculty at research universities may be more resistant to education reform than most. The process also provided an additional benefit of increased interaction and information flow with departmental members, laying the groundwork for positive change.

Acknowledgements

We would like to gratefully acknowledge the financial support of the National Science Foundation, under NSF Award No. EEC-0431784, which made this study possible. The authors would also like to thank the faculty members who participated in the interviews cited in this paper, as well as the interviewers who assisted in the process.

Bibliography

1. J. Eyler, D. Giles, C. Stenson, and C. Gray. *At a glance: What We Know about the Effects of Service-Learning on College Students, Faculty, Institutions and Communities, 1993-2000: Third Edition.* Vanderbilt University, 2001, URL http://www.compact.org/resource/aag.pdf

2. A. Driscoll, "Studying Faculty and Service-Learning: Directions for Inquiry and Development," *Michigan Journal of Community Service Learning*, Fall 2000, Special Issue, pp. 35-41, 2000.

3. C. Hammond, "Integrating Service and Academic Study: Faculty Motivation and Satisfaction in Michigan Higher Education," *Michigan Journal of Community Service Learning*, Fall 1994, Vol. 1, No. 1, pp. 21-28, 1994.

4. G. Hesser, "Faculty Assessment of Student Learning: Outcomes Attributed to Service-Learning and Evidence of Changes in Faculty Attitudes about Experiential Education," *Michigan Journal of Community Service Learning*, Fall 1995, pp. 33-42, 1995.

5. V. McKay and P. Rozee, "Characteristics of Faculty Who Adopt Community Service Learning Pedagogy," *Michigan Journal of Community Service Learning*, Spring 2004, pp. 21-33, 2004.

6. E. Abes, G. Jackson, and S. Jones, "Factors that Motivate and Deter Faculty Use of Service-Learning," *Michigan Journal of Community Service Learning*, Fall 2002, pp. 5-17, 2002.

7. S. Adams and F. Pereira, "Measuring Faculty Preparation to Lead Teams in the Engineering Classroom: A Pilot Study," *Proceedings, 2002 ASEE Annual Conference,* ASEE, Montreal, Quebec, Canada, 2002.

8. M. Zwyno, "Engineering Faculty Teaching Styles and Attitudes toward Student-Centered and Technology-Enabled Teaching Strategies," *Proceedings, 2003 ASEE Annual Conference,* ASEE, Nashville, TN, 2003.

9. J. Mitchell, "Time Professors Spend Improving their Teaching," *Proceedings, 34th ASEE/IEEE Frontiers in Education Conference*, IEEE, Savannah, GA, 2004.

10. W. Oakes, *Service-Learning in Engineering: A Resource Guidebook*, Campus Compact, Providence, RI, 2004, URL http://www.compact.org/publication/SL_and_Engineering-WEB.pdf

11. E. Tsang, *Projects that matter: Concepts and models for service learning in engineering*, American Association for Higher Education, Washington, DC, 2000.

12. M. Pinnell, C. Daprano, and G. Williamson, "A Multi-Disciplinary Community Based Service-Learning Project: The Girl Scout Wall Project," *Proceedings, 2003 ASEE Annual Conference,* ASEE, Nashville, TN, 2003.

13. E. Tsang, "Integrating Service-Learning in a Sophomore-level Materials, Manufacturing & Design Lab," *Proceedings, 2002 ASEE Annual Conference,* ASEE, Montreal, Quebec, Canada, 2002.

14. W. Oakes, J. Duffy, T. Jacobius, P. Linos, S. Lords, W. Schultz, and A. Smith, "Service Learning in Engineering," *Proceedings, 32nd ASEE/IEEE Frontiers in Education Conference*, IEEE, Boston, MA, 2002.

15. J. Duffy, E. Tsany, and S. Lord, "Service-Learning in Engineering: What, Why, and How," *Proceedings, 2000 ASEE Annual Conference,* ASEE, St Louis, MS, 2000.

16. Orne, M. T. "On the social psychology of the psychological experiment: With particular reference to demand characteristics and their implications," *American Psychologist, 17,* pp. 776–783, 1962.

Biographical Information

AMY BANZAERT is a graduate student in MIT's mechanical engineering department. Previously, she worked for three years as MIT's service learning coordinator, developing the program from its early beginnings. She has also worked as a design and manufacturing engineer for Texas Instruments.

SUMI ARIELY is Research and Assessment Coordinator for the MIT Public Service Center and senior lecturer at the Sloan School of Management. She received her Ph.D. from the University of North Carolina at Chapel Hill in 1999.

DAVID WALLACE is Esther and Harold E. Edgerton Associate Professor in the Department of Mechanical Engineering at MIT. He is principal investigator on an NSF grant supporting service learning work in the mechanical engineering department at MIT.

BARBARA MASI is the Director of Education Innovation and Assessment in the MIT School of Engineering. Dr. Masi was an evaluator for the NSF ECSEL project at MIT, and has consulted on numerous engineering education, online learning, and K-12 math/ science project.