

Educating Engineers for the 21<sup>st</sup> Century: A Framework for Skill Development  
Through Co-Curricular and Extracurricular Involvement

by

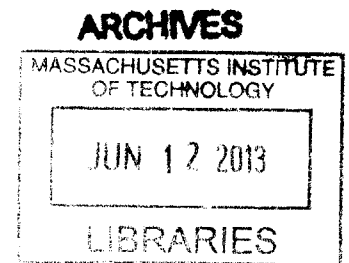
Dara R. Fisher

B.S.E., Earth Systems Science and Engineering  
University of Michigan, 2011

Submitted to the Engineering Systems Division  
in Partial Fulfillment of the Requirements for the Degree of  
Master of Science in Technology and Policy

at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY  
June 2013



© 2013 Massachusetts Institute of Technology  
All Rights Reserved

Signature of Author \_\_\_\_\_  
Technology and Policy Program  
Engineering Systems Division  
May 10, 2013

Certified by \_\_\_\_\_  
Sanjay Sarma  
Professor of Mechanical Engineering  
Thesis Supervisor

Accepted by \_\_\_\_\_  
Dava J. Newman  
Professor of Aeronautics and Astronautics and Engineering Systems  
Director, Technology and Policy Program



# Educating Engineers for the 21<sup>st</sup> Century: A Framework for Skill Development Through Co-Curricular and Extracurricular Involvement

by

Dara R. Fisher

Submitted to the Engineering Systems Division on May 10, 2013  
in Partial Fulfillment of the Requirements for the Degree of  
Master of Science in Technology and Policy

## **ABSTRACT**

As the global marketplace becomes increasingly interconnected and multidisciplinary, graduates of undergraduate engineering programs face new challenges in communication, creative thinking, and teamwork as they enter the international workforce. To address this shift, over the last two decades American universities have adjusted educational objectives of undergraduate engineering programs to include new themes in international awareness, communication, teamwork, and other professional skills.

Motivated by student leadership development programs at the new Singapore University of Technology and Design (SUTD), this thesis examines how student engagement in co-curricular and extracurricular activities promotes professional skill development in engineering education at the undergraduate level. Using a two-stage analysis of MIT student organizations and current literature in student involvement, this work presents a two-dimensional framework of the leadership and professional skills developed through participation in 22 categories of co-curricular and extracurricular involvement. The relevance of these skills to engineering education and practice is validated through interviews with managers and supervisors of entry-level engineers. In addition, these skills are compared with key educational outcomes specified by ABET, Inc. (previously known as the Accreditation Board for Engineering and Technology), further validating the relevance of the two-dimensional framework of skill development to engineering practice. Lastly, this thesis provides an analysis of strategies to promote student involvement and leadership development in engineering undergraduates.

Thesis Supervisor: Sanjay Sarma  
Title: Professor of Mechanical Engineering





# Acknowledgments

---

First and foremost, I would like to thank my advisor and mentor, Sanjay Sarma, for all of his help and support over the past year and a half of work on the SUTD project. Sanjay, I had no idea what I was getting into when I walked into your office in December 2011, and the opportunities you have given me over the past 18 months are more than any grad student ever could have asked for. Thank you so much for enabling me to learn and grow as a researcher as much as I have during my time at MIT; I absolutely could not have asked for a better advisor.

In addition, I would not have been able to succeed in Singapore (and beyond) had it not been for the incredible help and support of the MIT-SUTD Collaboration and MISTI staff members, including John Brisson, Anine Ward, Jon Griffith, Kate Rhodes, Sean Gilbert, and Matt Burt. I also send special thanks and gratitude to Katerina Bagiati, my mentor in research and globetrotting partner-in-crime. Katerina, thank you so much for your insight and guidance during my bumpy introduction to academic writing and presenting; I would not have achieved half of what I did this year without you.

During my academic career, I have also been blessed with numerous mentors and friends who continue to provide their advice and guidance this day. My success could not have been possible without two remarkable Wolverines, James Holloway and Jennifer Wegner, whose advice and inspiration continues to motivate me at MIT and beyond. Special thanks also go to my mentors in Washington, Danielle Evers and Franca Jones, two amazing women whom I aspire to emulate some day.

This thesis would not have been possible without the help and support of my friends outside of TPP, who took the time to remind me of the world outside of E40 when I needed it. Thank you Katie Duffy, Eve Dolkart, Josephine Wolff, and Chris Peterson for inviting me out and maintaining my good spirits when I had pages and pages ahead of me to write. Special thanks to my long-distance pen- and video chat-pals Steph Parrish and Raleigh Davis, whose support over the past two years has been both invaluable and consistently hilarious.

I would like to thank my TPP family for all of their love and support during my tenure at MIT. I would not have made it through these two years without your academic support in reading group, willingness to drop everything for a quick meal at Cosi, and unending faith in my trip and excursion planning abilities. I look forward to traveling the world to see each and every one of you, and my couch is always open should you find yourselves again in Cambridge.

Lastly, to Dad and Joyce—despite my initial hesitations regarding my return to Boston, I have loved the opportunity to be close to you, my family. Much love to you both, and I am so excited for another five years together.



# Table of Contents

---

|                                                                            |           |
|----------------------------------------------------------------------------|-----------|
| <b>Acknowledgments .....</b>                                               | <b>5</b>  |
| <b>Table of Contents .....</b>                                             | <b>7</b>  |
| <b>Chapter 1: Introduction .....</b>                                       | <b>11</b> |
| 21 <sup>st</sup> Century Engineering Education .....                       | 11        |
| Student Life and Campus Involvement.....                                   | 13        |
| Project Motivation: The Singapore University of Technology and Design..... | 14        |
| Thesis Organization.....                                                   | 15        |
| <b>Chapter 2: Creating a Framework for Student Involvement.....</b>        | <b>17</b> |
| MIT Student Governance .....                                               | 17        |
| <i>The Undergraduate Association (UA)</i> .....                            | 17        |
| <i>The Graduate Student Council (GSC)</i> .....                            | 18        |
| <i>The Association of Student Activities (ASA)</i> .....                   | 18        |
| MIT Student Groups.....                                                    | 19        |
| <i>Group Recognition</i> .....                                             | 19        |
| <i>Funding Sources</i> .....                                               | 19        |
| Producing Student Organization Categories .....                            | 20        |
| <i>ASA Database</i> .....                                                  | 20        |
| <i>Methods for Analysis</i> .....                                          | 21        |
| <i>Results</i> .....                                                       | 21        |
| <i>Construction of 2D Framework</i> .....                                  | 23        |
| <b>Chapter 3: Student Skill Development by Organization Type.....</b>      | <b>25</b> |
| Skill Definitions .....                                                    | 25        |
| Literature Review By Organization Type .....                               | 25        |
| <i>Academic &amp; Professional Organizations</i> .....                     | 25        |
| <i>Academic Competitions</i> .....                                         | 26        |
| <i>Advocacy Groups</i> .....                                               | 28        |
| <i>The Arts</i> .....                                                      | 29        |
| <i>Athletics</i> .....                                                     | 30        |
| <i>Campus Community Organizations</i> .....                                | 31        |
| <i>Cultural Interest Groups</i> .....                                      | 31        |
| <i>Departmental Groups</i> .....                                           | 32        |
| <i>Energy &amp; the Environment</i> .....                                  | 33        |
| <i>Games &amp; Hobbies</i> .....                                           | 34        |
| <i>Greek Life</i> .....                                                    | 35        |

|                                                                                 |           |
|---------------------------------------------------------------------------------|-----------|
| <i>Honorary Organizations</i> .....                                             | 35        |
| <i>Housing Community Associations</i> .....                                     | 36        |
| <i>Innovation &amp; Entrepreneurship Groups</i> .....                           | 37        |
| <i>Martial Arts</i> .....                                                       | 38        |
| <i>Media</i> .....                                                              | 38        |
| <i>Professional Organization Chapters</i> .....                                 | 39        |
| <i>Project Teams</i> .....                                                      | 39        |
| <i>Recreation</i> .....                                                         | 41        |
| <i>Religious Groups</i> .....                                                   | 41        |
| <i>Service Organizations</i> .....                                              | 42        |
| <i>Student Governance</i> .....                                                 | 42        |
| Construction of 2D Framework of Student Skill Development.....                  | 43        |
| <b>Chapter 4: Framework Validation through Supervisor Interviews .....</b>      | <b>47</b> |
| Study Procedure .....                                                           | 47        |
| <i>Participant Identification</i> .....                                         | 47        |
| <i>Interview Protocol</i> .....                                                 | 48        |
| <i>Respondent Demographics</i> .....                                            | 49        |
| Validation of Key Skills .....                                                  | 49        |
| <i>Additional Skills Identified Through Interviews</i> .....                    | 58        |
| <i>Validated Framework</i> .....                                                | 59        |
| Reflections on Student Involvement at MIT .....                                 | 62        |
| <i>Building Community</i> .....                                                 | 62        |
| <i>Time Management and Work/Life Balance</i> .....                              | 63        |
| <i>Collaboration and Teamwork</i> .....                                         | 63        |
| <i>Personal Development</i> .....                                               | 64        |
| <i>MIT and Entrepreneurship</i> .....                                           | 64        |
| <i>Networking</i> .....                                                         | 65        |
| <b>Chapter 5: Framework Validation through ABET Accreditation Criteria.....</b> | <b>67</b> |
| ABET and the Development of EC2000.....                                         | 67        |
| <i>History of ABET</i> .....                                                    | 67        |
| <i>EC2000 Accreditation Criteria</i> .....                                      | 68        |
| Validation of 2D Framework Skills .....                                         | 69        |
| <i>Relationship of EC2000 Criteria to Framework Skills</i> .....                | 69        |
| <i>Validated Framework</i> .....                                                | 71        |
| <b>Chapter 6: Policy Mechanisms to Promote Student Involvement .....</b>        | <b>75</b> |
| University-Level Processes .....                                                | 75        |
| <i>Divisions of Student Affairs</i> .....                                       | 75        |
| <i>Student-Led Governance Mechanisms</i> .....                                  | 76        |

|                                                                        |           |
|------------------------------------------------------------------------|-----------|
| <i>Undergraduate Leadership Programs</i> .....                         | 77        |
| <i>University Business Plan Competitions</i> .....                     | 78        |
| Governmental Initiatives .....                                         | 79        |
| <i>Broader Impacts Requirements for Federal Research Funding</i> ..... | 79        |
| <i>Administration Initiatives</i> .....                                | 80        |
| <i>Challenge.Gov</i> .....                                             | 81        |
| <i>Legislation</i> .....                                               | 81        |
| Private and Nonprofit Organizations .....                              | 82        |
| <i>Professional Societies</i> .....                                    | 82        |
| <i>Intercollegiate Organizations</i> .....                             | 82        |
| <i>National and International “Challenges”</i> .....                   | 83        |
| <i>Social Media</i> .....                                              | 84        |
| Recommendations .....                                                  | 85        |
| <b>Chapter 7: The SUTD Approach</b> .....                              | <b>87</b> |
| MIT International Science and Technology Initiatives .....             | 87        |
| <i>History and Background</i> .....                                    | 87        |
| <i>The Singapore Leadership Initiative</i> .....                       | 88        |
| <i>Inaugural MISTI-SLI Cohort</i> .....                                | 89        |
| MISTI-SLI Pre-Departure Training .....                                 | 89        |
| <i>Preparation for Study Abroad: Parkinson’s Best Practices</i> .....  | 91        |
| <i>Leadership Training: The Social Change Model</i> .....              | 91        |
| The SUTD-MIT 5 <sup>th</sup> Row Leadership Programme .....            | 92        |
| <i>SUTD Participant Recruitment and Team Introductions</i> .....       | 92        |
| <i>Orientation</i> .....                                               | 93        |
| <i>Leadership Sessions</i> .....                                       | 93        |
| <i>SUTD 5<sup>th</sup> Row Activities Showcase</i> .....               | 95        |
| <i>Program Outcomes</i> .....                                          | 95        |
| Applicability to Student Skill Development .....                       | 96        |
| <b>Chapter 8: Conclusions</b> .....                                    | <b>97</b> |
| Final 2D Framework of Validated Skills .....                           | 97        |
| Project Limitations .....                                              | 100       |
| <i>Limitations of Existing Student Involvement Research</i> .....      | 100       |
| <i>Variations in Cultural Context</i> .....                            | 100       |
| Opportunities for Future Research .....                                | 100       |
| <i>Additional Validation Methodologies</i> .....                       | 100       |
| <i>Cross-Comparison of Validation Criteria</i> .....                   | 100       |
| <i>Longitudinal Studies of Student Skill Development</i> .....         | 101       |
| <i>Student Life and Online Education</i> .....                         | 101       |
| <i>Impacts of Different Policy Mechanisms</i> .....                    | 102       |

|                                                                   |            |
|-------------------------------------------------------------------|------------|
| Framework Applicability .....                                     | 102        |
| <b>References.....</b>                                            | <b>103</b> |
| <b>Appendix A: Coding Scheme for ASA-Registered Groups .....</b>  | <b>115</b> |
| <b>Appendix B: Skill Definition for Development Analysis.....</b> | <b>119</b> |
| <b>Appendix C: Request for Interview Text .....</b>               | <b>123</b> |

# Chapter 1: Introduction

---

This thesis considers both student involvement and undergraduate engineering education. This research borrows from both existing student affairs and engineering education literature to create a framework for student skill development at the intersection of these two fields. Although the implications of this work are applicable to any institution with an undergraduate program in engineering, this research was performed in the specific context of the Singapore University of Technology and Design (SUTD), a new engineering and design institution established with particular focus on student engagement both inside and outside of the classroom.

## **21<sup>ST</sup> CENTURY ENGINEERING EDUCATION**

Two distinct events have defined modern research and policy in engineering education: the restructuring of the accreditation requirements of ABET (previously known as the Accreditation Board for Engineering and Technology) in 1997 and the national and international feedback to the “Engineer of 2020” reports released by the American National Academy of Engineering (NAE) in 2004 and 2005. These two events have shaped over a decade of research in engineering education, prompting both domestic and international institutions to re-imagine how they approach the education of both undergraduate and graduate engineers.

Originally called the Engineers’ Council for Professional Development (ECPD), ABET, Inc. was founded in 1932 by seven major engineering societies with the mission to serve as “an engineering professional body dedicated to the education, accreditation, regulation, and professional development of the engineering professionals and students in the United States” (ABET, 2011). In its first 20 years of operation, ECPD accredited over 500 engineering and engineering technology degree programs and produced numerous guidance and training publications including the “Reading List for Junior Engineers” in 1945 and “Speaking Can be Easy...for Engineers Too” in 1950 (ABET, 2011). Today, ABET accredits more than 3,100 domestic and international engineering programs at over 600 colleges and universities (ABET, 2011).

In 1997, ABET adopted a new set of accreditation criteria, called Engineering Criteria 2000 (EC2000) (ABET, 2011). These new criteria adopted an outcomes-based education (OBE) assessment approach rather than the traditional teaching-based approach employed by ABET pre-1997 (ABET, 2011). In addition to “hard science” learning outcome requirements, EC2000 also includes outcomes related to professional and communication skills, including but not limited to ethics, teamwork, professional communication, and knowledge of contemporary issues (Shuman, Besterfield-Sacre, & McGourty, 2005). These reforms reflected continued discussion among engineering education and technology policy professionals during the latter half of the

20<sup>th</sup> century citing the consistent need for professional, communicative, and innovative engineers (Shuman et al., 2005).

A 1992 study conducted by the Center for the Study of Higher Education at Pennsylvania State University found considerable change in engineering curricula in response to EC2000, citing “greater emphasis on professional skills and active learning after EC2000” (Lattuca, Terenzini, & Volkwein, 2006, p. 3). Student self-reports of communication and professional skills after the implementation of EC2000 indicate that students are better prepared upon graduation than their counterparts before the EC2000 criteria were implemented (Lattuca et al., 2006). Despite these observed outcomes, there still exists disagreement within the engineering education community as to the appropriateness of an OBE approach to engineering accreditation (Riley, 2012), and this discussion is likely to continue as ABET’s influence continues to spread internationally (Prados, Peterson, & Lattuca, 2005).

As colleges and universities were in the process of adapting their curricula in response to EC2000, in 2001 the American National Academy of Engineering (NAE) began an initiative to set a vision and chart the course for American engineering education in the 21<sup>st</sup> century (National Academy of Sciences [NAS], 2004). In the second report of this project, *Educating the Engineer of 2020: Adapting Engineering Education to the New Century*, the NAE sought to define “how to enrich and broaden engineering education so that those technically grounded graduates will be better prepared to work in a constantly changing global economy” (NAS, 2005). Synthesizing the needs of the academic and industrial components of the engineering profession, this report offered policy recommendations in the realms of undergraduate and graduate education, K-12 engineering outreach, faculty training and qualifications, and initiatives to promote lifelong learning (NAS, 2005). A notable recommendation of this report was the concept of a B.S. “preengineering” or “engineer in training” degree (NAS, 2005). Under this system, an M.S. in engineering serves as a “professional” degree required to practice in the field, while a B.S. serves as a general introduction to engineering (NAS, 2005). Although this model has yet to be widely adopted in the United States, some institutions—such as the Thayer School of Engineering at Dartmouth College—have practiced this curriculum design since as early as the 1960’s (Hansen, 2006).

The impact of the *Engineer of 2020* reports was both significant and far-reaching; these publications have been credited with setting the stage “to substantively elevate the status of education research in faculty performance reviews, improve engineering educational research quality by demanding appropriate assessment, attract engineering professors into the field, and increase collaborations between engineering faculty and faculty in other areas” (Haghighi, 2005). In addition, the “Engineer of 2020” concept has become a dominant theme in the engineering education literature both domestically and internationally as other nations attempt to define the



scope of their engineering education over the next decade and beyond (Nor, Rajab, & Ismail, 2008).

As is demonstrated by the impacts of EC2000 as well as the *Engineer of 2020* reports, the field of engineering education is currently characterized by discussion and debate regarding the best methods to prepare engineering graduates for the demands of the 21<sup>st</sup> century workplace. Colleges, universities, and other academic organizations will undoubtedly continue to grapple with this issue for years to come, testing new initiatives and curriculum methodologies to best prepare their students for the challenges ahead. Additionally, the field of engineering education itself is on a path towards international unification; as the EC2000 requirements continue to expand to institutions abroad, American institutions will be able to engage more easily in collaborations with students and researchers across the globe.

## **STUDENT LIFE AND CAMPUS INVOLVEMENT**

Most universities in the United States offer infrastructure for co-curricular<sup>1</sup> and extracurricular involvement to their students, be it through the arts, journalism, or in the form of student government. Many colleges and universities consider the criteria of co-curricular and extracurricular involvement in their freshman admissions decisions (Kaufman & Gabler, 2004), and students often continue to be involved in clubs and student organizations after enrolling in college.

The dominant theory of the benefits of student involvement in college is Alexander Astin's 1984 "student involvement theory" (Astin, 1984). Motivated by longitudinal research on the motivation of college dropouts, this theory was developed in response to the traditional "black box" analyses of student development during college, which remove the student as a factor in his/her own development (Astin, 1984). According to Astin's theory, "the greater the student's involvement in college, the greater the amount of student learning and personal development" (Astin, 1984). In this case, "involvement" is defined as "the quantity and quality of the physical and psychological energy that students invest in the college experience," which can take the form of extracurricular engagement, time studying, or faculty or peer interactions (Astin, 1984). Astin followed this theory with the development of the input-environment-outcome (I-E-O) conceptual framework for the study of students, which continues to be employed widely in educational research (Astin & Sax, 1998).

---

<sup>1</sup> Within the context of this study, "co-curricular" activities are those administratively tied to a student's academic life such as undergraduate research or some multidisciplinary design projects (University of Michigan College of Engineering, 2013), while extracurriculars are activities pursued by students entirely outside of the academic experience.

The general consensus of literature specific to co-curricular and extracurricular involvement is consistent with Astin's theory; most research concludes that this type of involvement has positive impact on students. Broadly, the literature states that "college student organization participation cultivates satisfaction with the college experience, increases campus and community involvement, and enhances intellectual development" among other benefits (Montelongo, 2002). Additionally, there is an observed positive relationship between student engagement and persistence in undergraduate degree programs (Kuh, Cruce, Shoup, Kinzie, & Gonyea, 2008). Generally, students involved in co-curricular and extracurricular activities are less likely to drop out of college than their non-involved counterparts; at American institutions, this is especially true of lower-ability students as well as students of color (Kuh et al., 2008).

Despite the existence of these and other broad theories concerning student involvement, there exists relatively little area-specific literature regarding the specific benefits or issues with particular co-curricular and extracurricular involvement types such as student government, journalism, or the arts. Notable exceptions include student involvement in Greek Life (Asel, Seifert, & Pascarella, 2009), varsity athletics (Aries, McCarthy, Salovey, & Banaji, 2004), cultural and diversity initiatives (Museus, 2008), and community service (Astin & Sax, 1998). One possible explanation for this uneven distribution of research is the public visibility of these involvement areas; these four activity types are generally the most often discussed in the media and public discourse, raising their profiles and possibly prompting demand for relevant academic research. In contrast, this research seeks to identify benefits of all student involvement types, then place these benefits in the context of the skills required to effectively practice engineering.

## **PROJECT MOTIVATION: THE SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN**

In 2010, the Massachusetts Institute of Technology (MIT) entered into a collaboration with the Singapore Ministry of Education to begin development of the Singapore University of Technology and Design (SUTD), the fourth publicly supported technical university in Singapore (Sakhrani, Bagiati, Sarma, & de Neufville, 2012). Although the SUTD Collaboration project would be MIT's most holistic transplantation venture to date at its time of initiation, the Institute has a long history of international educational projects dating back to the 1950's and 60's (Sakhrani et al., 2012). In the 60 years preceding the initiation of the SUTD project, MIT engaged in major academic collaborations in India, Iran, the United Kingdom, Malaysia, Brazil, Portugal, and the United Arab Emirates of varying scope and scale (Sakhrani et al., 2012). From these collaborative experiences, MIT's administration and faculty gained valuable insight regarding the efficacy of their international practices and programs, preparing the Institute for a large-scale institutional transplantation venture like SUTD (Sakhrani et al., 2012).

In the SUTD Collaboration project, MIT staff and faculty have approached the goal of “institutional transplantation” through three specific avenues: (1) curriculum design and development, (2) faculty training, and (3) student life initiatives (Fisher et al., 2012). Through each of these avenues, MIT seeks to communicate its academic culture and mentality to the new institution, creating student and faculty cultures similar to those found at MIT’s campus in Cambridge (Fisher et al., 2012). In both the student and faculty arenas MIT’s culture can be described as entrepreneurial, innovative, multidisciplinary, and occasionally irreverent, and it is these characteristics that the Collaboration team sought to communicate to the new SUTD community (Fisher et al., 2012).

In the realm of student life, the MIT team chose the vehicle of co-curricular and extracurricular involvement to communicate the student culture of MIT to SUTD (Fisher et al., 2012). As was described in the “Student Life and Campus Involvement” section above, participation in student organizations contributes to the “valued outcomes of college” (Kuh, 1995) and is a major vehicle for student interaction both within and between members of college classes. In its inaugural year of operation, the SUTD students and administration—with support from the MIT-SUTD Collaboration staff—sought to establish strong extracurricular and co-curricular opportunities for students, referred to as the “5<sup>th</sup> Row” within the SUTD community. As a result of these efforts, after only three months of formal academic operation the 320 freshman students of SUTD had initiated over 20 student clubs and organizations, with many students participating in more than one “5<sup>th</sup> Row” activity.

Inspired by the success of co-curriculars and extracurriculars at SUTD in its inaugural year, through this research we seek to justify continued support for all SUTD student-initiated clubs and organizations as the institution grows and establishes itself within the Singaporean educational landscape. In addition, in this thesis we present an argument for student self-governance regarding campus issues and suggests that a student-driven model be maintained at SUTD in the future.

## **THESIS ORGANIZATION**

Although some literature exists on the benefits of student involvement to aspiring engineers, these studies have traditionally been confined to specific skill areas such as ethical development (Finelli, Holsapple, Ra, Bielby, Burt, Carpenter, Harding, & Sutkus, 2012) or specific involvement types such as participation in multidisciplinary design teams (Coyle, Jamieson, & Oakes, 2005). Here, we seek to develop, present, and validate a two-dimensional framework for the professional skills of relevance to the study and practice of the engineering profession developed through all types of co-curricular and extracurricular involvement. This framework validates the benefits of involvement of engineering undergraduates in any type of

student organization, despite generally held perceptions regarding the benefits of particular involvement types.

In Chapter 2, an analysis is performed of the 436 student organizations registered in January 2013 with the MIT Association of Student Activities, the recognition body for all student clubs and activities at the Institute. Through this analysis, 22 “categories” of student involvement are defined, encompassing 99% of the registered groups at MIT.

In Chapter 3, small-scale literature reviews are performed for each of the 22 categories identified in Chapter 2, with the goal of identifying “key skills” fostered by participation in each type of activity. When combined with the involvement categories, these key skills form a “2D Framework of Student Involvement,” illustrating the benefits of involvement in each activity type.

In Chapter 4, the results of interviews with practicing engineering managers and supervisors are used to validate the relevance of the “key skills” in Chapter 3 to the demands and requirements of the engineering profession. Those skills not identified by interviewees are noted and hypotheses regarding the reasons for omission are provided. In addition, interviewee reflections regarding the strengths and weaknesses of an MIT undergraduate education are discussed.

Chapter 5 further validates the relevance of the 2D Framework using ABET-specified EC2000 learning outcomes. The relationship between these outcomes and the Chapter 4 interview results are discussed and analyzed in terms of practical relevance to engineering students and academic organizations.

Chapter 6 presents an analysis of methodologies by which universities promote leadership and involvement in undergraduate students. It presents a set of “best practices” for student self-governance and other recommendations to promote student engagement.

In Chapter 7, the inaugural “5<sup>th</sup> Row Leadership Programme” at the Singapore University of Technology and Design (SUTD) is used as a case study of efforts to promote student leadership at a new academic institution. The methodologies used to design and implement this program are discussed, as well as the limitations of the work and opportunities for future research at SUTD.

Chapter 8 provides broad conclusions regarding the implications of the 2D Framework as well as its relevance and applicability at institutions of higher education. Possible future work building from this effort is defined within both the SUTD context and the broader higher education landscape.

# Chapter 2: Creating a Framework for Student Involvement

---

To begin analysis for a framework of student skill development, the Massachusetts Institute of Technology (MIT) was selected as a case study for undergraduate student involvement. MIT was selected as a case study for many reasons, including:

1. MIT's established reputation for undergraduate programs in engineering.
2. MIT's relationship with the Singapore University of Technology and Design (SUTD).
3. As a convenience sample based on researcher knowledge and proximity.

This chapter presents a brief history and overview of MIT student involvement, followed by an analytical categorization of the 436 student groups registered with the MIT Association of Student Activities in January 2013 (MIT Association of Student Activities [ASA], 2013). In later chapters, these categories will be employed as sub-categories for student extracurricular and co-curricular engagement, narrowing the broad topic of "student involvement" to well-defined, specific areas for skill development.

## MIT STUDENT GOVERNANCE

At MIT, three primary organizations are responsible for student governance, issue advocacy, group recognition, and funding: the Undergraduate Association (UA), Graduate Student Council (GSC), and the Association of Student Activities (ASA) (O'Keefe & Sarma, 2011). Each of these groups maintains its own distinct structure and operating procedures, each designed to best suit the needs of its particular constituents and membership (O'Keefe & Sarma, 2011). Although each of these organizations is distinct in this way, each is entirely staffed and governed by students, with faculty and staff members serving in purely advisory roles (O'Keefe & Sarma, 2011). The subsections below outline the overall structure and primary responsibilities of the UA, GSC, and ASA.

### *The Undergraduate Association (UA)*

The UA is the student government at MIT representing the Institute's roughly 4,500 undergraduate students (Institutional Research, n.d.). Modeled after the United States government, the operations arm of the UA is composed of three branches: the UA Executive Board, the UA Judicial Board, and the UA Senate (O'Keefe & Sarma, 2011). The 10 members of the Executive Board are elected annually by the student body; in addition, each graduating class elects a Class Council president, who also serves as a voting member of the UA Executive Board (O'Keefe & Sarma, 2011). By contrast, the UA Senate, the legislative body of the

Undergraduate Association, is composed of delegates elected by the individual MIT living communities (O’Keefe & Sarma, 2011). This Senate oversees the standing policy and administrative committees as well as ad hoc committees organized to address specific campus issues (O’Keefe & Sarma, 2011). The three members of the Judicial Board are appointed for each academic year by the previous year’s UA President, and are subject to confirmation by 2/3 of the sitting UA Senate (O’Keefe & Sarma, 2011). All MIT undergraduates are considered default members of the Undergraduate Association (O’Keefe & Sarma, 2011).

In addition to the three branch organizations of the Undergraduate Association, each MIT undergraduate class also elects its own Class Council, consisting of an eight-member board (O’Keefe & Sarma, 2011). These councils are responsible for organizing class-specific programming, and are allocated a budget—varying by class year—to spend on class events (O’Keefe & Sarma, 2011).

### *The Graduate Student Council (GSC)*

Although it serves a similar function to the UA, the GSC has a very different organizational structure to its undergraduate counterpart. The GSC General Council is the graduate student representative body, consisting of the eight co-chairs of the four standing GSC committees—Academic, Research, and Careers; Activities; Housing and Community Affairs; and Orientation—as well as the four-member Executive Committee and the GSC President of ASA (MIT Graduate Student Council [GSC], n.d.). In addition to the standing committees represented by co-chairs on the General Council, four committees are chaired by Executive Committee members: the Muddy Charles Pub, the Nominations Board, the Funding Board, and the Publicity and Publications Board (GSC, n.d.). The General Council also maintains the authority to form ad hoc committees as needed (O’Keefe & Sarma, 2011).

### *The Association of Student Activities (ASA)*

The ASA is a joint committee of the Undergraduate Association and Graduate Student Council, organized to oversee student groups and organizations at MIT (MIT ASA, n.d. a). The ten-member ASA Executive Board “advocates on behalf of student groups to gain resources for student groups’ benefit, allocates resources among student groups, and arbitrates among student groups and any other involved parties” (MIT ASA, n.d. a). Of these ten Executive Board members, two representatives are nominated by the UA and GSC Presidents; the remaining eight Board members are elected by the General Body, an organization composed of all ASA-recognized student groups (MIT ASA, n.d. a).

## MIT STUDENT GROUPS

### *Group Recognition*

As stated above, the MIT Association of Student Activities is the group responsible for managing the activities of MIT student groups. For most student organizations, the group recognition process is administered by ASA; club sports, however, are recognized and administered by the Club Sports Council (CSC) through the Department of Athletics, Physical Education, and Recreation (DAPER) (MIT ASA, n.d. c).

To begin the ASA recognition process, new groups may submit applications twice per semester for ASA Executive Board review (MIT ASA, n.d. c). The new group application requirements are as follows (MIT ASA, n.d. c):

1. An online questionnaire including information regarding group purpose, size of group, need for ASA recognition, and classification.
2. Membership of at least five MIT students with MIT students representing at least 50% of the total membership.
3. A constitution including group purpose, definition of membership, officer positions, election procedures, meeting information, and amendment processes.
4. Sponsorship letters (if seeking sponsorship from an MIT department or office).

Once the group application is complete, those seeking recognition must meet with the ASA Executive Board to review responses and determine final status as an ASA-recognized organization (MIT ASA, n.d. c). After recognition has been granted, new groups must submit start-up forms, confirm membership of five MIT students, submit MIT's anti-hazing form, provide a finalized constitution, and satisfy any other case-specific conditions as specified by the ASA Board (MIT ASA, n.d. c).

### *Funding Sources*

At MIT, there are a variety of groups that allocate funding to student organizations, and it is the responsibility of each student organization's leadership to seek out these sources and submit applications to support group activities (O'Keefe & Sarma, 2011). These funding organizations include, but are not necessarily limited to (MIT ASA, n.d. d):

- Student Activities Finance Office
- GSC Funding Board and Grants
- UA Finance Board, Senate Discretionary Fund, and Fresh Fund
- Club Sports Council
- MIT Large Event Fund
- Assisting Recurring Cultural and Diversity Events Fund

- Council of Arts Grants
- Public Service Center Grants
- Student Activities Office Supplementary Fund
- Weekends@MIT
- Baker Foundation
- Committee on Race and Diversity Grant Program
- Florez Humor Fund
- Graduate Student Life Grants

In addition, MIT student groups may seek outside funding to support their events and initiatives, and “are given the autonomy and responsibility to spend their funds as the group sees fit” (MIT ASA, n.d. d).

## **PRODUCING STUDENT ORGANIZATION CATEGORIES**

### *ASA Database*

The MIT Association for Student Activities maintains a public, online database of all ASA-registered student groups. As of January 2013, 436 student groups had entries in this database, with the following information available to the public on the database’s “The Groups” home screen (MIT ASA, 2013):

- Group name
- Abbreviation (if applicable)
- ASA status
- Link to group website
- Group description
- Meeting time

Although some of the groups omitted information in one or more of the aforementioned categories, each group’s name, website link, and ASA status was available for view (MIT ASA, 2013).

This database was selected for analysis because of its breadth in representation of MIT student groups; as ASA status is important in securing campus funding for activities and initiatives, it acts as a de facto indicator for status as an MIT student organization (MIT ASA, n.d. d). One limitation of this methodology, however, is the omission of many informal, cultural activities at MIT from analysis, notably groups like MIT’s undergraduate “hackers” (IHTEP Hack Gallery, 2011).



## *Methods for Analysis*

To analyze the ASA-registered student groups of MIT, group names and descriptions on the ASA database were examined for keywords indicating a broad student organization “category” in which the organization could be classified. As these keywords and categories were developed, a coding system was written and continuously revisited throughout the analysis process, using Babbie’s (2012) strategy for coding both manifest and latent content in unobtrusive research. This research methodology—classified by Babbie (2012) as “analytic induction”—requires a researcher to develop coding schemes and variables as relevant data is reviewed (Babbie, 2012). Although this methodology does have some associated risk in terms of misclassification of observations to support an emerging hypothesis (Babbie, 2012), it was deemed the most relevant method to examine the data in the ASA database and was executed carefully to avoid unintentional researcher bias.

To execute this method on the ASA database, several procedures were put in place to address non-classifiable data. In cases in which an accurate categorization could not be produced through this method, the “About” section of student group websites were used to provide supplemental information. When none of these methods could produce a categorization—because of either a lack of or unclear information—groups were coded as “Unclassifiable” in the analysis. Conversely, when student organization descriptions contained keywords for more than one organization type, researcher judgment was used to determine a primary classification for the organization. A full list of keywords and associated categories can be found in Appendix A: Coding Scheme for ASA-Registered Groups.

## *Results*

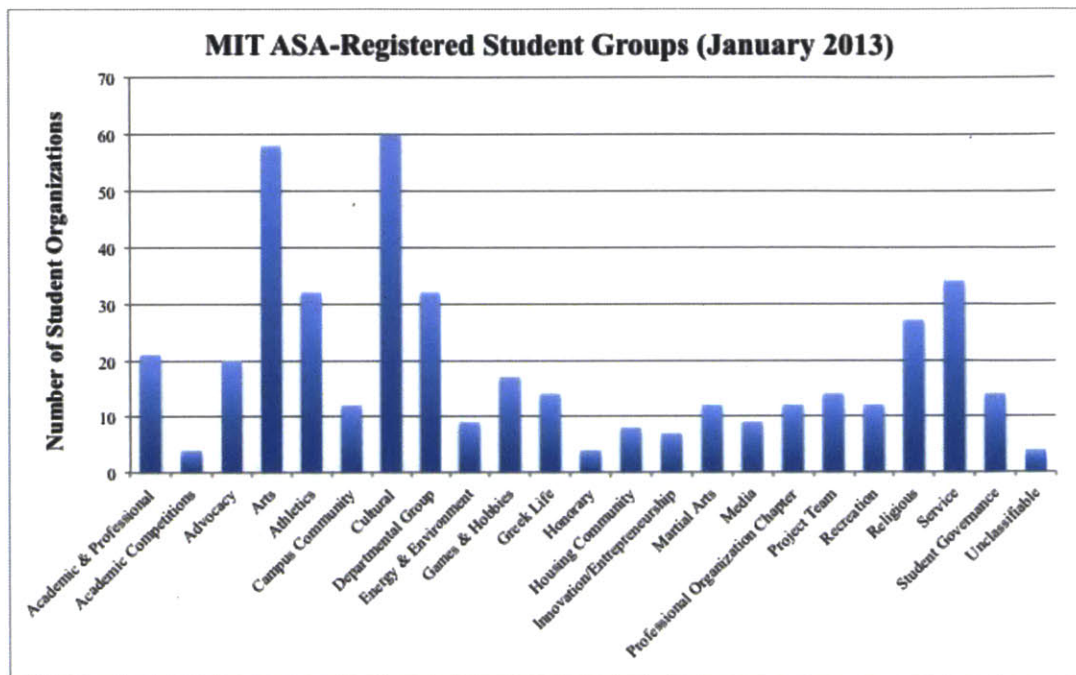
The above analysis of 436 student groups yielded 22 student group categories with between four and 60 organizations each; in addition, four organizations were deemed unclassifiable due to the lack of descriptive information available on the ASA database or on the groups’ organizational websites. A full breakdown of these group categories is available in Table 2-1 on page 22.

| Category                          | Number of Groups |
|-----------------------------------|------------------|
| Academic & Professional           | 21               |
| Academic Competitions             | 4                |
| Advocacy                          | 20               |
| Arts                              | 58               |
| Athletics                         | 32               |
| Campus Community                  | 12               |
| Cultural                          | 60               |
| Departmental Group                | 32               |
| Energy & Environment              | 9                |
| Games & Hobbies                   | 17               |
| Greek Life                        | 14               |
| Honorary                          | 4                |
| Housing Community                 | 8                |
| Innovation & Entrepreneurship     | 7                |
| Martial Arts                      | 12               |
| Media                             | 9                |
| Professional Organization Chapter | 12               |
| Project Team                      | 14               |
| Recreation                        | 12               |
| Religious                         | 27               |
| Service                           | 34               |
| Student Governance                | 14               |
| Unclassifiable                    | 4                |
| <b>TOTAL</b>                      | <b>436</b>       |

**Table 2-1: Breakdown of ASA-registered student groups by organizational category.**

As is illustrated in Table 2-1 above, arts groups, cultural organizations, and academic/professional activities have by far the greatest representation in the MIT student group community. By contrast, interest areas such as academic competitions and honorary

organizations each represented less than 1% of MIT student groups. A full comparison of each of the 22 group categories (as well as the unclassifiable groups) is presented in Figure 2-1 below.



**Figure 2-1: Distribution of organizational categories for ASA-registered student groups.**

### *Construction of 2D Framework*

The 22 student group categories developed through this methodology will be used as a case study for student organizations at technical institutions, employed as the classifications within a framework for student skill development. Chapter 3 presents a review of the existing student affairs research regarding student experience and learning in each of these categories, identifying key skills developed by participation in organizations in each activity type.



# Chapter 3: Student Skill Development by Organization Type

---

In the previous chapter, MIT student organizations were examined as a case study for student leadership at technical universities. The result of this analysis was a list of 22 student organization categories, through which 99% of student organizations at MIT could be decisively classified. In this chapter, each of these categories are independently addressed through a small-scale literature review to identify which leadership and professional skills, if any, have been demonstrated by students as a result of participation in the category's activities. When organizational categories lacked substantial student affairs or education literature, other relevant sources—such as national organizations or associations—were utilized to fill knowledge gaps when appropriate. At the conclusion of each small-scale literature review, a list of “key skills” was identified for each category; these key skills were then used to construct the final 2D framework of student skill development by organization type. In total, over 135 papers and other source documents were reviewed in the context of these literature searches.

## **SKILL DEFINITIONS**

For the purposes of this framework, working definitions were created for key skills areas as they were identified through the literature review. These definitions were used to identify keywords within the identified readings to indicate each type of skill. For a list of these working definitions, please refer to Appendix B: Skill Definition for Development Analysis.

## **LITERATURE REVIEW BY ORGANIZATION TYPE**

### *Academic & Professional Organizations*

During the student group categorization outlined in Chapter 2, “Academic & Professional Organizations” were classified as those clubs and organizations with focus on a specific MIT subject area interest such as medicine, consulting, synthetic biology, transportation, and many others. In addition, organizations with a particular focus on a specific profession or general career preparation were also classified as Academic & Professional Organizations. For the purposes of this study, the influence of internship or co-op participation on students was not considered.

When joining academic and professional organizations—specifically those relevant to a particular career path such as law or medicine—most students cite an interest in career development and exploration as a primary motivation for involvement (Holzweiss, Rahn & Wickline, 2007); in addition, many students also seek to gain disciplinary knowledge about their

chosen field or opportunities to network with students and mentors with similar interests (Holzweiss et al., 2007). After participating in organizations, students cite gains in their networking and public speaking abilities as well as their disciplinary knowledge (Holzweiss et al., 2007); academic literature review-based organizations in particular have been shown to increase student self-confidence and communication ability (Roddam, McCandless, Thewlis, & McDonald, 2009). When students assume leadership positions in these groups, coordinating events within an academic or professional group has been shown to expose students to skills such as organizational management, teamwork, public speaking, and communication in addition to enhancing disciplinary knowledge specific to the subject matter area (Bonczek, Snyder, & Ellis, 2007).

**Key skills:** Disciplinary Knowledge, Interpersonal Communication, Networking, Organizational Management, Public Speaking, Self-Confidence, Teamwork

### *Academic Competitions*

Of the 436 MIT student groups analyzed in Chapter 2, only four are categorized as “Academic Competitions:” the MIT Debate Team, the Harvard-MIT Mathematics Tournament, Model United Nations, and the MIT Quiz Bowl Team (MIT ASA, 2013). To broaden applicability to other universities, additional organization types such as Science and Math Olympiads and Mock Trial teams were also included in the Academic Competition literature review.

Student speeches and debates have been studied as a vehicle for student development both inside and outside of the classroom. As an instructional tool, debates are particularly effective as a forum to produce disciplinary knowledge, as students are forced to actively analyze and discuss information relevant to the debate topic at hand (Kennedy, 2007). Depending on the topic of a specific competition, debates can also increase a student’s humanitarianism (Bartanen, 1995) and empathy (Kennedy, 2007), global awareness (Bartanen, 1995), and civic responsibility (Huryn, 1986). Most notably, debating has been shown to increase students’ communication abilities—particularly in the realm of public speaking—and critical thinking skills by training students *how* to think rather than *what* they should think (Kennedy, 2007). Similarly, intercollegiate speech competitions have also been shown to increase students’ interpersonal communication skills and public speaking abilities (Kelly, 2005).

Intercollegiate Model United Nations (MUN) has a rich history dating back to the Harvard Model League of Nations of the early twentieth century; today, the “program has expanded to over 60 thousand students ranging in academic level from the sixth grade to graduate school” (McIntosh, 2001). Similar to student debates, MUN increases disciplinary awareness, civic responsibility, global awareness, and critical thinking skills in students

depending on the topic chosen for conferences and other activities (McIntosh, 2001). In preparing for conferences and MUN events, students also develop communication and teamwork skills (McIntosh, 2001) in addition to public speaking practice at the events themselves (Muldoon, 1995). In its student leaders, MUN fosters organizational management skills; organizing MUN activities is so time-consuming, in fact, that few MUN Secretariats have enough spare time or resources to remain up-to-date on the activities of the United Nations itself (Muldoon, 1995). Lastly, MUN presents a unique opportunity for student networking among domestic and international universities (Muldoon, 1995).

Used as a teaching tool in law-related education in the United States, intercollegiate Mock Trial dates back to 1985, when the first national American Mock Trial Association tournament was held between the teams of twelve participating universities (Vile & Van Dervort, 1994). Mock Trial, which situates students in a simulation “courtroom” to debate a legal case at the state or federal level, gives students valuable disciplinary and strategy knowledge about political science and the legal profession (Vile & Van Dervort, 1994). In evaluating the positions of the prosecution and defense for these cases, students increase their critical thinking while gaining exposure to the ethical implications of the legal profession (Shepelak, 1996). In addition, students’ teamwork and public speaking abilities are also developed as a result of participation in intercollegiate Mock Trial (Vile & Van Dervort, 1994).

The final types of student organization researched as a subset of this category are intercollegiate math and science competitions. The International Mathematical Olympiad (IMO) is a high school competition designed to “bolster educational quality” in K-12 mathematics worldwide (Biondi, Vasconcellos, & Menezes-Filho, 2012). Although not available at the undergraduate level, similar organizations—such as the Harvard-MIT Mathematics Tournament—do exist to facilitate intercollegiate competition (MIT ASA, 2013); because of their structural similarities to the IMO and similar secondary-level competitions, IMO participation is considered equivalent to undergraduate math competition participation for the purposes of this study. At the secondary level, the IOD and similar competitions have been shown to increase students’ disciplinary knowledge, motivation, memorization, and self-direction in studying and preparation for competition (Biondi et al., 2012). Intercollegiate science competitions, on the other hand, have been shown to demonstrate student development in disciplinary knowledge, ability to work in teams, and networking skills (Ward & Rude, 2010).

**Key skills:** Civic Responsibility, Critical Thinking, Disciplinary Knowledge, Ethics, Global Awareness, Humanitarianism, Interpersonal Communication, Memory, Networking, Organizational Management, Public Speaking, Self-Direction, Strategy, Teamwork, Time Management

## *Advocacy Groups*

Activities categorized as “Advocacy Groups” through the analysis performed in Chapter 2 can be classified in two distinct categories: political advocacy organizations and campus or group advocacy organizations. Although these two organizational subcategories are associated with similar types of skill development, specific distinctions can be identified between the two types of advocacy organizations.

Campus political advocacy groups are those organizations associated with a particular political party or movement; members in these types of organizations have been studied at length as “campus activists” since the student protests of the 1960’s and 70’s (Kerpelman, 1969). First and foremost, participation in political advocacy groups has been shown to develop civic responsibility in participating students as they get to know political and influence structures of a university, political, or special interest group (Freyss, 2006). In addition, students are shown to develop interpersonal communication skills as they interact with relevant stakeholders and policymakers within their area of engagement (Freyss, 2006). Lastly, students with an interest in political advocacy at the undergraduate level are given opportunities to network within politically engaged communities, a practice shown to lead to civic engagement and activism later in life (McFarland & Thomas, 2006). In some cases, this can also include interaction with members different socioeconomic and cultural groups, contributing to students’ cross-cultural skill development (Freyss, 2006).

Campus and group advocacy organizations, on the other hand, are groups devoted to the causes of a particular interest group on campus, in a campus community, or at a national or international level. These causes can span a multitude of subject areas, from the rights of particular groups—such as undocumented students or lesbian, gay, bisexual, or transgender (LGBT) individuals—or causes such as the environment or animal rights. Although participation in campus and group advocacy groups has been shown to demonstrate student skills similar to political advocacy organizations—such as civic responsibility and interpersonal communication (Gonzales, 2008)—these organizations also foster unique skills and attributes in participating students. Because campus and group advocacy organizations often interact with complex bureaucracies such as local governments or university administrations, students in these organizations are exposed to skills such as organizational management (Zimmerman & Halfacre-Hitchcock, 2006), teamwork (Case, Kanenberg, Erich, & Tittsworth, 2012), public speaking (Case et al., 2012), strategic thinking (Zimmerman & Halfacre-Hitchcock, 2006), and critical thinking (Goodhart, Hsu, Baek, Coleman, Maresca, & Miller, 2006). In addition, developments in humanitarianism are characteristic of almost all campus and group advocacy organizations (Case et al., 2012); in the case of technical causes such as environmentalism, students may also



attain disciplinary knowledge relevant to engineering fields (Zimmerman & Halfacre-Hitchcock, 2006).

**Key skills:** Civic Responsibility, Critical Thinking, Cross-Cultural Skills, Disciplinary Knowledge, Humanitarianism, Interpersonal Communication, Networking, Organizational Management, Public Speaking, Strategy, Teamwork

### *The Arts*

One of the largest student group categories identified in Chapter 2, “the Arts” at MIT consist of 58 student groups and associations spanning a wide variety of arts disciplines including instrumental performance, writing, dance, theater, visual arts, film, and vocal performance. To touch upon each of these unique organization types, three areas were selected for literature review: musical performance, dance, and theater.

Much study has been devoted to the effects of musical listening and performance on cognition, specifically in the developmental stages of childhood and adolescence. In these stages, music listening and instruction have been strongly linked to development of spatial reasoning, a skill important to practice in the engineering profession (Hetland & Winner, 2004). At the collegiate level, participation in musical activities has been linked to student self-confidence, creativity, and critical thinking ability (Kokotsaki & Hallam, 2007). In addition, participation in collaborative music ensembles has been shown to increase both student teamwork and self-direction, as students are inclined to devote themselves fully to practice and training in hopes of performing to the standards of their fellow performers (Kokotsaki & Hallam, 2007). Lastly, musicians illustrate increases in memory capabilities when compared to both control groups and test subjects with backgrounds in theatrical performance (Jonides, 2008).

Dance performance—both in ensembles and individually—has been shown to yield similar skill development outcomes to musical performance at the collegiate level. Individual dance students demonstrate skills such as critical thinking, problem solving, and self-direction in rehearsal, leading to increased self-confidence both within and outside of the practice (Baum, Owen, & Oreck, 1997). Students who participate in ensemble performances also enhance their interpersonal communication and teamwork abilities through their work with fellow performers (Oliver & Hearn, 2008). Lastly, students who take initiative in coordinating dance performances also demonstrate organizational management skills; said one student: “Having the artistic freedom in choreography, staging, and lighting are all rewarding learning and leadership experiences” (Oliver & Hearn, 2008, p.8).

The final subcategory of the arts, theatrical performance and management, provides students with strong benefits in interpersonal communication skills (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2005) and public speaking ability (Winship,

1950). Additionally, students have been shown to gain both personal self-confidence and increased creativity through theater and drama activities (UNESCO, 2005). Lastly, student coordinators and directors of theatrical performances gain great organizational management skills, as they are required to coordinate complex organizations and personnel to mount a single performance (Winship, 1950).

**Key skills:** Creativity, Critical Thinking, Interpersonal Communication, Memory, Organizational Management, Problem Solving, Public Speaking, Self-Confidence, Self-Direction, Teamwork

### *Athletics*

Although literature does exist on student skill development through athletic involvement, current and past research primarily focuses upon youth (i.e. K-12) participation in sport as well as the skills and attributes of NCAA varsity athletes, yielding a dearth of information on the club and recreational activities identified in the “Athletics” organizational category. For the purposes of this study, any athletic involvement at the undergraduate level—club, varsity, or recreational—will be incorporated into analysis due to the similarities in activities and culture across levels of competition.

At the pre-college level, “in recent studies of the benefits of extracurricular activities [...], sport was the only activity that showed both positive (e.g. the development of teamwork, emotional control and initiative) and negative developmental outcomes (e.g. pressure to do things that are morally wrong, and alcohol use)” (Gould & Carson, 2008, p. 63). At the undergraduate level, this dichotomy of positive and negative outcomes has been shown to persist, especially for minority student athletes (Melendez, 2007). A component of these negative benefits has been attributed to external perception of athletic group membership, as athletes consider it more difficult to earn good grades and be taken seriously by their professors as a result of their athletic participation (Aries, McCarthy, Salovey, & Banaji, 2004).

Despite these observed negative outcomes of athletic participation, collegiate athletes have also been shown to demonstrate leadership skills such as teamwork (Extejt & Smith, 2009), interpersonal communication skills (Melendez, 2007), initiative and self-direction (Gould & Carson, 2008), and self-confidence (Melendez, 2007). In addition, undergraduate athletes—especially those in “low profile” sports—have been shown to demonstrate cross-cultural skills due to their interaction with students of different backgrounds within the athletic community (Gayles & Hu, 2009).

**Key skills:** Cross-Cultural Skills, Interpersonal Communication, Self-Confidence, Self-Direction, Teamwork

## *Campus Community Organizations*

Organizations classified as “Campus Community” groups represent a subcategory of “Advocacy” groups specifically focused on campus issues, causes, and events. At MIT, these organizations include interest groups such as Feminists@MIT and Graduate Women at MIT in addition to campus services and events organizations such as “The Forum” and the MIT Lecture Series Committee. Because of the similarities to “Advocacy” organizations, the skills developed through Campus Community involvement are very similar to the Advocacy category previously discussed.

Similar to advocacy organizations, participation in campus community-focused groups can improve student skills in organizational management, interpersonal communication, critical thinking, and civic responsibility (Goodhart et al., 2006) as well as their strategy, teamwork, humanitarianism, and comfort and skill public speaking (Case et al., 2012). In addition, participation in campus community groups—especially those in the realms of diversity and inclusion—can also enhance students’ cross-cultural skills (Zuniga, Williams, & Berger, 2005) and global awareness (Kuh, 1995). Lastly, campus community organizations enable students to network with other organizations and students across the undergraduate campus, broadening participating students’ social groups and experiences (Kuh, 1995).

**Key skills:** Civic Responsibility, Critical Thinking, Cross-Cultural Skills, Global Awareness, Humanitarianism, Interpersonal Communication, Networking, Organizational Management, Public Speaking, Strategy, Teamwork

## *Cultural Interest Groups*

Cultural Interest Groups represent a unique body of literature within this broad subject review, as campus cultural organizations are primarily studied as vehicles for social inclusion, student retention, and identity development rather than as vehicles for development of professional skills. Despite this focus, skill development of participating students also merits discussion, and it is clear within the literature that undergraduate students can develop important key skills through involvement with cultural groups.

Most notably within the cultural organization literature, cultural interest groups provide a sense of community for students; said Gibson, Bejinez, Hidalgo, and Rolon (2004, p. 129): “quite simply, students function better and participate more in school settings and situations where they feel they belong.” Cultural organizations provide a sense of comfort to students, especially those that hail from groups underrepresented in a campus community (Guiffrida, 2003). In these communities, students can “let their guards down and be themselves,” providing an opportunity for students to openly discuss issues of relevance to their communities (Guiffrida, 2003, p. 310). Students from underrepresented communities also cite the support of cultural

interest organizations as an influence on their continued pursuit of education despite the obstacles inherent to degree completion (Reyhner & Dodd, 1995). For students studying internationally at the undergraduate level, these groups can also reduce “culture shock” upon arrival in the United States (Lin, 2006) and promote self-awareness of identity and cultural issues for students in a new global context (Inkelas, 2004). Although these characteristics of participation in cultural groups are not directly relevant to required skills of the engineering profession, they are imperative to student growth and retention and should not be dismissed from consideration when analyzing the benefits of student involvement.

In addition to these retention, identity, and community benefits of participation in cultural organizations, students involved in these groups can also develop key skills of relevance to engineering practice. Firstly, students’ interpersonal skills can be developed through a variety of forums within these groups and associations, including discussion groups (Grier-Reed, Madyun, & Buckley, 2008), mentorship programs (Gibson et al., 2004), and advocacy activities (Museus, 2008). Within cultural communities, organizations can also enhance students’ teamwork through community building and provide a network for academic and professional development of underrepresented students (Gibson et al., 2004). Through organizational activities—such as the development of support programs for incoming university students—cultural interest group participants can also increase their civic responsibility, organizational management skills, and writing abilities through development of newsletters, websites, and other welcome programs (Lin, 2006). Specifically for students engaged in cultural groups related to their heritage but not nationality, cultural interest groups can also develop cross-cultural skills and global awareness for issues relevant to those of their cultural background (Inkelas, 2004). Lastly, discussion group-based activities can also encourage critical thinking and problem solving skills in student participants, particularly in the realm of addressing community or campus issues (Grier-Reed et al., 2008).

**Key skills:** Civic Responsibility, Critical Thinking, Cross-Cultural Skills, Global Awareness, Interpersonal Communication, Networking, Organizational Management, Problem Solving, Teamwork, Written Communication

### *Departmental Groups*

By their nature, “Departmental Groups” participate in similar activities to campus Academic & Professional organizations, yielding a similar skill development framework to the first organizational category of analysis. For the purposes of this framework, participation in undergraduate research programs has also been classified under “Departmental Groups.”

A large body of literature on the merits of undergraduate research, a component of participation in departmentally-focused groups. An increase in problem-solving skills are the

most-cited result of participation in undergraduate research, as students are trained through these activities to solve complex problems (Becker, 2005), “think logically about complex material” (Zydney, Bennett, Shahid, & Bauer, 2002, p. 154), and utilize self-direction in acquiring information (Zydney et al., 2002). In addition, students have been shown to gain disciplinary knowledge through participation in research, gaining the technical skills of a particular discipline (Mabrouk & Peters, 2000) and learning to understand and interpret scientific findings (Zydney et al., 2002). Other observed outcomes of research experience include teamwork (Becker, 2005), professional self-confidence (Mabrouk & Peters, 2000), and ethical development through interactions with faculty and professional mentors (Burt, Carpenter, Finelli, Harding, Sutkus, Holsapple, Bielby, & Ra, 2011). Lastly, undergraduate research experience has been understood to positively influence retention within an academic discipline at the undergraduate level (Beck, Buckner, & Nikolova, 2007); in addition, students participating in undergraduate research programs are more likely to pursue graduate degrees than their peers without research experience (Zydney et al., 2002).

In addition to the skills developed through research activities, departmental groups are also assumed to foster student networking, public speaking, interpersonal communication skills, and organizational management ability through similar mechanisms to the Academic and Professional Organizations. For a full description of the processes for the development of these skills, please see the “Academic & Professional Organizations” subsection above.

**Key skills:** Disciplinary Knowledge, Ethics, Interpersonal Communication, Networking, Organizational Management, Problem Solving, Public Speaking, Self-Confidence, Self-Direction, Teamwork

### *Energy & the Environment*

Undergraduate student groups focused on energy and the environment participate in similar activities to many of the aforementioned organization types; students may advocate within their community for environmental issues, organize events and conferences, or network with professionals in a relevant field, among others. Despite these similarities, there does exist a unique literature on the impact of student energy and environmental groups, specifically in the realm of campus sustainability program development and implementation.

When organizing environmental or sustainability initiatives on a college campus, students must develop great strategic and teamwork abilities to confront and affect university administrations (Zimmerman & Halfacre-Hitchcock, 2006). In pursuit of this goal, students develop disciplinary knowledge regarding energy and environmental fields, written communication skills in preparing project plans and proposals, organizational management abilities when planning large events, and public speaking skills through the delivery of their

ideas to relevant stakeholders (Mero, 2011). Many environmental and sustainability groups also participate in the organization of student forums, through which students can improve their interpersonal communication skills (Sharp, 2002). In addition, through pursuit of these efforts students develop a great sense of civic responsibility to improve sustainable practices within their university communities (Zimmerman & Halfacre-Hitchcock, 2006). Lastly, many energy and environment clubs include international and systems projects and initiatives, broadening students global awareness and problem solving as a result of their involvement (MIT Clean Energy Prize, 2013).

**Key skills:** Civic Responsibility, Disciplinary Knowledge, Global Awareness, Interpersonal Communication, Organizational Management, Problem Solving, Public Speaking, Strategy, Teamwork, Written Communication

### *Games & Hobbies*

“Games & Hobbies” is likely the most diverse of the organizational categories defined in Chapter 2—at MIT, groups in this category held widely varying organizational missions and scopes. As a result, the literature in this area is less established than in the categories discussed previously; this analysis therefore relies on only one academic paper focused on the benefits of game play. In addition to the student skills identified in this work, “Games & Hobbies” are also assumed to develop the general skills characteristic of all student organizations in the broad undergraduate involvement literature, specifically organizational management skills through the development of programming and other group activities (MIT ASA, 2013).

According to Zagal, Rick, and Hsi (2006), games can fall into three categories within the scope of game theory: those of a competitive nature, those of a cooperative nature, and those of a collaborative nature. Due to these distinctions, students can acquire different sets of skills from different types of game play, increasing the broad set of skills developed through gaming. In each of these game types, participants exercise skill development in the areas of strategy, problem solving, and critical thinking as they attempt to win the game within the context of the stated rules (Zagal, Rick, & Hsi, 2006). In collaborative and cooperative games, participants are also required to develop teamwork and interpersonal communication skills as they work with other players to accomplish goals or proceed through the game phases (Zagal et al., 2006). In addition, some game types—specifically role-playing games—can encourage participant creativity as they design and adhere to complex storylines for their assumed characters (Zagal et al., 2006).

**Key skills:** Creativity, Critical Thinking, Interpersonal Communication, Organizational Management, Problem Solving, Strategy, Teamwork

## *Greek Life*

Participation in undergraduate fraternities and sororities—henceforth known as “Greek Life”—is perhaps the most controversial of the involvement types analyzed within the scope of this literature review. Much research has been devoted to the implications of student involvement in Greek organizations with both positive and negative outcomes observed (Asel, Seifert, & Pascarella, 2009). Despite this dichotomy of results, fraternity and sorority involvement is understood to develop student leadership, and Greek undergraduates are generally observed to be more involved in campus co-curricular and extracurricular activities than their non-Greek counterparts (Kimbrough & Hutcheson, 1998). Many national fraternal organizations cite student leadership development in their formal mission statements; fraternity and sorority alumni in turn often cite their Greek organizations as important factors in leadership development during their undergraduate years (Harms, Woods, Roberts, Bureau, & Green, 2006).

Within the scope of a fraternity or sorority, general members are most likely to manifest gains in interpersonal communication skills when compared to their non-Greek peers (Pike, 2000) as well as increases in teamwork ability (Kelley, 2008). Those students that pursue leadership roles in Greek organizations may also develop organizational management skills through event planning and house management and self-direction in pursuit of a leadership role (Harms et al., 2006). Lastly, Greek affiliation has been shown to increase student self-confidence in leadership abilities, specifically for women (Dugan, 2008) and students of color (Kimbrough & Hutcheson, 1998).

**Key skills:** Interpersonal Communication, Organizational Management, Self-Confidence, Self-Direction, Teamwork

## *Honorary Organizations*

Undergraduate “Honorary Organizations” serve small communities of academically high achieving students either within a discipline or demographic group. Invitation-only, these organizations reach out to upperclassmen students reaching minimum grade point average requirements and invite them to be inducted as new members. For the purposes of this analysis, the two largest engineering honor societies, Tau Beta Pi (TBP) and Eta Kappa Nu (HKN) will be examined as case studies for Honorary Organizations.

From the TBP *2012-2013 Information Book*, “an honor society is an association of primarily collegiate members and chapters whose purposes are to encourage and recognize superior scholarship and/or leadership achievement either in broad fields of education or in department fields at either undergraduate or graduate levels” (Tau Beta Pi [TBP], 2012, p. 2). Inducting its first student member in 1885, TBP was meant to serve as a field-based alternative to Phi Beta Kappa, a discipline-nonspecific organization (TBP, 2012). To be eligible for election

and initiation to TBP, engineering students must be in the top eighth of their engineering class during their penultimate undergraduate year or in the top fifth their final year (TBP, 2012). Once initiated, students have the opportunity to pursue leadership positions within either the collegiate chapter or national organization, through which they may gain organizational management experiences and skills (TBP, 2012). Collegiate chapters convene annually at a national convention, allowing participating students to network with other academically high-achieving engineering undergraduate and graduate students (TBP, 2012). The MIT TBP chapter undertakes projects such as the Spring Career Fair and an annual project to sponsor student entrance fees to the Boston Museum of Science, promoting civic engagement, strategy, and teamwork in its participating members (MIT Mass Beta, 2012).

HKN, unlike TBP, is an organization devoted to academic achievement within a particular discipline—in this case, computer science and electrical engineering as well as all other fields designated by IEEE (IEEE-HKN, 2011). From IEEE-HKN: “although the organization’s original purpose was to honor scholarship, it was also noted that selecting students with the character and attitude that would make them probable leaders in the profession was even more important” (IEEE-HKN, 2011). In this vein, the 200+ university chapters of HKN (IEEE-HKN, 2011) organize and participate in a variety of service and engagement activities; the MIT chapter, for example, creates an “Underground Guide to Course V1 and V1-A,” participates in service activities, and organizes social events (MIT Eta Kappa Nu, 2012). Through these activities, students may gain interpersonal communication skills, civic engagement, and writing abilities.

**Key skills:** Civic Responsibility, Interpersonal Communication, Networking, Organizational Management, Strategy, Teamwork, Written Communication

### *Housing Community Associations*

Diverse in nature, housing programs and living-learning communities may range from small, primarily residential programs to large-scale, coordinated entities between university student affairs and academic affairs departments (Inkelas, Soldner, Longerbeam, & Leonard, 2008). Although organizations may represent these varying levels of curricular focus, each type of program seeks to integrate academic and social development in college (Purdie & Rosser, 2011). This integration is generally achieved through some combination of centralized housing, coordinated curricula, common coursework, and faculty and peer mentorship (Inkelas et al., 2008). Although often not tied directly to co-curricular or extracurricular activities, participants in residential groups are often found to be more involved on campus than their non-participating peers (Zhao & Kuh, 2004).



The existing literature on living-learning communities primarily focuses on students' personal development, specifically as social justice allies through increases in civic responsibility and humanitarianism (Broido, 2000). Similarly, the character education components of housing communities can also contribute to students' ethical development during college (Healea, 2005). In addition, students gain interpersonal communication and critical thinking skills from their interactions with peers and academic mentors in the context of living-learning programs (Purdie & Rosser, 2011). Lastly, depending on the specific organization of the living-learning program, participating students may also develop writing skills (Healea, 2005) or global awareness (Zhao & Kuh, 2004).

**Key skills:** Civic Responsibility, Critical Thinking, Ethics, Global Awareness, Humanitarianism, Interpersonal Communication, Written Communication

### *Innovation & Entrepreneurship Groups*

Over the last few decades, innovation and entrepreneurship in higher education has received greater and greater attention, primarily in the realm of curricular activities (Hills, 1988). Although this discussion began with the inquiry as to whether entrepreneurship can be effectively taught to college undergraduates, the current literature focuses on the most effective methodologies for content delivery rather than the question as to whether the content can be delivered at all (Edwards & Muir, 2005). This analytical shift also often includes discussion as to the role of student clubs and groups on promoting an entrepreneurial ecosystem on college campuses.

The primary goal of entrepreneurship and innovation groups at the undergraduate level is to prepare and encourage members to pursue entrepreneurial career paths; as such, these groups cultivate practical business skills in their membership. For example, through business plan competitions students may gain writing abilities, strategy, and public speaking skills while students organizing club events and activities may gain teamwork skills and organizational management techniques (Barbe, Magids, & Thornton, 2003). Entrepreneurship clubs often also include mentorship components with local members of entrepreneurial communities, enabling students to network with role models in their chosen field (Barbe et al., 2003) and self-direct after being inspired by the success of others (Edwards & Muir, 2005). Lastly, innovation and entrepreneurship organizations cultivate student self-confidence (Barbe et al., 2003) as well as disciplinary knowledge when students execute particular startup ideas (Edwards & Muir, 2005).

**Key skills:** Disciplinary Knowledge, Networking, Organizational Management, Public Speaking, Self-Confidence, Self-Direction, Strategy, Teamwork, Written Communication

## *Martial Arts*

The literature on the effects of martial arts on college student development is very sparse; many studies focus on the effects of martial arts on children rather than individuals of college age (Lakes & Hoyt, 2004); however, there does exist some academic analysis on the effectiveness of self-defense training for undergraduate women. Overall, this literature has shown that participation in martial arts increases overall psychological and physiological well being (Woodward, 2009).

In both formal martial arts and informal “self-defense” courses, the primary benefit derived from participation is individual self-confidence (Cummings, 1992). In addition, women participating in self-defense courses also demonstrate increases in self-direction, showing increased drive and motivation to ensure their own safety and well being (Finkenberg, 1990). Lastly, those students who pursue coaching positions in martial arts organizations also gain practical skills in organizational management, interpersonal communication, and public speaking (Rowold, 2006).

**Key skills:** Interpersonal Communication, Organizational Management, Public Speaking, Self-Confidence, Self-Direction

## *Media*

Of the 436 MIT student organizations analyzed in Chapter 2, 9 were categorized as “Media” organizations, representing a number of journalistic fields including radio, television, print media, and magazines. To perform a literature review analysis of this category, articles in each of these areas were identified and included in the review, providing a thorough analysis of all types of media-related student involvement.

Although MIT maintains an active student-run radio station, the number of undergraduate students participating in college radio nationally is on the decline (Tremblay, 2003). Student radio can take two forms—journalistic and music-based—and each type of radio activity develops a different set of student skills, although both promote public speaking, teamwork, and interpersonal communication (Chavez & Soep, 2005). Journalistic radio work requires students to interact with members of their campus and local communities through interviews and other reporting, promoting public speaking skills, journalistic ethics, civic engagement, humanitarianism, and cross-cultural communication in students (Chavez & Soep, 2005). The more practical components of radio journalism also enhance students’ critical thinking, teamwork, and organizational management abilities (Chavez & Soep, 2005). In addition to many of these skills, entertainment radio may also promote student creativity and strategy as they design music playlists and operate within the political world of record producers and music representatives (Sauls, 1998).

Written forms of student media, including newspapers and student magazines, have also been shown to promote student skill development. Involvement in these types of organization may promote ethics and civic responsibility in students, as journalists are required to know their First Amendment rights as members of the press as well as the restrictions on these rights due to their status as students (Meyer, 1989). Literary magazines, on the other hand, promote student creativity in storytelling, composition, and style (Wilson, 1955). Both of these literary formats promote writing abilities and student self-direction as they work independently to complete literary pieces or journalistic assignments.

**Key skills:** Civic Responsibility, Creativity, Critical Thinking, Cross-Cultural Skills, Ethics, Humanitarianism, Interpersonal Communication, Organizational Management, Public Speaking, Self-Confidence, Self-Direction, Strategy, Teamwork, Written Communication

### *Professional Organization Chapters*

No literature exists on the benefits of membership in professional organizations at the undergraduate level; however, these groups can be assumed to develop the same skills as “Departmental Groups” due to their similarities in structure and organizational mission. Additionally, many of the professional organization chapters represent specific cultural or underrepresented minority groups such as the National Society of Black Engineers or the Society of Hispanic Professional Engineers, and membership in these groups is meant to inspire self-confidence in students and persistence in engineering fields (National Society of Black Engineers, 2013).

From the “Departmental Groups” section above, these benefits include public speaking experience, increases in interpersonal communication skills, enhanced organizational management ability, and opportunities to network with professionals in the relevant engineering field.

**Key skills:** Interpersonal Communication, Networking, Organizational Management, Public Speaking, Self-Confidence

### *Project Teams*

In the field of engineering education, discussion of the benefits of project-based learning most often appears in literature regarding the teamwork and interpersonal communication benefits of in-class experiences such as capstone design courses (Dutson, Todd, Magleby, & Sorensen, 1997). For the purposes of this study, it is assumed that students participating in extracurricular or co-curricular “Project Teams”—such as solar car, Formula SAE, or rocket teams—gain the same skills inherent to multidisciplinary design projects in addition to the leadership skills characteristic of student organizations.

In contrast to design projects mandated by engineering curricula, “extracurricular teams are mostly populated by sophomore and junior level students and driven only by their passion and self motivation rather than a curricular requirement” (Khorbotly & Al-Olimat, 2010, p. F1C-1). First and foremost, engineering design projects provide students with hands-on disciplinary knowledge and experience, problem solving skills, and practice working in teams (Savage, Chen, & Vanasupa, 2007). Encouraging a systems-level approach to an engineering task, these projects require students to think critically about the challenge and hand and collaboratively develop creative solutions to a problem (Savage et al., 2007). Design competitions enable to students to network with members of their chosen field, and often include a public speaking or written communication component in a required presentation, promoting student self-confidence in their professional abilities (Khorbotly & Al-Olimat, 2010). Additionally, students must be extremely self-motivated to commit to the time constraints and demands of a co-curricular or extracurricular engineering project (Khorbotly & Al-Olimat, 2010). Lastly, undergraduate project teams are by their nature multidisciplinary, enabling students to gain interpersonal communication skills across professional disciplines invaluable to future requirements of the workplace (Davis & Masten, 1996).

A particular subcategory of undergraduate extracurricular and co-curricular “Project Teams” is the category of multidisciplinary project teams for international development or domestic service. In the words of Coyle, Jamieson, & Oakes (2005, p.1), “not-for-profit organizations—such as community service agencies, schools, museums, and local government offices—face a future in which they must rely to a great extent upon technology for the delivery, coordination, accounting and improvement of the services they provide to the community,” creating a relevant space for engineering students to contribute to the solutions of real-world problems. In the case of these projects, students gain many skills in addition to those developed through “traditional” project teams, including global awareness, humanitarianism, and cross-cultural communication abilities (Borg & Zitomer, 2008); additionally, due to the nature of development projects, students must engage in organizational management of project tasks and practice strategy in collaborating with foreign organizations and governments (Borg & Zitomer, 2008). These interactions require students to possess interpersonal communication skills with individuals outside of the engineering profession (Schafer & Richards, 2007). Lastly, in order to develop responsible and sustainable international projects, students must also gain understanding of the ethical implications of development work (Amadei, Sandekian, & Thomas, 2009).

**Key skills:** Creativity, Critical Thinking, Cross-Cultural Skills, Disciplinary Knowledge, Ethics, Global Awareness, Humanitarianism, Interpersonal Communication, Networking, Organizational Management, Problem Solving, Public Speaking, Self-Confidence, Self-Direction, Strategy, Teamwork, Time Management, Written Communication

## *Recreation*

In developing the student group categories outlined in Chapter 2, groups categorized as “Recreation” activities generally represented sporting activities not considered to be official “sports” (i.e. those included in Olympic competition). These groups included, but were not limited to, the MIT Outing Club, the MIT Quiddich Team, the MIT Skydiving club, and the Scuba Club, among others.

The primary benefits associated with student “Recreation” activities are the general benefits of exercise on student physical and mental health, none of which are included in the list of professional skills developed for this 2D framework. Despite this fact, similarly to martial arts organizations, students accepting coaching roles in recreational groups may gain skills such as organizational management, public speaking, and interpersonal communication as a result of their leadership positions (Rowold, 2006). Additionally, all participants gain skills in teamwork characteristic of group athletic organizations (Extejt & Smith, 2009).

**Key skills:** Interpersonal Communication, Organizational Management, Public Speaking, Teamwork

## *Religious Groups*

Religious organizations make up 6% of ASA-registered groups at MIT and encompass a variety of faiths from around the world (MIT ASA, 2013). Despite popular rhetoric citing a decline of religiosity on American college campuses, many religious denominations have experienced a growth in campus presence over the last several decades (Schmalzbauer, 2007).

Although the most-often cited benefits of religious observance in college are personal well-being and sense of self (Buchko, 2004), students can also gain practical professional skills through involvement in student religious organizations. Most notably, students develop interpersonal communication skills through activities such as Bible study discussions (Butchko, 2004) and forming of peer and mentor relationships (Frankel & Hewitt, 1994). Additionally, students must demonstrate teamwork and organizational management in religious organizations through the coordination of mentorship and service activities (Constantine, Miville, Warren, Gainor, & Lewis-Coles, 2006). Outside of the skill development realm, campus religious organizations can also provide a sense of community for participants, increasing feelings of “belonging” on campus, especially for traditionally underrepresented minority students (Hurtado & Carter, 1997).

**Key skills:** Interpersonal Communication, Organizational Management, Teamwork

## *Service Organizations*

Service activities—more than any other type of club or organization activity—are prevalent across the spectrum of student organizations. Many organization types including Greek Life, project teams, religious groups, and honor societies include some component of service in their organization’s Constitution or mission statement. For the purposes of this analysis, “Service Organizations” are those groups with a primary mission focus on either local or national community service or international development.

Generally, the most-cited student outcomes of participation in undergraduate “Service Organizations” are increases in student humanitarianism and empathy (Markus, Howard, & King, 1993), civic responsibility (Astin & Sax, 1998), teamwork and interpersonal communication (Blomstrom & Tam, 2009), ethical development (Finelli, Holsapple, Ra, Bielby, Burt, Carpenter, Harding, & Sutkus, 2012), and critical thinking (Astin & Sax, 1998). In many cases, the specific aspects of a type of service or service organization may also attract student members; for example, some volunteers are drawn to service due to the organizational management aspects of participation (Serow, 1991), while some tutoring or educational volunteers may seek to develop memory, public speaking, or self-confidence skills (Blomstrom & Tam, 2009).

Undergraduate students may also participate in Service Organizations through co-curricular—as opposed to extracurricular—involvement in service-learning activities. As of 2000, over 11,800 service-learning courses were available to undergraduates in the United States, a subset of which were offered through engineering courses and programs (Duffy, Tsang, & Lord, 2000). These courses generally offer project-based learning similar to the programs described in the “Project Teams” section above, thereby improving students’ disciplinary knowledge, self-direction, critical thinking, problem solving, and writing abilities in addition to the skills listed in the paragraph above (Duffy et al., 2000). When performed internationally, these activities may also increase students’ global awareness and cross-cultural communication skills (Borg & Zitomer, 2008).

**Key skills:** Civic Responsibility, Critical Thinking, Cross-Cultural Skills, Disciplinary Knowledge, Ethics, Global Awareness, Humanitarianism, Interpersonal Communication, Memory, Organizational Management, Problem Solving, Public Speaking, Self-Confidence, Self-Direction, Teamwork, Time Management, Written Communication

## *Student Governance*

Student self-governance has a profound and significant history at American institutes of higher education; today’s student governments evolved from past student literary societies, honor systems, student assemblies, class councils, and student councils (May, 2010). Although the term “Student Government” is generally accepted to mean the centralized student governance

structure of a university, “Student Governance” organizations can exist in a variety of forms. At MIT, for example, in addition to the centralized undergraduate and graduate student governments, governance structures exist for sporting groups, Greek organizations, residential communities, and other groups.

First and foremost, participation in “Student Governance” organizations promotes civic responsibility, interpersonal communication, networking, strategy, and critical thinking in participating students as they work to address local and campus issues of relevance to their constituents (Bamenek & Sifton, 2003). Because student governance organizations require students to work collaboratively towards goals, students gain important teamwork skills such as conflict management, compromise, and consensus forming through participation (Moore, Lovell, McGann, & Wyrick, 1998). Organizational management capabilities are enhanced through student lobbying efforts (Bamenek & Sifton, 2003), event planning (May, 2010), and election organizing (Lewis & Rice, 2005), preparing students for their future careers (Cowen, 1960). Additionally, students assigned to different tasks within a governance organization may need to develop global awareness regarding university policies (Bamenek & Sifton, 2003), public speaking skills during campaigns (Lewis & Rice, 2005), ethics in performing disciplinary hearings on honor code policies (Cowen, 1960), and proposal writing for new initiatives or campus policy recommendations (Bamenek & Sifton, 2003). Lastly, due to the volunteer nature of student government, students must demonstrate self-direction in accomplishment of tasks (Moore et al., 1998) as well as excellent time management abilities (Lewis & Rice, 2005).

**Key skills:** Civic Responsibility, Critical Thinking, Ethics, Global Awareness, Interpersonal Communication, Networking, Organizational Management, Problem Solving, Public Speaking, Self-Direction, Strategy, Teamwork, Time Management, Written Communication

## **CONSTRUCTION OF 2D FRAMEWORK OF STUDENT SKILL DEVELOPMENT**

The final 2D Framework of Student Involvement is presented in Figure 3-1 on pages 44-45. This framework synthesizes all “key skills” identified in the preceding sections in terms of relevance to particular organizational categories; boxes indicated with a check mark illustrate those skills developed by a particular category of co-curricular or extracurricular involvement. In the following chapters, the relevance of this framework to the education of undergraduate engineers is validated through two distinct methods: comparison with the needs of engineering employers and assessment in the context of the accreditation requirements of ABET, Inc.

|                             | Academic/Professional | Academic Competitions | Advocacy | Arts | Athletics | Campus Community | Culture | Department Groups | Energy & Environment | Games & Hobbies | Greek Life |
|-----------------------------|-----------------------|-----------------------|----------|------|-----------|------------------|---------|-------------------|----------------------|-----------------|------------|
| Civic Responsibility        |                       | ✓                     | ✓        |      |           | ✓                | ✓       |                   | ✓                    |                 |            |
| Creativity                  |                       |                       |          | ✓    |           |                  |         |                   |                      | ✓               |            |
| Critical Thinking           |                       | ✓                     | ✓        | ✓    |           | ✓                | ✓       |                   |                      | ✓               |            |
| Cross-Cultural Skills       |                       |                       | ✓        |      | ✓         | ✓                | ✓       |                   |                      |                 |            |
| Disciplinary Knowledge      | ✓                     | ✓                     | ✓        |      |           |                  |         | ✓                 | ✓                    |                 |            |
| Ethics                      |                       | ✓                     |          |      |           |                  |         | ✓                 |                      |                 |            |
| Global Awareness            |                       | ✓                     |          |      |           | ✓                | ✓       |                   | ✓                    |                 |            |
| Humanitarianism             |                       | ✓                     | ✓        |      |           | ✓                |         |                   |                      |                 |            |
| Interpersonal Communication | ✓                     | ✓                     | ✓        | ✓    | ✓         | ✓                | ✓       | ✓                 | ✓                    | ✓               | ✓          |
| Memory                      |                       | ✓                     |          | ✓    |           |                  |         |                   |                      |                 |            |
| Networking                  | ✓                     | ✓                     | ✓        |      |           | ✓                | ✓       | ✓                 |                      |                 |            |
| Organizational Management   | ✓                     | ✓                     | ✓        | ✓    |           | ✓                | ✓       | ✓                 | ✓                    | ✓               | ✓          |
| Problem Solving             |                       |                       |          | ✓    |           |                  | ✓       | ✓                 | ✓                    | ✓               |            |
| Public Speaking             | ✓                     | ✓                     | ✓        | ✓    |           | ✓                |         | ✓                 | ✓                    |                 |            |
| Self-Confidence             | ✓                     | ✓                     |          | ✓    | ✓         |                  |         | ✓                 |                      |                 | ✓          |
| Self-Direction              |                       | ✓                     |          | ✓    | ✓         |                  |         | ✓                 |                      |                 | ✓          |
| Strategy                    |                       | ✓                     | ✓        |      |           | ✓                |         |                   | ✓                    | ✓               |            |
| Teamwork                    | ✓                     | ✓                     | ✓        | ✓    | ✓         | ✓                | ✓       | ✓                 | ✓                    | ✓               | ✓          |
| Time Management             |                       | ✓                     |          |      |           |                  |         |                   |                      |                 |            |
| Written Communication       |                       |                       |          | ✓    |           |                  | ✓       |                   | ✓                    |                 |            |

**Table 3-1: 2D Framework of student skill development (Part 1 of 2).**



|                             | Honor Societies | Housing Communities | Innovation/Entrepreneurship | Martial Arts | Media | Professional Org. Chapters | Project Teams | Recreation | Religious Groups | Service Organizations | Student Governance |
|-----------------------------|-----------------|---------------------|-----------------------------|--------------|-------|----------------------------|---------------|------------|------------------|-----------------------|--------------------|
| Civic Responsibility        | ✓               | ✓                   |                             |              | ✓     |                            |               |            |                  | ✓                     | ✓                  |
| Creativity                  |                 |                     |                             |              | ✓     |                            | ✓             |            |                  |                       |                    |
| Critical Thinking           |                 | ✓                   |                             |              | ✓     |                            | ✓             |            |                  | ✓                     | ✓                  |
| Cross-Cultural Skills       |                 |                     |                             |              | ✓     |                            | ✓             |            |                  | ✓                     |                    |
| Disciplinary Knowledge      |                 |                     | ✓                           |              |       |                            | ✓             |            |                  | ✓                     |                    |
| Ethics                      |                 | ✓                   |                             |              | ✓     |                            | ✓             |            |                  | ✓                     | ✓                  |
| Global Awareness            |                 | ✓                   |                             |              |       |                            | ✓             |            |                  | ✓                     | ✓                  |
| Humanitarianism             |                 | ✓                   |                             |              | ✓     |                            | ✓             |            |                  | ✓                     |                    |
| Interpersonal Communication | ✓               | ✓                   |                             | ✓            | ✓     | ✓                          | ✓             | ✓          | ✓                | ✓                     | ✓                  |
| Memory                      |                 |                     |                             |              |       |                            |               |            |                  | ✓                     |                    |
| Networking                  | ✓               |                     | ✓                           |              |       | ✓                          | ✓             |            |                  |                       | ✓                  |
| Organizational Management   | ✓               |                     | ✓                           | ✓            | ✓     | ✓                          | ✓             | ✓          | ✓                | ✓                     | ✓                  |
| Problem Solving             |                 |                     |                             |              |       |                            | ✓             |            |                  | ✓                     | ✓                  |
| Public Speaking             |                 |                     | ✓                           | ✓            | ✓     | ✓                          | ✓             | ✓          |                  | ✓                     | ✓                  |
| Self-Confidence             |                 |                     | ✓                           | ✓            | ✓     | ✓                          | ✓             |            |                  | ✓                     |                    |
| Self-Direction              |                 |                     | ✓                           | ✓            | ✓     |                            | ✓             |            |                  | ✓                     | ✓                  |
| Strategy                    | ✓               |                     | ✓                           |              | ✓     |                            | ✓             |            |                  |                       | ✓                  |
| Teamwork                    | ✓               |                     | ✓                           |              | ✓     |                            | ✓             | ✓          | ✓                | ✓                     | ✓                  |
| Time Management             |                 |                     |                             |              |       |                            | ✓             |            |                  | ✓                     | ✓                  |
| Written Communication       | ✓               | ✓                   | ✓                           |              | ✓     |                            | ✓             |            |                  | ✓                     | ✓                  |

**Table 3-1: 2D Framework of student skill development (Part 2 of 2).**



# Chapter 4: Framework Validation through Supervisor Interviews

---

Chapter 3 outlined the creation of a 2D Framework of professional skills developed through student involvement; this chapter serves to validate the “key skills” in that framework in terms of relevance to the practice of the engineering profession. To perform this task, open-ended research interviews were conducted with 10 alumni of the Massachusetts Institute of Technology (MIT) who have served as managers of entry-level engineering graduates in the last five years. These interviews sought to identify which of the key skills developed through the analysis in Chapter 3 are relevant to practicing the engineering profession; in addition, respondents were given the opportunity to discuss the long-term impact of their co-curricular and extracurricular experiences during their undergraduate years, providing insight into the personal importance of student life activities during college.

## STUDY PROCEDURE

### *Participant Identification*

All potential interview respondents identified to participate in this study were alumni of the Massachusetts Institute of Technology holding S.B. degrees with graduation years from 2000-2009. This range of graduates was selected for study due to their expected career trajectories: those who have been in the workplace for three to thirteen years are likely to hold managerial—but not executive—supervisory positions. To narrow the field of potential respondents further, two states of work and residence—Massachusetts and California—were selected for respondent identification. These states are home to the largest populations of MIT alumni domestically, with a total of over 45,000 registered alumni between the two regions combined (MIT Alumni Association [MITAA], 2013).

Using these criteria, a total of 2,495 alumni were identified through the MIT *Infinite Connection Alumni Database* as qualified participants for this study, and narrowing to graduates of MIT’s School of Engineering further reduced the size of this sample. Once this criterion was imposed, a final round of participant selection was performed, through which engineering managers and supervisors were identified. To perform this classification, alumni who held positions including title terms such as “manager,” “supervisor,” “lead,” or “founder” were identified as individuals likely to perform managerial and supervisory tasks on the job. Academics and physicians were excluded from the final sample, as they were deemed unlikely to supervise engineering graduates in a setting similar to private industry.

After all criteria for participant selection were imposed on the 2,495 alumni identified in the first-round search, 368 alumni were selected as final candidates to contact for interview requests. After interview requests were sent (see Appendix C for interview request email text), subjects who agreed to participate were scheduled for 30-40 minute phone interview slots. These participants were then emailed required subject consent forms and contacted for phone interviews at the agreed-upon date and time. In total, 10 individuals participated in interviews from the 368 alumni contacted with requests<sup>2</sup>.

### *Interview Protocol*

The interviews for this study were conducted either in person or via phone, with durations of approximately 30-40 minutes. The broad interview protocol consisted of three distinct stages: MIT experience, career path, and impressions of engineering graduates; however, interviews were conducted in an open-ended fashion and the researcher was given discretion to alter the protocol in response to particular insights of the interviewees. Often, interviewees requested background on the research project and SUTD generally, which was provided when asked (generally at the beginning or end of the interview protocol).

In the first interview stage, respondents were asked to discuss their pre-MIT and MIT experiences, beginning with the motivating factors that brought them to the Institute. After discussing their reasons for application submission and their decisions to enroll, respondents were asked to discuss their academic, co-curricular, and extracurricular experiences during their undergraduate years. In this section, respondents often discussed components of their coursework, particularly meaningful extracurricular activities, or other defining components of their undergraduate experiences.

In the second interview stage, respondents discussed their career paths post-graduation from MIT's undergraduate programs in the School of Engineering. For each position they held post-graduation, interviewees described their title, responsibilities, and key challenges they faced transitioning from previous employment roles. When appropriate, respondents were asked to tie their employment experiences back to specific activities or skills discussed during the MIT stage of the interview protocol.

In the final interview stage, respondents were asked to discuss their interactions in the workplace with entry-level engineers, with specific focus on the skills required for new hires to succeed in the workplace. In many cases, this interview segment included discussion regarding how employers approach recruitment of new hires, often including particular personality traits

---

<sup>2</sup> Although a larger interview sample size would have been preferred to further validate the framework results, after 4-6 interviews responses began to become redundant, illustrating that a small sample was adequate for the purposes of this study.

that the respondents look for when identifying potential candidates and why these traits are important and relevant to work in industry.

Following these three interview stages, respondents were asked for final relevant thoughts or impressions not covered earlier in the interview. Each time respondents provided new thoughts or information, they were asked again for additional thoughts; this process concluded when interviewees responded that they had no further information to add.

### *Respondent Demographics*

Of the 10 respondents interviewed for this study, six were contacted through the Massachusetts sample and the remaining four were contacted through the California sample. Six women and four men were interviewed, and the respondents came from a variety of industries and experiences, including software development, consulting, entrepreneurial ventures, governmental agencies and laboratories, and large, multi-national defense, aerospace, and manufacturing companies<sup>3</sup>. The average number of years since completion of their undergraduate studies was 10, with the two oldest graduates from the class of 2000 and the most recent graduate from the class of 2009.

## **VALIDATION OF KEY SKILLS**

After coding was performed during re-examination of interview recordings, key skills in the 2D Framework were considered “validated” if at least one respondent discussed that skill during their interview session<sup>4</sup> as either a task they performed during their first job after college or as a requirement they see as a manager for new, entry-level hires. In the summaries below, key interview quotes and ideas are employed to illustrate the relevance of the key skill to the engineering workplace.

### **Civic Responsibility – Not Validated**

None of the interview respondents discussed civic responsibility as a valuable skill in engineering entry-level hires.

### **Creativity – Not Validated**

The skill of creativity was not mentioned in any of the respondent interviews; however, one respondent did discuss using constructive brainstorming as an interviewing and recruitment

---

<sup>3</sup> It should be noted that none of the employers interviewed for this study worked at non-profit or humanitarian organizations, which may explain the dearth of discussion of issues such as civic responsibility, humanitarianism, and global awareness in the sections below.

<sup>4</sup> Although response sizes of greater than one would be preferred for this study, one response was considered “validation” due to the small respondent sample size.

exercise. Although this practice may require candidates to exhibit creativity in problem solving, this connection was not strong enough to validate creativity as a required skill.

### **Critical Thinking – Validated**

Skills associated with critical thinking were often cited as important by the managers interviewed in this study, including specific skills like “understanding the big picture,” problem identification, and incorporating non-technical factors (e.g. cost) into technical decisions. Said one respondent regarding her success at a startup she joined after leaving MIT:

"On any given day we had to do something different, and so that—I think—was very in touch with what an MIT experience is like sometimes. You know, you tackle a different problem every day and you kind of learn to really understand how to approach a problem. [You use] your critical thinking and logical skills, and if you don't know the answer that doesn't mean that you can't participate or be a productive member of the team, you just have to spend a little bit more time at researching and catching up with what other people know."

Similarly, an upper-level manager at a large defense corporation discussed how she never expects her new hires to have memorized the right answer; rather, she values those individuals that can think critically and figure out how to address technical problems in a group.

Another component of critical thinking—the ability to approach “intangible problems” in fluid environments—was also discussed in several of the interviews conducted for this study. One respondent discussed how many of her new hires that claim to have independent research experience have actually been closely supervised by professors, thereby not receiving training on how to define complex problems without clear and specific guidance. She strongly valued the ability to define these types of problems in the workplace, and observed: “I think finding what the problem is is harder than finding the solution.”

### **Cross-Cultural Skills – Validated**

Only three of the 10 interview respondents discussed any aspect of international or cross-cultural awareness during their interviews. Of these three, two discussed specific roles at their past or present organizations requiring work abroad; the third discussed at length her interactions with individuals and engineers of different cultures both at MIT and in her role as a supervisor at a consulting firm. Said this interviewee:

"I think when you're working with people around the world and training engineers who are going to do that, I think helping them—especially, frankly, people who are white Americans who may not have that awareness or people from [...] somewhere with people

who are just like them—[is really important]. I think it's hard for people like that to see differences and deal with them."

This interviewee discussed her own journey to cross-cultural awareness, and also outlined her approach to hiring individuals of a different culture: "[I need to] make sure that if I do hire someone they feel comfortable even if they're not from the same cultural background as me." This self-awareness of the importance of her own cross-cultural skills was considered validation of this skill for the purposes of this framework.

### **Disciplinary Knowledge – Validated**

After problem solving ability, disciplinary knowledge was the most-cited skill of the 2D Framework during respondent interviews. Despite this consistent focus on technical ability, several important aspects of disciplinary knowledge emerged throughout the course of the ten respondent interviews.

First and foremost, the employers interviewed for this study required that their new hires be competent in their technical roles; said one manager at a software solutions firm: "You have to have a baseline technical ability; otherwise, you're not really that useful for any of the roles that I have." Other respondents discussed recruiting new hires proficient in engineering basics and fundamentals, with the technical specifics of a particular role taught on the job once an individual has been hired. In contrast, one specific interviewee cited how subject matter expertise was of particular interest to her organization: "At career fairs I notice a lot certain skill sets that stand out. So, like, optics, robotics, or these types of things, so I might make a note of this type of thing where it's something I know we need more of in our company."

Some interviewees went further in their discussion of disciplinary knowledge on the job, citing the difference in skill sets required across different roles at their organization. Said one consulting manager: "If I'm hiring for a more technical job then it's more important to me that that person has those technical skills and I might be less concerned about their ability to present it or their ability to write, for example." Another respondent discussed the contrast between "specialists" and "generalists" in his hiring process:

"What I need from a startup company standpoint is generally specialists—people who know a lot about a very specific aspect so I can hire them and know that they can take care of, you know, this one technical aspect with no issue whatsoever."

The final component of disciplinary knowledge addressed in the ten respondent interviews was that of the practical skills of engineering graduates. Said one interviewee:

"[New grads] are getting very competent in terms of the hands-on skills—the last kid I hired was very good with designing things once you told him what to design he could

design it, but he couldn't figure out [...] 'Here's the question that needs to be answered.'  
You had to pose the question very rigidly, but then he was excellent at implementing it."

This comment connects disciplinary ability with the critical thinking skills above, further validating the need for both of these skill sets in young, entry-level engineering hires.

### **Ethics – Not Validated**

None of the interview respondents discussed ethics as a valuable skill in engineering entry-level hires.

### **Global Awareness – Validated**

One interview respondent discussed global awareness when discussing training of today's technical students; she called for the education of "really worldly engineers" for the emerging global workplace. Based on the criteria for validation described above, this comment is considered sufficient to validate global awareness as a relevant skill in the 2D Framework.

### **Humanitarianism – Not Validated**

None of the interview respondents discussed humanitarianism as a valuable skill in engineering entry-level hires.

### **Interpersonal Communication – Validated**

Skills associated with interpersonal communication were discussed by several interviewees, specifically those in customer- and client-oriented fields such as technical consulting. Said one respondent, who works in satellite manufacturing:

"The soft skills—that's also something that's very important in that somebody who's very technically knowledgeable sometimes has some difficulty dealing with talking to the customer and being able to hold presentations and being able to answer questions without compromising the team. [...] And I personally believe that I'm in the role that I'm in because I'm able to talk to the customers; I'm able to make them feel like we really are trying to do everything we can for them and we are really seeking to satisfy their business and to make sure what we're doing is in line with what they've requested."

The same respondent also discussed how those engineers that possess communication skills are more likely to be promoted in engineering organizations: "A lot of the people who have those soft skills are actually the ones that you will see as vice presidents and CEOs because they have that ability to connect and make you feel comfortable and yet still be very technically sound in the stuff that they're saying."

Other interviewees discussed how interpersonal communication skills relate to new hires' ability to effectively work in teams. Said one recruiter:



"For me, personally, I look for people who are definitely extroverted. [...] Introverts are wonderful and can do so many things—and like I said, it depends on exactly which job you're looking for—when you're looking for somebody who's going to sit in the lab and be able to sit there and focus on a problem and solve this problem that's what you need. [...] But when you need people who are going to work on teams—particularly large teams where they're working with [multidisciplinary groups] [...]—you kind of need to have a little bit more of a people focus."

Similarly, another respondent discussed the importance of communication skills when recruiting for his startup companies, discussing how he looks for strong, dynamic communicators who are both good workers and easy to spend time around.

Finally, interviewees discussed the importance of new hires being able to explain technical information to non-technical audiences; one respondent at a large company discussed how the ability to explain information was the only way to distribute good ideas within her company. Another respondent, who primarily works in startup organizations, discussed the merits of good communicators as follows: "It is extremely helpful. Communication is probably the biggest one, just being able to, you know, explain what you're working on, explain what the problem is." As a manager, he especially values employees who can distill technical information to enable his decisionmaking independent of the day-to-day technical details of his company.

### **Memory – Not Validated**

None of the interview respondents discussed memory as a valuable skill in engineering entry-level hires.

### **Networking – Validated**

Although none of the interview respondents specifically discussed networking as a skill important for their entry-level hires, seven of the 10 individuals interviewed discussed using their own networks to find positions or recruit new hires. These networking connections included friends, professors, coworkers, and MIT internship programs that led to full-time positions after interviewees graduated from MIT. Said one interviewee of her own hiring practices:

"Honestly, thus far because I run a small business [...] almost everyone we hire we know, we meet through a personal connection for better or for worse. It can be hard finding engineers, so I just try to reach out to my personal network and you can generally hear about their work products through that network."

From these comments and the discussion of networking practices in respondent interviews, networking is considered a validated skill for the purposes of the 2D Framework.

## **Organizational Management – Validated**

Although none of the technical supervisors interviewed for this study cited managerial skills as a qualification for their engineering hires, several interviewees discussed how their own managerial skills enabled them to be promoted quickly after beginning their first position after graduating MIT. Said one interviewee of his first role at a large consulting firm:

“What's good about it is regardless of your actual title you are able to go to different jobs [...] based on your skill set and what you're interested in and whether or not someone's willing to take a risk on you, basically. So even if you're not a manager you could be in a management role, and even if you are a manager you could be in a non-management role.”

Said another respondent of her role at a large manufacturing company:

“[Assuming leadership roles at my company] starts as soon as they can they start stepping you up. From [...] working with somebody and somebody pretty much spoon-feeding you everything to now...where I am I don't manage a lot of people, I don't directly manage anybody, but I have had interns, I have had people who indirectly report to me [...] and I do train almost all of the process engineers [at my company].”

Other respondents also discussed their transitions to managerial roles due to their success during their first few years on the job, further validating organizational management skills as a vehicle to enable success in the working world.

## **Problem Solving – Validated**

In addition to disciplinary knowledge and critical thinking skills, problem solving was the most-cited skill set during all of the interviews conducted for this study. Respondents discussed the importance of “solving intangible problems,” knowing how to approach problems, solving problems in “a fluid environment,” and problem discovery. Said one interviewee:

“What I'm looking for is someone who can figure out how to get the job done, and I find that that is—aside from technical ability—that is the one key difference between the best employees and the other ones. [...] What that means is that if I give you an assignment or give you a goal that you don't come back to me and say 'Oh, but I ran into this roadblock and I don't know what to do.' It's thinking about it and figuring out how to do it.”

Another respondent discussed how his best employees learn to succeed even after encountering failure when approaching a problem: “So for me that's really important. Someone who's enthusiastic, [who] is okay failing just to figure out the right way to do it next time and do it quickly.” These and other comments serve as validation for the problem solving skill set within the context of the 2D Framework.

## **Public Speaking – Validated**

Often discussed by the respondents in the context of interpersonal communication, public speaking was also identified as an important skill for entry-level hires. One interviewee explained how being able to present to a group is very important at her company, and how she views presentation ability as the determining factor for how much an individual can contribute to the workplace in terms of generating new ideas.

## **Self-Confidence – Validated**

Unlike most of the skills validated through employer interviews, respondents discussed both the positive and negative components of high self-confidence in new engineering graduates. In some cases, respondents provided examples of the success of confident hires, including standout applicants comfortable presenting soon after hire or bringing issues to the attention of relevant supervisors. Said one respondent: "If you're timid when you're first starting out it's generally a bad thing because you're not going to pick things up as quickly. [...] You just kind of get thrown into the deep end and figure your way out even though it's a little uncomfortable."

In addition to these positive aspects of self-confidence, respondents also discussed incidents in which student self-confidence can negatively affect their performance in an industrial setting. For example, one interviewee discussed how he avoids hiring students with "big egos" as they can be difficult to work with in his startup. Another respondent discussed how as a recruiter she faces difficulty with the aggressive nature of some recruits; she described receiving numerous emails from candidates and meeting individuals at multiple college career fairs in one recruiting season. Despite these assertions, student self-confidence and comfort was generally described as a positive trait, validating this skill for the purposes of the 2D Framework.

## **Self-Direction – Validated**

The managers interviewed for this study often discussed the importance of new hires to possess drive and determination. One respondent discussed this issue at length during her interview:

"I think one of the things that's very important is the ability to be a self-starter and to be able to investigate information on their own. And I know that's typically said a lot—you have to be proactive, you have to work well with a team, and you have to work well on your own without supervision—but I think that those things are said so often that they kind of lose their meaning to some degree...but it is very imperative and very important that students that graduate from college really have this ability. [...] I've encountered, unfortunately, people now that there needs to be a lot of hand-holding, and it is very frustrating because there's an expectation of you've explained it once, twice, or three

times and beyond that it's really not clicking or it's not sticking and it becomes a little bit more difficult to really continue to help that person grow."

Although other respondents did not focus as heavily on self-direction during their interviews, several discussed the importance of self-discipline and the ability to focus on a particular task at hand. Said one interviewee about his experience creating a startup company during his undergraduate years: "Experience isn't as important as people make it out to be; it's more your determination, willpower, and in general being conscientious." This sense of motivation was also discussed by one respondent with experience in technical consulting: "I do prefer working with people who have been trained to take some initiative; [...] I don't always see people coming out of school with that. Part of it is the school that they go to, part of it is culture."

### **Strategy – Validated**

Throughout the course of the ten employer interviews, several respondents discussed how they struggled with the bureaucracy and politics of industrial organizations after leaving the open, innovative, merit-based structure of MIT. Said one respondent of his first job at a consulting firm:

"I think we [MIT students] are at a somewhat disadvantage because we fail to see—at least initially—how the interactions of people really drive a lot of our careers, more so than technical bits. So, whereas I think I was significantly better than my peers at computer stuff and the technical bit, I wasn't necessarily better at seeing all the politics behind the scenes and understanding that there's so much more than just doing a good job on paper."

In addition to these observations, respondents also discussed the issues some of their coworkers have in dealing with the politics of the workplace. When outlining her role in a consulting firm, one respondent discussed how many engineers have trouble providing clients with technically “inferior” solutions to their problems, even if these answers are those requested by a particular client. Similarly, another respondent discussed how many of her coworkers were unwilling to assume training functions, limiting the number of roles they could assume at their large manufacturing company:

"I became the person who did it because (1) I enjoy doing it and (2) I was good at it. We had a lot of guys who were not; they don't explain what they're doing or why they're doing it. They just kind of do it and are like 'Just watch me' and then do it and don't really explain. And that may be something I got from MIT...this kind of, like, how do you teach someone to do what you're doing, to follow you. And so I got really good at it

and so I spent a lot of time, actually, training people. It became one of my kind of secondary functions that they had me do."

These observed successes and failures illustrating the importance of strategy to success in the workplace, validating the relevance of this skill to the 2D Framework.

### **Teamwork – Validated**

Although not all of the respondents discussed the importance of teamwork at length, all respondents discussed working on teams after arriving at their jobs in industry. Summarizing this issue, one interviewee explained that no complex technical problem can be solved by one individual acting alone, necessitating teamwork as a skill in the engineering workplace. When describing her recruiting practices, one respondent discussed teamwork as follows: "I kind of look for people who can bring that self-awareness, I guess, of their strengths and weaknesses; that they know how to fit into a team and work together with others." Similarly, another interviewee talked about the importance of teams to the success of her aerospace company as follows:

"That's the whole concept of teamwork—there's going to be stuff that you don't understand or somebody else doesn't understand but if it's a collaborative team we kind of work with each other and take the expertise from each one of the persons in the team and that enables our program to be successful."

One respondent, a recruiter for a large manufacturing company, also mentioned the importance of multidisciplinary teamwork to her organization:

"A big one that they really should have [coming out of college] is those team skills. [...] A lot of times you see that they've worked in a team within their group, like, you know, it'll be a group of chemical engineers that have worked together for a project. But the cross functional teams, where they actually worked with—you know, 'I'm a ChemE but I worked with a mechanical engineer and a software engineer and we all worked together to make a project'—[that's what's really valuable]. Because that's the way the real world works. [...] A lot of colleges now are trying to get them into groups but I find that even when they get them into groups they're getting them within their major."

These comments regarding multidisciplinary teamwork—in addition to other respondents' discussion of the importance of team abilities—validates this skill set for the 2D Framework.

### **Time Management – Validated**

Many of the respondents discussed time management during their first career after graduating MIT, specifically in contrast to the accepted schedules of undergraduates at the Institute. Said one respondent of her first startup job after graduation: "You know, it wasn't very

hard [to transition there]. I guess I was kind of in that mentality of having to work long hours and really have to put my mind and energy into what I was doing." Similarly, another respondent discussed the difference between his academic role as a graduate student and researcher and his positions in entrepreneurial startups:

"[The lab I worked at was] very similar to the academic culture, which was 'If I don't get this done today, I'll just do it tomorrow; I'll tack a day on to whenever I graduate.' [...] As opposed to the startup environment, where it was always 'This has to get done and any day we lose hurts the product launch and could have dire impact on the company in general.' The main thing I liked is just how fast everything moved."

In terms of recruiting practices, only one respondent discussed the importance of time management to work at her company, citing the importance of prioritization on technical projects. Describing this practice as “triage,” this respondent noted that the best employees can quickly determine what components should be “saved” of a particular project and what should be changed or thrown away.

### **Written Communication – Validated**

One interview respondent, a manager at a technical consulting firm, directly discussed the importance of writing ability to success at her company. Regarding the importance of writing skills in new hires, she said: "I also look for people [...] I feel like can write, because it's hard to get around that. [...] You don't need to be able to write eloquently or particularly complicated stuff, but you have to be able to communicate yourself clearly."

Although this interviewee was the only respondent to discuss the importance of writing skills in new hires, other respondents discussed composing specifications, reports, or proposals on their first job after MIT, validating this skill’s relevance to the 2D Framework.

### *Additional Skills Identified Through Interviews*

Although many points discussed by interview respondents related to the 20 skills identified in the 2D Framework, some additional skills and requirements of entry-level engineers were also cited throughout the course of respondent interviews. External to the framework at the center of this thesis, these skills are nevertheless relevant and important to undergraduate student development in engineering programs. These skills include:

- Flexibility
- Self-awareness
- Ability to give and accept criticism
- Willingness to learn
- Cross-generational communication skills

- Diversity of experience
- Dynamism and tenacity
- Curiosity
- Energy
- Understanding of importance of non-technical factors (e.g. project cost)

From the opposite perspective, one interviewee also spoke highly of a new college graduate entry program she had participated in at her company, and discussed how today's industrial organizations should renew their focus on transitioning college graduates to industry, rather than just "sitting them at a desk and telling them to do work." Although this observation did not directly connect to the validation of this framework, it was relevant in terms of the broader ecosystem of the university-industry transitional phase.

### *Validated Framework*

Table 4-1 on pages 60-61 illustrates which of the 2D Framework skills were validated through the employer interview study process. Validated skills are highlighted in grey, while the rows of those skills not mentioned in at least one interview are indicated in white in Table 4-1. As is shown in this table, all but six skills developed through the Chapter 3 literature review were validated by employer interviews, illustrating the relevance and applicability of the completed framework for skill development to the practice of the engineering profession.

|                             | Academic/Professional | Academic Competitions | Advocacy | Arts | Athletics | Campus Community | Culture | Department Groups | Energy & Environment | Games & Hobbies | Greek Life |
|-----------------------------|-----------------------|-----------------------|----------|------|-----------|------------------|---------|-------------------|----------------------|-----------------|------------|
| Civic Responsibility        |                       | ✓                     | ✓        |      |           | ✓                | ✓       |                   | ✓                    |                 |            |
| Creativity                  |                       |                       |          | ✓    |           |                  |         |                   |                      | ✓               |            |
| Critical Thinking           |                       | ✓                     | ✓        | ✓    |           | ✓                | ✓       |                   |                      | ✓               |            |
| Cross-Cultural Skills       |                       |                       | ✓        |      | ✓         | ✓                | ✓       |                   |                      |                 |            |
| Disciplinary Knowledge      | ✓                     | ✓                     | ✓        |      |           |                  |         | ✓                 | ✓                    |                 |            |
| Ethics                      |                       | ✓                     |          |      |           |                  |         | ✓                 |                      |                 |            |
| Global Awareness            |                       | ✓                     |          |      |           | ✓                | ✓       |                   | ✓                    |                 |            |
| Humanitarianism             |                       | ✓                     | ✓        |      |           | ✓                |         |                   |                      |                 |            |
| Interpersonal Communication | ✓                     | ✓                     | ✓        | ✓    | ✓         | ✓                | ✓       | ✓                 | ✓                    | ✓               | ✓          |
| Memory                      |                       | ✓                     |          | ✓    |           |                  |         |                   |                      |                 |            |
| Networking                  | ✓                     | ✓                     | ✓        |      |           | ✓                | ✓       | ✓                 |                      |                 |            |
| Organizational Management   | ✓                     | ✓                     | ✓        | ✓    |           | ✓                | ✓       | ✓                 | ✓                    | ✓               | ✓          |
| Problem Solving             |                       |                       |          | ✓    |           |                  | ✓       | ✓                 | ✓                    | ✓               |            |
| Public Speaking             | ✓                     | ✓                     | ✓        | ✓    |           | ✓                |         | ✓                 | ✓                    |                 |            |
| Self-Confidence             | ✓                     | ✓                     |          | ✓    | ✓         |                  |         | ✓                 |                      |                 | ✓          |
| Self-Direction              |                       | ✓                     |          | ✓    | ✓         |                  |         | ✓                 |                      |                 | ✓          |
| Strategy                    |                       | ✓                     | ✓        |      |           | ✓                |         |                   | ✓                    | ✓               |            |
| Teamwork                    | ✓                     | ✓                     | ✓        | ✓    | ✓         | ✓                | ✓       | ✓                 | ✓                    | ✓               | ✓          |
| Time Management             |                       | ✓                     |          |      |           |                  |         |                   |                      |                 |            |
| Written Communication       |                       |                       |          | ✓    |           |                  | ✓       |                   | ✓                    |                 |            |

**Table 4-1: Employer-validated 2D Framework of student skill development (Part 1 of 2).**



|                             | Honor Societies | Housing Communities | Innovation/Entrepreneurship | Martial Arts | Media | Professional Org. Chapters | Project Teams | Recreation | Religious Groups | Service Organizations | Student Governance |
|-----------------------------|-----------------|---------------------|-----------------------------|--------------|-------|----------------------------|---------------|------------|------------------|-----------------------|--------------------|
| Civic Responsibility        | ✓               | ✓                   |                             |              | ✓     |                            |               |            |                  | ✓                     | ✓                  |
| Creativity                  |                 |                     |                             |              | ✓     |                            | ✓             |            |                  |                       |                    |
| Critical Thinking           |                 | ✓                   |                             |              | ✓     |                            | ✓             |            |                  | ✓                     | ✓                  |
| Cross-Cultural Skills       |                 |                     |                             |              | ✓     |                            | ✓             |            |                  | ✓                     |                    |
| Disciplinary Knowledge      |                 |                     | ✓                           |              |       |                            | ✓             |            |                  | ✓                     |                    |
| Ethics                      |                 | ✓                   |                             |              | ✓     |                            | ✓             |            |                  | ✓                     | ✓                  |
| Global Awareness            |                 | ✓                   |                             |              |       |                            | ✓             |            |                  | ✓                     | ✓                  |
| Humanitarianism             |                 | ✓                   |                             |              | ✓     |                            | ✓             |            |                  | ✓                     |                    |
| Interpersonal Communication | ✓               | ✓                   |                             | ✓            | ✓     | ✓                          | ✓             | ✓          | ✓                | ✓                     | ✓                  |
| Memory                      |                 |                     |                             |              |       |                            |               |            |                  | ✓                     |                    |
| Networking                  | ✓               |                     | ✓                           |              |       | ✓                          | ✓             |            |                  |                       | ✓                  |
| Organizational Management   | ✓               |                     | ✓                           | ✓            | ✓     | ✓                          | ✓             | ✓          | ✓                | ✓                     | ✓                  |
| Problem Solving             |                 |                     |                             |              |       |                            | ✓             |            |                  | ✓                     | ✓                  |
| Public Speaking             |                 |                     | ✓                           | ✓            | ✓     | ✓                          | ✓             | ✓          |                  | ✓                     | ✓                  |
| Self-Confidence             |                 |                     | ✓                           | ✓            | ✓     | ✓                          | ✓             |            |                  | ✓                     |                    |
| Self-Direction              |                 |                     | ✓                           | ✓            | ✓     |                            | ✓             |            |                  | ✓                     | ✓                  |
| Strategy                    | ✓               |                     | ✓                           |              | ✓     |                            | ✓             |            |                  |                       | ✓                  |
| Teamwork                    | ✓               |                     | ✓                           |              | ✓     |                            | ✓             | ✓          | ✓                | ✓                     | ✓                  |
| Time Management             |                 |                     |                             |              |       |                            | ✓             |            |                  | ✓                     | ✓                  |
| Written Communication       | ✓               | ✓                   | ✓                           |              | ✓     |                            | ✓             |            |                  | ✓                     | ✓                  |

**Table 4-1: Employer-validated 2D Framework of student skill development (Part 2 of 2).**

## REFLECTIONS ON STUDENT INVOLVEMENT AT MIT

In addition to providing insight on their experiences as employers and managers in the industrial workplace, interviewees also reflected upon their own MIT experiences outside of the classroom and the lasting lessons these activities have imparted. Although no formal analysis of these comments was completed within the scope of this study, some key quotes and reflections of interviewees are below. Despite the lack of formal assessment of these and other qualitative data from alumni interviews, the content of these reflections illustrate the value MIT alumni place on their extracurricular and co-curricular experiences during college. Future research could incorporate these reflections in an analysis of the value, strengths, and weaknesses of an MIT undergraduate education.

### *Building Community*

Many of the interview respondents discussed the importance of their communities during college, be it through cultural organizations, Greek life, other extracurricular activities, or living communities. One respondent—who chose to attend MIT after enjoying a campus visit during which he stayed at a fraternity—discussed the importance of his Greek experience both inside and outside of the classroom:

“I did not-so-great as a freshman in terms of grades because I was testing the system to see where the pass/fail line was...sometimes I found it, sometimes I was on the wrong side of it! And, in a way, it [being in a fraternity] was good when I was a freshman because I had guys I hung out with and we established strong bonds; [they're] still some of my best friends today. And then as a sophomore I came in [...] and it was kind of the other side of the fraternity house. I started hanging out with the two 'nerds' of the house who studied a lot, and they kind of took me in and I spent most of my time with those guys, who were a year older than I was. [I] spent most of my time studying, which basically completely changed my experience of MIT. I went from being sort of on the edge in terms of not succeeding to, you know, getting a high GPA and doing well.”

Another interviewee—an electrical engineer who came to MIT from California—discussed how her involvement with cultural organizations eased her transition away from home to life in Boston:

"I created a nuclear family at the Institute and some of the organizations I really participated the most in were the Hispanic organizations. [...] I was very heavily involved with the underrepresented community. [...] My time at MIT was enriched heavily by being involved in all of those different organizations and I met some of my very close friends [through those groups]."

Lastly, one respondent discussed creating an entrepreneurial venture within the context of his cultural community, explaining how he and some friends created a cultural dance group during their time on campus. The interviewee then discussed how this project was made a profitable enterprise, bridging the gap between student cultural activities and entrepreneurial ventures.

### *Time Management and Work/Life Balance*

Several respondents discussed the struggle balancing extracurricular and academic life at MIT. Said one respondent: “[People who come to MIT] recognize that extracurriculars are ‘the thing,’ almost, but it’s hard for MIT people—I mean, we’re overachievers in general—to accept the bad grade. So people are still [...] slaves to the grading system. So a little bit of both.” Another interviewee called learning to balance her school, work, and extracurricular lives at MIT “a big lesson in time management.” Said a third interviewee, a graduate student who created several startups during his tenure at MIT: “What I got out of doing startups was that...we worked on a part-time basis so we would bill on an hourly basis. I realized how much a person’s time is worth. [...] That shifts your perspective about what you should be putting your time into.”

Other respondents reflected on their lack of extracurricular leadership at MIT, choosing instead to focus their time on other personal or professional activities. For example, one respondent discussed her experience being a mother during college, and how her daughter was her “extracurricular” at MIT. Another respondent discussed participating in activities on campus but not pursuing leadership roles: “I was much more interested in doing the activities and getting good grades.”

### *Collaboration and Teamwork*

Almost all interviewees talked about the collaborative nature of the Institute and its affect on their development during college. Specifically, one interviewee provided an example of how interacting with his peers helped him discover his academic skills in fluid mechanics, which ultimately drove much of his future career:

"You learn that [specialty] in sort of interacting with your classmates and seeing your other classmates and how they're doing. You know, spending the long hours with them at night in terms of doing the design work and all that classwork. [...] How you split up a project—'You do this part; I'll do this part'—I think those strengths really come out and it gives you confidence in your individual skill sets."

## *Personal Development*

One respondent's academic experience at MIT shaped her cross-cultural views both at MIT and into her professional career. She reflected, in the context of a discussion of her religious extracurriculars:

“Around the same time that I was in leadership in that [religious] organization I took a class at MIT about racial and cultural differences that was really life-changing for me. [...] [As a result of this class we put in a lot of thought] within that organization—how to make it [...] accommodating for people of all races and ethnicities and talked a little bit about what that meant, which was a big deal for that organization (which was predominantly white at the time). [...] I do think that the cultural awareness class was really great and that it was really instrumental to working in an international world.”

Another respondent described his personal experiences studying abroad in the United Kingdom, which also impacted his cross-cultural awareness: “I think I developed the most as a person in my year abroad; partially because it was, you know, in a different environment...just simply being in another country forces that upon you. [It] forces you to meet new people (and so on and so forth) of a different culture. And partially because Cambridge really emphasized extracurricular activities.”

In addition to these individual insights and skills, MIT graduates also reflected on their skill development during college and at the beginning stages of their career. One respondent discussed that at his first job at a Massachusetts-based startup, he often called upon organizational management skills he acquired in high school and collegiate extracurriculars. Similarly, another respondent discussed how her leadership roles in the MIT hacking community were analogous to her first project management roles as an engineer in the professional workplace. Lastly, some respondents talked about the skills developed through specific experiences at MIT; for example, said one respondent regarding her job as a consultant and her involvement in MIT theater: “I present a ton in front of clients and I learned in those theater classes how to do that.”

## *MIT and Entrepreneurship*

One interviewee, a current doctoral student in California, discussed at length her experience creating her own research project during her time at MIT:

“We started an organization making a research submarine. [...] We sort of created our own project; like, it wasn't necessarily a UROP, it was its own thing. We got a class number designation for it. We were just like 'We want to work on this project! We think we can get credit for it too!'. It was really cool—MIT was very supportive and we found our own teacher to grade us, so we had a professor from mechanical engineering who was

the advisor kind of helping us out but also giving us a grade at the end of the year. We had a number of kids enrolled in that class. [...] That was a really good experience [...]; it was almost like creating our own company as well because we were working with the Navy research submarine but it took a lot of funding so we had to identify key players to get our funding from—both enterprises and government. [...] Now I'm very entrepreneurial and that was just really my first exposure to it even though it was a very academic endeavor. Managing the team, figuring out the scope of the project, and then how do you implement it either through actually getting your experiment deployed in a larger organization—in this case, the Navy—or funded. It was a great experience, and it was kind of self-taught too, to a large extent."

This same respondent later discussed how, after arriving at graduate school, she helped to initiate a \$100K-esque competition to help to promote innovation within the university's student community. This activity was largely inspired by her opportunities as an undergraduate student in Cambridge: "That was the one thing I loved about MIT so much—they give a lot of freedom to the students."

Other respondents had similar reflections, including one who created a startup as an undergraduate that won a project bid from the U.S. Army. In each of these cases, interviewees cited the open and innovative nature of the Institute as the primary driver for their entrepreneurial success.

### *Networking*

One respondent—a current graduate student involved in MIT entrepreneurship and leadership programs—discussed at length the benefits of the collaborative, mentor-heavy environment of both MIT and the Boston area:

"I think what also really matters is the whole ecosystem around the institution. So what's great about MIT is that it's really easy to get mentorship. I can talk to people that usually I can't talk to anywhere else and they're willing to give their time. [...] They need to have a lot of faith in young people. [...] That's one thing that separates the Boston area—and also Silicon Valley—from the rest of the world: the ability to get support. And what that also means is the ability to dream big and have really no bounds to what you want to do."

In addition to discussion of mentorship activities in and around MIT, interviewees often discussed their interactions with the MIT alumni network during their job searches. One respondent, an area manager for a Massachusetts-based startup, was recruited for her current position based on her involvement in one of MIT's cultural interest groups, which recruiters found listed on her LinkedIn profile. Other respondents discussed being hired through MIT connections or by friends creating new entrepreneurial ventures.



# Chapter 5: Framework Validation through ABET Accreditation Criteria

---

In Chapter 4, the 2D Framework of Student Involvement was validated through interviews with supervisors and managers of entry-level engineers; in this chapter, this same framework is further validated through comparison with the specified outcomes of ABET, Inc.'s (formerly known as the Accreditation Board for Engineering and Technology) "Engineering Criteria 2000" (EC2000). These criteria, launched by ABET in 1997, represent a learning outcomes-based approach to engineering program assessment and were developed as a departure from the traditional, teaching-based approach of previous accreditation methodologies.

## **ABET AND THE DEVELOPMENT OF EC2000**

### *History of ABET*

As was discussed in the Introduction chapter of this thesis, ABET has been in existence since 1932, when it was founded as the Engineers' Council for Professional Development (ECPD) (ABET, 2011). A joint effort, this organization was founded by seven major engineering societies of the time, as follows (ABET, 2011):

- The American Society of Civil Engineers,
- The American Institute of Mining and Metallurgical Engineers,
- The American Society of Mechanical Engineers,
- The American Institute of Electrical Engineers,
- The Society for the Promotion of Engineering Education,
- The American Institute of Chemical Engineers, and
- The National Council of State Boards of Engineering Examiners.

During its first 40 years of operation, ECPD evaluated engineering and technology degree programs and produced numerous guidance and training publications for aspiring engineering students (ABET, 2011). ECPD engaged in its first international accreditation activities in 1970 after joining a Mutual Recognition Agreement with the Canadian Engineering Board, and in 1980 the organization changed its name to the Accreditation Board for Engineering and Technology (ABET, 2011). From the organization (ABET, 2011):

Currently, ABET accredits over 3,100 programs at more than 600 colleges and universities worldwide. Each year, over 2,000 volunteers from 31 Member Societies contribute to ABET's goals of leadership and quality assurance in applied science, computing, engineering, and engineering technology education, serving as program

evaluators, committee and council members, commissioners, and members of the Board of Directors. (ABET, 2011)

In this role, ABET maintains a unique relationship with American universities, as “the U.S. Department of Education formally recognizes ABET’s exclusive jurisdiction for accreditation of engineering and engineering technology education” (Sarin, 2000, p. 496). In addition, completion of ABET-recognized programs also serves as the chief educational qualification in the Professional Engineer licensure process (Sarin, 2000). These relationships provide ABET with firm legal and political standing within the higher education landscape, and as a result ABET’s policy decisions have great impact on many students, educators, and academic professionals both nationally and internationally.

### *EC20000 Accreditation Criteria*

The most notable recent change to ABET’s practices and accreditation procedures took place in 1997, when the organization released “Engineering Criteria 2000” (EC2000), a new, outcomes-based approach to engineering program accreditation (ABET, 2011). The development of EC2000 was prompted by widely held industrial views of engineering education; many industry leaders of the 1990’s believed that the skill sets of engineering program graduates were poorly aligned with the requirements of the modern workforce (Volkwein, Lattuca, Terenzini, Strauss, & Sukhbaatar, 2004). During this period, practitioners of engineering education also claimed that ABET’s strict accreditation guidelines limited capacity for innovation in technical higher education (Volkwein et al., 2004). As a result of these long-standing issues, ABET leadership brought together representatives of the National Science Foundation, engineering academics, industrial leaders, and ABET staff for a set of consensus-building workshops in the mid-1990’s to develop new standards of accreditation criteria, participation, and process (Volkwein et al., 2004). EC2000 represents the result of these efforts and contains “both common criteria for all engineering programs and program-specific criteria for 23 different engineering sub-disciplines” (Volkwein et al., 2004, p. 318).

In contrast to the teaching specification approach of the ABET process pre-1997, EC2000 includes both “traditional” hard science requirements such as libraries, laboratories, and technical curriculum components as well as broadly defined desirable “outcomes” of engineering education (Sarin, 2000). These outcomes—known as “Criterion 3” within the engineering education community—have sparked much discourse and debate since their introduction in 1997 (Shuman, Besterfield-Sacre, & McGourty, 2005). In the 2013-2014 “Criteria for Accrediting Engineering Programs” ABET lists the Criterion 3 outcomes as follows (ABET, 2012):

- a) an ability to apply knowledge of mathematics, science, and engineering
- b) an ability to design and conduct experiments, as well as to analyze and interpret data



- c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- d) an ability to function on multidisciplinary teams
- e) an ability to identify, formulate, and solve engineering problems
- f) an understanding of professional and ethical responsibility
- g) an ability to communicate effectively
- h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- i) a recognition of the need for, and an ability to engage in life-long learning
- j) a knowledge of contemporary issues
- k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice. (p. 3)

Although many engineering educators question the merits and efficacy of this criterion (Riley, 2012), studies performed in the years since EC2000's implementation have indicated positive results regarding the new accreditation methodologies. In a study of almost 10,000 graduates of American engineering programs, Lattuca, Terenzini, and Volkwein (2006) showed that graduates educated under EC2000-accredited programs illustrate greater awareness of global issues, group skills, knowledge of ethics, and engineering skill application abilities than their pre-EC2000 educated counterparts. In addition, large sample surveys of employers post-EC2000 also indicate that recent engineering graduates are more prepared for the demands of the workplace than graduates of earlier programs (Lattuca, Terenzini, & Volkwein, 2006).

## **VALIDATION OF 2D FRAMEWORK SKILLS**

### *Relationship of EC2000 Criteria to Framework Skills*

To validate the skills of the Chapter 3 2D Framework of student skill development, the list of Framework “key skills” was organized in the context of the 11 Criteria 3 outcomes from ABET’s 2013-2014 accreditation guidelines (ABET, 2012, p. 3). Table 5-1 on page 70 illustrates which key skills are associated with particular Criterion 3 outcomes.

| <b>ABET Criterion 3 Outcome</b>                                                                                                                                                                                                   | <b>Relevant Framework Skill(s)</b>                                                                                                                                                                                                          |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| (a) an ability to apply knowledge of mathematics, science, and engineering                                                                                                                                                        | <ul style="list-style-type: none"> <li>• Disciplinary Knowledge</li> </ul>                                                                                                                                                                  |
| (b) an ability to design and conduct experiments, as well as to analyze and interpret data                                                                                                                                        | <ul style="list-style-type: none"> <li>• Critical Thinking</li> <li>• Disciplinary Knowledge</li> <li>• Organizational Management</li> </ul>                                                                                                |
| (c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability | <ul style="list-style-type: none"> <li>• Civic Responsibility</li> <li>• Critical Thinking</li> <li>• Disciplinary Knowledge</li> <li>• Ethics</li> <li>• Global Awareness</li> <li>• Humanitarianism</li> <li>• Problem Solving</li> </ul> |
| (d) an ability to function on multidisciplinary teams                                                                                                                                                                             | <ul style="list-style-type: none"> <li>• Cross-Cultural Skills</li> <li>• Interpersonal Communication</li> <li>• Teamwork</li> </ul>                                                                                                        |
| (e) an ability to identify, formulate, and solve engineering problems                                                                                                                                                             | <ul style="list-style-type: none"> <li>• Creativity</li> <li>• Critical Thinking</li> <li>• Disciplinary Knowledge</li> <li>• Organizational Management</li> <li>• Problem Solving</li> </ul>                                               |
| (f) an understanding of professional and ethical responsibility                                                                                                                                                                   | <ul style="list-style-type: none"> <li>• Ethics</li> <li>• Humanitarianism</li> </ul>                                                                                                                                                       |
| (g) an ability to communicate effectively                                                                                                                                                                                         | <ul style="list-style-type: none"> <li>• Cross-Cultural Skills</li> <li>• Interpersonal Communication</li> <li>• Public Speaking</li> <li>• Written Communication</li> </ul>                                                                |
| (h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context                                                                                    | <ul style="list-style-type: none"> <li>• Civic Responsibility</li> <li>• Cross-Cultural Skills</li> <li>• Ethics</li> <li>• Global Awareness</li> <li>• Humanitarianism</li> </ul>                                                          |
| (i) a recognition of the need for, and an ability to engage in life-long learning                                                                                                                                                 |                                                                                                                                                                                                                                             |
| (j) a knowledge of contemporary issues                                                                                                                                                                                            | <ul style="list-style-type: none"> <li>• Civic Responsibility</li> <li>• Global Awareness</li> <li>• Humanitarianism</li> </ul>                                                                                                             |
| (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.                                                                                                                    | <ul style="list-style-type: none"> <li>• Disciplinary Knowledge</li> <li>• Problem Solving</li> </ul>                                                                                                                                       |

**Table 5-1: 2D Framework skills of relevance to EC2000 Criterion 3 outcomes.**

As can be seen in Table 5-1, only Criterion 3(i)—“recognition of the need for, and an ability to engage in life-long learning” (ABET, 2012, p. 3)—is not related to one of the 20 key skills included in the Chapter 3 2D Framework. In contrast, six key skills from the 2D Framework—memory, networking, self-confidence, self-direction, strategy, and time management—could not be categorized by at least one Criterion 3 outcome.

### *Validated Framework*

Table 5-2 on pages 72-73 illustrates which of the 2D Framework skills were validated through comparison to the ABET EC2000 criteria. Validated skills are highlighted in gray, while the rows of those skills not suggested by ABET assessment are indicated in white in Table 5-2. As is shown in this table, all but six skills developed through the Chapter 3 literature review were validated through comparison to ABET accreditation practices, further illustrating the relevance and applicability of the completed framework given the similarities of its skills to widely accepted learning outcomes in undergraduate engineering education. For further analysis regarding the validity of each framework validation methodology, refer to the final 2D framework of validated skills in Chapter 8 (page 97).

|                             | Academic/Professional | Academic Competitions | Advocacy | Arts | Athletics | Campus Community | Culture | Department Groups | Energy & Environment | Games & Hobbies | Greek Life |
|-----------------------------|-----------------------|-----------------------|----------|------|-----------|------------------|---------|-------------------|----------------------|-----------------|------------|
| Civic Responsibility        |                       | ✓                     | ✓        |      |           | ✓                | ✓       |                   | ✓                    |                 |            |
| Creativity                  |                       |                       |          | ✓    |           |                  |         |                   |                      | ✓               |            |
| Critical Thinking           |                       | ✓                     | ✓        | ✓    |           | ✓                | ✓       |                   |                      | ✓               |            |
| Cross-Cultural Skills       |                       |                       | ✓        |      | ✓         | ✓                | ✓       |                   |                      |                 |            |
| Disciplinary Knowledge      | ✓                     | ✓                     | ✓        |      |           |                  |         | ✓                 | ✓                    |                 |            |
| Ethics                      |                       | ✓                     |          |      |           |                  |         | ✓                 |                      |                 |            |
| Global Awareness            |                       | ✓                     |          |      |           | ✓                | ✓       |                   | ✓                    |                 |            |
| Humanitarianism             |                       | ✓                     | ✓        |      |           | ✓                |         |                   |                      |                 |            |
| Interpersonal Communication | ✓                     | ✓                     | ✓        | ✓    | ✓         | ✓                | ✓       | ✓                 | ✓                    | ✓               | ✓          |
| Memory                      |                       | ✓                     |          | ✓    |           |                  |         |                   |                      |                 |            |
| Networking                  | ✓                     | ✓                     | ✓        |      |           | ✓                | ✓       | ✓                 |                      |                 |            |
| Organizational Management   | ✓                     | ✓                     | ✓        | ✓    |           | ✓                | ✓       | ✓                 | ✓                    | ✓               | ✓          |
| Problem Solving             |                       |                       |          | ✓    |           |                  | ✓       | ✓                 | ✓                    | ✓               |            |
| Public Speaking             | ✓                     | ✓                     | ✓        | ✓    |           | ✓                |         | ✓                 | ✓                    |                 |            |
| Self-Confidence             | ✓                     | ✓                     |          | ✓    | ✓         |                  |         | ✓                 |                      |                 | ✓          |
| Self-Direction              |                       | ✓                     |          | ✓    | ✓         |                  |         | ✓                 |                      |                 | ✓          |
| Strategy                    |                       | ✓                     | ✓        |      |           | ✓                |         |                   | ✓                    | ✓               |            |
| Teamwork                    | ✓                     | ✓                     | ✓        | ✓    | ✓         | ✓                | ✓       | ✓                 | ✓                    | ✓               | ✓          |
| Time Management             |                       | ✓                     |          |      |           |                  |         |                   |                      |                 |            |
| Written Communication       |                       |                       |          | ✓    |           |                  | ✓       |                   | ✓                    |                 |            |

**Table 5-2: ABET-validated 2D Framework of student skill development (Part 1 of 2).**

|                             | Honor Societies | Housing Communities | Innovation/Entrepreneurship | Martial Arts | Media | Professional Org. Chapters | Project Teams | Recreation | Religious Groups | Service Organizations | Student Governance |
|-----------------------------|-----------------|---------------------|-----------------------------|--------------|-------|----------------------------|---------------|------------|------------------|-----------------------|--------------------|
| Civic Responsibility        | ✓               | ✓                   |                             |              | ✓     |                            |               |            |                  | ✓                     | ✓                  |
| Creativity                  |                 |                     |                             |              | ✓     |                            | ✓             |            |                  |                       |                    |
| Critical Thinking           |                 | ✓                   |                             |              | ✓     |                            | ✓             |            |                  | ✓                     | ✓                  |
| Cross-Cultural Skills       |                 |                     |                             |              | ✓     |                            | ✓             |            |                  | ✓                     |                    |
| Disciplinary Knowledge      |                 |                     | ✓                           |              |       |                            | ✓             |            |                  | ✓                     |                    |
| Ethics                      |                 | ✓                   |                             |              | ✓     |                            | ✓             |            |                  | ✓                     | ✓                  |
| Global Awareness            |                 | ✓                   |                             |              |       |                            | ✓             |            |                  | ✓                     | ✓                  |
| Humanitarianism             |                 | ✓                   |                             |              | ✓     |                            | ✓             |            |                  | ✓                     |                    |
| Interpersonal Communication | ✓               | ✓                   |                             | ✓            | ✓     | ✓                          | ✓             | ✓          | ✓                | ✓                     | ✓                  |
| Memory                      |                 |                     |                             |              |       |                            |               |            |                  | ✓                     |                    |
| Networking                  | ✓               |                     | ✓                           |              |       | ✓                          | ✓             |            |                  |                       | ✓                  |
| Organizational Management   | ✓               |                     | ✓                           | ✓            | ✓     | ✓                          | ✓             | ✓          | ✓                | ✓                     | ✓                  |
| Problem Solving             |                 |                     |                             |              |       |                            | ✓             |            |                  | ✓                     | ✓                  |
| Public Speaking             |                 |                     | ✓                           | ✓            | ✓     | ✓                          | ✓             | ✓          |                  | ✓                     | ✓                  |
| Self-Confidence             |                 |                     | ✓                           | ✓            | ✓     | ✓                          | ✓             |            |                  | ✓                     |                    |
| Self-Direction              |                 |                     | ✓                           | ✓            | ✓     |                            | ✓             |            |                  | ✓                     | ✓                  |
| Strategy                    | ✓               |                     | ✓                           |              | ✓     |                            | ✓             |            |                  |                       | ✓                  |
| Teamwork                    | ✓               |                     | ✓                           |              | ✓     |                            | ✓             | ✓          | ✓                | ✓                     | ✓                  |
| Time Management             |                 |                     |                             |              |       |                            | ✓             |            |                  | ✓                     | ✓                  |
| Written Communication       | ✓               | ✓                   | ✓                           |              | ✓     |                            | ✓             |            |                  | ✓                     | ✓                  |

**Table 5-2: ABET-validated 2D Framework of student skill development (Part 2 of 2).**



# Chapter 6: Policy Mechanisms to Promote Student Involvement

---

In the previous chapters of this thesis, a case for the importance of student involvement in undergraduate engineering education was made through the creation and validation of a framework for student involvement. Given the context of these known benefits, this chapter presents different methodologies by which universities, governments, and private organizations can support leadership and skill development in undergraduate students. In the following chapter, the inaugural leadership development program at the Singapore University of Technology and Design is presented as a case study to promote student involvement at a new higher education institution.

## UNIVERSITY-LEVEL PROCESSES

### *Divisions of Student Affairs*

According to NASPA, the national organization for Student Affairs Administrators in Higher Education: “People who work in student affairs provide services, programs, and resources that help students learn and grow outside of the classroom” (NASPA, 2012). These individuals, many of whom pursue graduate degrees in student affairs or higher education, support undergraduate students in a variety of campus roles. These initiatives include, but are not limited to: multicultural programming, Greek life, athletics and recreation, financial aid administration, student unions, student organization advising, admissions, alumni programming, campus leadership development, career services, study abroad administration, new student orientation planning and lesbian, gay, bisexual, and transgender programming and support, among many others (NASPA, 2012). At MIT, the Division of Student Life oversees many of these activities, including the Department of Athletics, Physical Education, and Recreation; religious life; residential life and dining; and numerous student development and support initiatives and offices on campus (MIT Division of Student Life, n.d.).

Student affairs departments are supported by university budgets and endowments as well as through collection of student fees during registration periods. These fees, which vary widely across institutions, may support student government activities, student legal or health services, athletic facilities, or other components of student affairs. MIT’s student activities fee—which was introduced in 2002—was initiated “to create a \$600,000 student activities fund and to help defray additional expenses associated with the Zesiger Sports and Fitness Center” (Fox, 2002, February 19). As of the 2013-2014 academic year, this fee is \$288 annually (MIT Student Financial Services, n.d.). For comparison, student fees for MIT’s peer institutions are listed in

Table 6-1 below<sup>5</sup> (Stanford University, 2013; UC Berkeley Office of the Registrar, 2012; Georgia Institute of Technology, 2012; University of Illinois Board of Trustees, 2008a; Regents of the University of Michigan, 2013). Based on these figures, it is clear that university administrations develop widely varying funding mechanisms to support student affairs and promote campus involvement; based on this observation, further research into the most effective structures of student affairs administration should be analyzed to determine “best practices” in the field of student affairs in undergraduate engineering education.

| <b>Institution</b>                         | <b>Fee Includes</b>                                                                                                                                                                                                                                                                                                              | <b>Annual Fee</b> |
|--------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| Stanford University                        | Student Government                                                                                                                                                                                                                                                                                                               | \$420             |
| University of California – Berkeley        | Student Government, Student Center, Ethnic Studies, Intramural Sports Facilities, Recruitment and Retention Centers, Recreational Sports, Green Initiative Fund, Lower Sproul, Daily Cal V.O.I.C.E                                                                                                                               | \$159.75          |
| Georgia Institute of Technology            | Recreation Facilities, Activities, Athletics                                                                                                                                                                                                                                                                                     | \$608             |
| University of Illinois at Urbana-Champaign | Cleaner Energy Technologies, Collegiate Readership, Cultural Programming, Krannert Center for the Performing Arts, Community Service Scholarships, Sustainable Campus Environment, Domestic Scholarships, Student Organization Resources, Study Abroad and Travel Scholarships (University of Illinois Board of Trustees, 2008b) | \$66              |
| University of Michigan Ann Arbor           | Central Student Government, School & College Government                                                                                                                                                                                                                                                                          | \$17.19           |

**Table 6-1: Annual student fees for MIT peer institutions.**

### *Student-Led Governance Mechanisms*

At most universities in the United States, governance of student life—be it in residence halls, student government, or other areas—is facilitated or advised by a panel of active student leaders. As was discussed in Chapter 3, this self-governance creates a sense of stakeholdership in students, developing a more engaged student body and alumni base than in the case of top-down administrative governance. The creation and promotion of student governance is therefore a relatively easy, cost-effective strategy to promote student engagement on campus.

---

<sup>5</sup> Peer institutions were selected based on undergraduate engineering program rankings in U.S. News & World Report. Only those peer institutions that provided itemized student fee information are included in Table 6-1. All data are current as of April 2013.



## *Undergraduate Leadership Programs*

John Dugan and Susan Komives, two experts in student leadership development at American universities, published a report in 2007 through the National Clearinghouse for Leadership Programs on trends in leadership programming for college students. In the realm of co-curricular and extracurricular leadership development, Dugan and Komives (2007) make the following observation:

Campus leadership practices expanded exponentially in the 1990s to include the first undergraduate leadership major at the Jepson School of Leadership Studies at the University of Richmond and a plethora of leadership certificate programs and academic minors at other institutions. Leadership educators also began offering a wide array of co-curricular leadership programs open to interested students such as emerging leaders. [...] Estimates indicated approximately 700 leadership programs existed on college campuses during this time period (Schwartz, Axtman, & Freman, 1998). More recently, that number is thought to have risen to over 1,000 programs nationally (Scott, 2004). (p. 6)

From these observations, it is clear that curricular and co-curricular leadership offerings at universities are expanding across the United States, with many institutions adopting their own programs and methodologies to educate their students. From this nationwide study of American college students, Dugan and Komives discovered that formal leadership programs—no matter their duration—positively influence student leadership outcomes from college including change, citizenship, and common purpose<sup>6</sup> (Dugan & Komives, 2007). Although all durations of leadership programs have been shown to yield positive impact, students who participated in long-duration programs—especially academic programs such as leadership majors and minors—demonstrated more leadership skills characteristic of the values described in Chapter 3 (Dugan & Komives, 2007).

Some leadership programs at American universities have developed to specifically address the leadership needs of engineering students. The MIT Gordon Engineering Leadership (GEL) program is the premier leadership development program at the Institute for undergraduates in engineering fields (MIT Gordon Engineering Leadership Program [MIT GEL], 2011). Available to MIT juniors and seniors, this program seeks to impart participants with the leadership attitudes, skills, and technical knowledge to serve as a leader in the engineering workplace (MIT GEL, 2011). Other American engineering leadership programs may be developed with different scopes and foci; for example, Iowa State University's Engineering

---

<sup>6</sup> These learning outcomes were developed from Komive and Wagner's "Social Change Model of Student Leadership"—for more information on this model, please refer to the "MISTI-SLI Pre-Departure Training" section of Chapter 7.

Leadership Program is designed “to inspire altruistic leadership in engineering students leading to greater civic and political engagement” (Athreya, Rover, Walter, Mickelson, McGrath, Kalkhoff, Rasmussen, Starns, Wiley-Jones, Saunders, & Shelley, 2007, p. T2J-15). In all of these cases, curricular and co-curricular leadership programs enable students to develop skills similar to those achieved by involvement, further preparing students for the demands of the engineering workplace upon graduation.

### *University Business Plan Competitions*

In the sections below, various challenge and competition avenues outside of universities—including private challenges as well as government-sponsored initiatives—are discussed as methods to promote student innovation outside of the classroom. Despite the relative success of these methodologies, the challenge platform with perhaps the most direct impact on college students is that of the university business plan competition. For the purpose of this analysis, two MIT competitions—the \$100K Business Plan Competition and the MIT Clean Energy Prize—will be described as case studies regarding the efficacy of these types of initiatives.

Begun in 1989 as the MIT \$10K Competition, today’s MIT \$100K is regarded as the premier collegiate business plan competition in the United States (MIT \$100K, 2013). This competition annually distributes over \$350,000 in cash and prizes in six distinct “industry tracks:” emerging market, energy, life sciences, mobile, products and services, and web/IT (MIT \$100K, 2013). Competitors in these categories participate in one or more of the three annual \$100K events, which include an elevator pitch contest, a demonstration contest, and a business plan contest (MIT \$100K, 2013). In addition, this contest enables networking, mentorship activities, and team-building support for future entrepreneurs (MIT \$100K, 2013). By providing these resources—as well as the incentive of large cash prizes and potential future success—the \$100K competition promotes involvement of MIT students in entrepreneurial ventures.

From its website, “the MIT Clean Energy Prize (CEP) is a multi-stage, student-organized business plan competition that culminates with a Grand Prize Awards Ceremony and Showcase” currently in its sixth year of operation (MIT Clean Energy Prize [MIT CEP], 2013). Similar to the \$100K competition, the MIT CEP is organized into three distinct tracks, including renewable energy, energy efficiency, and infrastructure and resources (MIT CEP, 2013). Through each of these tracks, competitors submit executive summaries and proposals for potential innovative clean energy startups, and these submissions are judged through a series of subsequent competition rounds (MIT CEP, 2013). Teams that pass early judging rounds gain access to mentorship and other CEP resources supporting their initiatives, gaining practical skills to help win the challenge grand prizes—valued at \$100,000 and \$150,000—and move their idea into the marketplace (MIT CEP, 2013). This discipline-specific prize competition effectively serves as

the “energy” track of the MIT \$100K, and students participating in the CEP thereby gain many of the same skills as those engaged in the traditional \$100K (MIT CEP, 2013).

## GOVERNMENTAL INITIATIVES

Although most governmental higher education policies and initiatives are related to issues of access or college affordability (New America Foundation, 2012), some government programs may directly affect how students are engaged outside of the classroom during their undergraduate years. This section describes in detail three specific avenues by which the federal government may impact student engagement at the undergraduate level; however, this list is by no means exhaustive, as other policy mechanisms to promote student engagement are likely to exist.

### *Broader Impacts Requirements for Federal Research Funding*

The National Science Foundation (NSF) includes discussion of the “broader impacts” of scientific research as a component of proposals for federal research funding (National Science Foundation [NSF], 2013). In its 2013 *Grant Proposals Guide*, NSF states that broader impact activities must related to “the achievement of societally relevant outcomes” including but not limited to:

- full participation of women, persons with disabilities, and underrepresented minorities in science, technology, engineering, and mathematics (STEM);
- improved STEM education and educator development at any level;
- increased public scientific literacy and public engagement with science and technology;
- improved well-being of individuals in society;
- development of a diverse, globally competitive STEM workforce;
- increased partnerships between academia, industry, and others;
- improved national security;
- increased economic competitiveness of the United States;
- and enhanced infrastructure for research and education. (NSF, 2013)

Although most responses to the Broader Impacts Criterion do not encompass the scientific or technical content of a grant proposal, the information provided under this section is critically examined by grant proposal reviewers, specifically content relating to broader participation of traditionally underrepresented groups in higher education (Texas State University, n.d.).

If developed in collaboration with graduate and undergraduate students, many activities classified as “Broader Impacts” may develop similar skills to those co-curricular and extracurricular organizations examined in Chapter 3; as an example, a professor may choose to develop a mentorship and outreach program staffed by undergraduate students, enabling

participants to act as tutors developing the skills characteristic of participation in service. Additionally, professors who choose to engage undergraduate students as researchers as a component of this proposal criterion also enable their students to gain skills relevant to the research enterprise. Through the requirement of these broader impacts activities to secure federal research funding, the National Science Foundation enables universities to foster engagement in their students through initiatives developed by faculty and research scientists.

### *Administration Initiatives*

In some cases, a presidential administration may choose to develop initiatives relevant to the engagement of college students, motivating engagement in a particular issue or cause outside of the classroom. The Obama Administration has launched two such initiatives since the Presidential Inauguration in 2009: the Interfaith and Community Service Campus Challenge and the “1 is 2 Many” initiative coordinated by the Office of the Vice President. Although no research exists on the practical efficacy of these programs to date, these initiatives may positively impact participation for some undergraduate students.

The President’s Interfaith and Community Service Campus Challenge, launched by the Obama Administration in fall 2011, is “an initiative inviting institutions of higher education to commit to a year of interfaith and community service programming on campus” (U.S. Department of Education, 2013). In its inaugural year, this 270 higher education institutions—including colleges, universities, community colleges, and graduate theological schools—participated in this initiative, facilitating year-long service projects for teams of students of differing religious and non-religious backgrounds, promoting student engagement across these groups (U.S. Department of Education, 2013). This program was continued in the 2012-2013 academic year after a successful gathering of 2011 academic year participants in July 2012 (U.S. Department of Education, 2013).

The second initiative relevant to student engagement at the undergraduate level is the “1 is 2 Many” campaign, launched by the office of Vice President Joe Biden in September 2011 (The White House, n.d.). This project, although not directly related to co-curricular and extracurricular involvement, seeks to promote awareness of sexual assault and dating violence, particularly on U.S. college campuses (The White House, n.d.). Using social media and other methods, this initiative encourages young people to take action against abuse by becoming involved on campus or at local crisis centers, thereby promoting involvement of undergraduate students (The White House, n.d.). Depending on its long-term observed effects, this program may be used as a model to promote engagement in and advocacy for relevant social issues on college campuses.

## *Challenge.Gov*

Similar to the private challenge platforms described in the “National and International Challenges” subsection below, Challenge.gov is an online platform designed to facilitate challenges sponsored by federal departments and agencies (ChallengePost, Inc., n.d.). Administered by the General Services Administration, Challenge.gov was launched in response to President Obama’s 2009 “Strategy for American Innovation,” which “called on agencies to increase their ability to promote innovation by using tools such as prizes and challenges to solve tough problems” (ChallengePost, Inc., n.d.). Currently, this system is available to federal departments and agencies at no cost, and to date has coordinated over 100 online challenges for the federal government (ChallengePost, Inc., n.d.). By providing incentivized challenges for the general public in this way, the federal government creates a platform for students to become engaged in real-world issues and problems outside of the classroom, enabling co-curricular and extracurricular involvement at the undergraduate level should students choose to participate.

## *Legislation*

In rare cases, the federal government may legislate to ensure equal opportunity for all college students, which may affect opportunities for and limitations on student involvement outside of the classroom. The most well known legislation regarding equity of opportunities for college students is Title IX of the Education Amendments of 1972, which “bars sex discrimination in all schools that receive federal funding, including in their athletic programs” (National Women’s Law Center, 2012). Since its implementation in the mid-1970’s, this legislation has prompted more than a fivefold increase in female intercollegiate sports participation, with over 193,000 women participating in college athletics in the 2010-2011 school year (National Women’s Law Center, 2012). Although women still do not represent 50% of college athletes, increases in women’s sports programs, scholarship opportunities, and facility quality have facilitated a strong increase in participation over the last 40 years (National Women’s Law Center, 2012). Through its requirements, Title IX therefore promoted student involvement outside of the classroom by granting women opportunities that they did not previously enjoy.

Although the athletic aspects of the impacts of Title IX are often the most discussed, this legislation has also addressed other issues of inequity in student life; for example, Title IX also limits academic and extracurricular exclusion on the basis of pregnancy or childbirth, further expanding opportunities for women on college and high school campuses (McNeeley, 2007). The most well known case employing Title IX in this way is the 1998 ruling of *Chipman v. Grant County School District*, in which two unmarried mothers successfully argued that their denial from the Grant County National Honor Society was a violation of Title IX (Schweitzer, 2000). Although this ruling was not made in the context of higher education, it illustrates the

methods by which legislation such as Title IX may positively impact women's opportunities for involvement in educational settings.

## **PRIVATE AND NONPROFIT ORGANIZATIONS**

### *Professional Societies*

As was discussed in Chapter 3, national-level societies of professional organizations—especially discipline-specific organizations such as the American Society of Mechanical Engineers or IEEE—often organize chapters on college campuses to promote networking and disciplinary expertise within the next generations of professional leaders. By facilitating a forum through which students can gain mentorship and insight into a particular engineering field, these chapters both encourage students to become involved outside of the classroom and increase persistence of engineering students, especially those in traditionally underrepresented groups. Similarly to other intercollegiate organizations, these societies often organize national conferences for particularly involved student members, encouraging undergraduates to become engaged in their own collegiate chapters to gain eligibility to attend these large events (ASME, 2013).

### *Intercollegiate Organizations*

In addition to student councils and governments on the university level, in the United States there exist inter-university governance structures to connect student leaders at different higher education institutions. In the discipline of engineering, the National Association of Engineering Student Councils (NAESC) fulfills this role, connecting engineering students nationwide (National Association of Engineering Student Councils [NAESC], 2011). From its website, “The National Association of Engineering Student Councils (NAESC, Inc.) is a student lead not-for-profit educational organization composed of over 300 engineering student leaders across the United States from 33 ABET-accredited universities” (NAESC, 2011). NAESC and similar governance organizations connect student leaders from across the United States, enabling them to network, develop their leadership abilities, and organize lobbying efforts on behalf of the engineering undergraduate community (NAESC, 2011). In addition to these organizations, national- and regional-level organizations for other interest groups—such as lesbian, gay, bisexual, transgender, queer, and ally communities—also take place annually across the United States (Drwencke, 2012).

Perhaps the most widely known organization promoting undergraduate student involvement is the National Collegiate Athletic Association (NCAA), the primary governing body for all intercollegiate athletics in the United States (National Collegiate Athletic Association [NCAA], 2013). Divided into three divisions, as of 2013 NCAA membership included 1,066 colleges and universities with over 430,000 total participating student athletes

(NCAA, 2013). In addition to the administration of 89 different national championships in 23 sports, the NCAA also governs financial, academic, and eligibility concerns of student athletes and their institutions (NCAA, 2013). NCAA leadership may adopts and modifies organizational legislation to which NCAA member schools must adhere to maintain eligibility in intercollegiate competitions (NCAA, 2013).

In addition to the NCAA, other organizations promote intercollegiate competition in areas such as club sports and academic and design competitions. These organizations—including groups such as the American Mock Trial Association, USA Ultimate, and the National Model United Nations—are often advised by academics and practitioners with ground-level organization carried out by student volunteers. Through their existence, these organizations promote involvement in undergraduate students by organizing competitions and enabling collaboration between higher education institutions.

For a university to gain membership in any of these organizations (with the exception of the NCAA membership, which is organized by staff members of university athletic departments), university students must reach out and get engaged with the representative group on behalf of their universities. Because of this structural disconnect, universities must rely on engaged, motivated students to enable them to participate in these groups. For this reason, it is imperative that intercollegiate organizations perform outreach to non-member universities in efforts to expand their networks and promote student participation.

### *National and International “Challenges”*

The rise of the Internet has enabled creation of many innovation and entrepreneurship-related challenges available at little-to-no cost to potential problem solvers around the world. Through a simple Internet connection, individuals anywhere can now employ online challenge platforms to submit proposals addressing the real-world problems of governments or private-sector companies. These challenges are open in nature, and therefore particularly accessible for undergraduate students who may have few resources at their disposal to start their own company or independently develop an innovative idea. For this reason, challenge platforms encourage student extracurricular engagement by providing incentives to develop projects outside of the classroom.

Over the past several years, several companies have introduced platforms to enable organizations to pose challenges to the general public. InnoCentive, a company based out of Waltham, Massachusetts, maintains an online platform through which organizations may facilitate design, technical, policy, or other challenges for the general public (InnoCentive, Inc., 2013). Using cash prize incentives for winning solutions, former clients of InnoCentive have included Booz Allen Hamilton, EMC Corporation, NASA, The Economist, Thompson Reuters,

and the U.S. Environmental Protection Agency (InnoCentive, Inc., 2013). Similarly, the website TopCoder facilitates software development and digital design challenges for numerous well-known clients; through the TopCoder system, project requests are opened to a community of almost 550,000 computer scientists, who code in the hope of earning prize money at the conclusion of a particular challenge (TopCoder, Inc., 2012). These and other challenge platforms provide incentives for innovative individuals—such as engineering undergraduates—to become engaged in problems and gain skills relevant to the professional workplace.

Challenges for college students have also been employed in areas outside of the innovation and entrepreneurship realm, including in advocacy, global development, journalism, and other areas. Although these challenges may appear similar to many of the intercollegiate competitions described in the section above, they differ in structure—rather than competing at a one-day event, participants in campus challenges develop and execute ideas on their own college campuses, convening only for final presentations and awards ceremonies.

The best-known American campus challenge competition is the ONE Campus Challenge, an initiative of the ONE Campaign cofounded by the singer-songwriter Bono (ONE, 2012). From its website:

The ONE Campus Challenge (OCC) is an intercollegiate competition designed to mobilize students in the fight against extreme poverty and preventable disease. Through life-saving actions, creative challenges and educational events, college students, professors, alumni and friends join together and urge political leaders to support smart and effective programs that save lives and improve futures for generations to come. (ONE, 2012)

In the 2012 challenge year, participants in ONE Campus recruited and educated more than 10,000 advocates equipped to lobby against extreme poverty and preventable disease, particularly in Africa (ONE, 2012). Similarly, the Clinton Global Initiative University branch also coordinates an annual global development competition with a project-proposal based focus; each year, students are invited to develop “Commitments to Action” addressing community or international issues such as sustainability, clean water availability, or educational access (Clinton Global Initiative University, n.d.).

### *Social Media*

In the age of Facebook, Twitter, and other social media platforms, 94% of college students report that they use social media at least weekly, with heavier social media users more strongly rating their peer interactions in college (Heiberger & Harper, 2008). Additionally, students involved in clubs and organizations also report high levels of positive peer interaction (Heiberger & Harper, 2008), and often these two factors of college—social media use and club



and organization participation—can combine to promote student involvement for both engaged and unengaged students. Since the widespread adoption of the Facebook platform, many students involved in co-curricular and extracurricular activities have used this social media interface to recruit students to join a particular organization or attend a campus event. Even if this act does not promote additional involvement for the participating student, it may encourage other undergraduates—especially those not already committed to out-of-class activities—to participate in organizations that they would not have otherwise joined.

In addition to these specific attributes of Facebook, other social media outlets have considerably lowered barriers to entry for student advocacy nationally and internationally. Websites like Change.org enable students to develop and promote their own petitions, allowing undergraduates to participate in advocacy work without the cost or time constraints of other lobbying methods (Change.org Inc., 2013). Some large-scale organizations require students to use social media for advocacy as a component of involvement; for example, the annual ONE Campus Challenge™ requires students to use social media and other lobbying mechanisms to advocate regarding issues of poverty and disease in Africa (ONE, 2012). All of these types of social media integration serve to make advocacy work easier for students, and in this way these mechanisms may promote student involvement at the undergraduate level.

## **RECOMMENDATIONS**

Table 6-2 on page 86 summarizes key recommendations in each of the stakeholder areas described above as well as for undergraduate students interested in promoting student involvement. Policymakers in each of these organizational types are encouraged to adopt these policies to promote engagement of undergraduate engineering students, as this involvement has been shown to develop skills relevant to the practice of the engineering profession (see Chapters 4 & 5).

| Stakeholder Group                   | Recommendations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Undergraduate Students              | <ul style="list-style-type: none"> <li>• <b>Students participating in organizations relevant to national initiatives (student governments, honorary societies, etc.)</b> should seek out and participate in collaborative events such as conferences, workshops, and networking sessions on a regional or national level.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Universities                        | <ul style="list-style-type: none"> <li>• <b>Research faculty</b> should include undergraduate student engagement as a component of “broader impacts” requirements when applying for NSF funding.</li> <li>• <b>Faculty and staff</b> should provide mentorship and guidance for students organizing campus-based business plan competitions.</li> <li>• <b>University administrators</b> should support development of leadership programs of varying duration diffused across academic institutions (Dugan &amp; Komives, 2007).</li> <li>• <b>University administrators</b> should develop university governance systems administered or advised by students whenever possible; in cases when students cannot fulfill primary leadership roles, advisory bodies of current students should be formed.</li> <li>• <b>University administrators</b> should allocate endowment funding to student affairs, reducing the cost burden of annual student fees on undergraduates and their families.</li> </ul> |
| Government                          | <ul style="list-style-type: none"> <li>• <b>Governmental funding organizations outside of the National Science Foundation</b> should consider including broader impacts or similar criteria in their grant proposal requirements.</li> <li>• <b>Government agencies</b> should consider use of challenge platforms for the development of new ideas or initiatives.</li> <li>• <b>Presidential administrations</b> should develop higher education initiatives promoting student involvement on campus.</li> <li>• <b>Congress</b> should continue to legislate against issues of inequity on college campuses, promoting equal opportunities for all students in the United States.</li> </ul>                                                                                                                                                                                                                                                                                                            |
| Private and Nonprofit Organizations | <ul style="list-style-type: none"> <li>• <b>Intercollegiate organizations</b> should perform outreach to non-member universities in efforts to recruit new students and expand existing membership networks.</li> <li>• <b>Professional societies</b> should continue to facilitate nationwide or regional conferences and events for student members.</li> <li>• <b>For-profit and nonprofit organizations</b> should consider use of challenge platforms for the development of new ideas or initiatives and promote awareness of these challenges on college campuses.</li> <li>• <b>For-profit organizations</b> should sponsor initiatives such as university business plan competitions to promote innovation on American college campuses.</li> </ul>                                                                                                                                                                                                                                               |

**Table 6-2: Policy recommendations to promote undergraduate student involvement.**

# Chapter 7: The SUTD Approach

---

As has been examined in the preceding chapters, out-of-class experiences in engineering education such as participation in an engineering design project competition, involvement in a student chapter of a professional society or association, or undergraduate research experience has been shown to uniquely contribute to student skill development at the undergraduate level (Strauss & Terenzini, 2007). Given these observed benefits of co-curricular activities—as well as their importance to student culture—the MIT-SUTD Collaboration team determined that a cross-cultural student organization development program should be instituted at the new university to both aid in SUTD student development and help “transfuse” the culture of MIT to SUTD (Fisher, Bagiati, & Sarma, 2012). In this chapter, this program will be utilized as a methodological case study for student leadership development at technical universities; in the future, a modified version of this approach may be suitable for implementation at other technically focused institutes of higher education. This case serves as an application to employ the frameworks developed in the preceding chapters, and a thorough analysis of the outputs of this approach could be used to determine the validity of the proposed frameworks themselves.

## **MIT INTERNATIONAL SCIENCE AND TECHNOLOGY INITIATIVES**

### *History and Background*

Initiated in 1981 as a Japanese internship exchange program (Kurasawa & Nagatomi, 2007), the MIT International Science and Technology Initiatives (MISTI) is an undergraduate and graduate program at MIT designed to place students in internships and research placements abroad (MIT International Science and Technology Initiatives [MISTI], n.d. b). Organized into 17 specific “country programs,” MISTI staff serve to place MIT undergraduate and graduate students in “hands-on, tailored internships with leading companies, labs, schools, and NGOs abroad” (MISTI, n.d. a). To begin the MISTI process, students select a destination from MISTI’s list of country programs based on interest, language skills, and cultural background (MISTI, n.d. a). As of January 2012, current MISTI program countries include: Belgium, Brazil, Chile, China, France, Germany, India, Israel, Italy, Japan, Korea, Mexico, the Netherlands, Russia, Singapore, Spain, and Switzerland (MISTI, n.d. b). Through these programs, MISTI sends over 400 undergraduate and graduate students abroad annually, generally for the summer term from June to August (MISTI, n.d. a).

After selecting a country of interest, students apply to the relevant program office, committing to fulfill the program’s educational requirements—cultural coursework, pre-departure training coordinated by MISTI, and language proficiency, if required—before departure (MISTI, n.d. a). After acceptance, admitted students then work with a MISTI program

officer to secure an internship placement, utilizing MISTI's established relationships with employers abroad interested in hiring MIT interns (MISTI, n.d. a). After an internship placement is secured, MISTI program officers then aid students in logistical details for their international experience, including in securing visas, required immunizations, and other considerations (MISTI, n.d. a). For both graduate and undergraduate students, participation in MISTI internships is free of cost, and students receive both a stipend and a reimbursement for travel costs to and from the host country (MISTI, n.d. a).

Prior to fall 2011, MISTI did not offer a Singapore-specific country program; however, in previous years students had been placed in Singaporean internships through the efforts of the MIT-China program staff (Bagiati, Fisher, & Sarma, 2012). In preparation for the launch of a Singapore-specific country program, an MIT graduate student and staff member traveled to Singapore in the fall of 2011 to discuss possible collaboration activities and explore the feasibility of placing MIT students in internships in Singaporean technology, design, and entrepreneurial firms in the summer of 2012 (Bagiati et al., 2012).

### *The Singapore Leadership Initiative*

In fall 2011, the MIT-SUTD Collaboration team approached MISTI to collaborate in development of a new MISTI program, called the Singapore Leadership Initiative (SLI) (Fisher et al., 2012). This "Singapore summer exchange program was developed for MIT undergraduate and graduate students to travel to SUTD and assist the new cohort of students first-hand in creating co-curricular activities and initiatives" (Fisher et al., 2012, p. 3). Through this program, participating MIT students would spend eight or more weeks in Singapore during the summer of 2012, engaging in research, industry, or entrepreneurial internships during working hours and aiding the inaugural class of SUTD students in student organization development during the evenings (Bagiati et al., 2012). In this role, these MIT students would serve as a "surrogate older cohort" to the freshman SUTD students, acting as organizational mentors in lieu of SUTD upperclassmen absent from the campus in its first year of operation (Fisher et al., 2012).

In engineering education, internship programs are well understood to provide benefits to undergraduate engineering students, specifically in their ability to provide "a unique opportunity for students to learn about the roles and tasks of engineers" (Rompelman & de Vries, 2002, p. 2). Rompelman and de Vries (2002), characterize three distinct developmental aspects of engineering internship experiences at the undergraduate level, as follows:

1. Insight into the practices and procedures of the engineering profession.
2. Acquisition of cultural 'survival' skills (in the case of international internship experience).
3. Development of application techniques for technical knowledge and skills.

Additionally, upon graduation, participation in internship programs can help students ease the transition from the university setting to the working world, reducing the “traditional distinctions between academia and practical working life” (Valo, 2000, p. 151).

The choice of an international internship exchange as the vehicle for student leadership development at SUTD ensured that the participating MIT students would benefit from participation regardless of the outcomes of the cultural “transfusion” efforts, as the participating students would still gain expertise inherent to participation in undergraduate internships (Fisher et al., 2012). In addition, these participating students would also gain components of the “global competencies” developed through international experience at the undergraduate level (Lohmann, Rollins, Jr., & Hoey, 2006).

### *Inaugural MISTI-SLI Cohort*

During the 2011 fall semester, MISTI and MIT-SUTD Collaboration staff worked to recruit and interview applicants for the 2012 MISTI-SLI student cohort. The final 18 students sent to Singapore in the summer of 2012 represented six years of study at MIT—rising freshman to second-year graduate student—and a ten academic departments and programs across the Institute (Fisher et al., 2012). These students were selected based on their diversity of co-curricular and extracurricular interests so as to best represent the diversity of MIT student leadership (Bagiati et al., 2012); collectively, they represented involvement in MIT’s fraternities and sororities, public service organizations, varsity athletic teams, academic-interest societies, and art and music groups (Fisher et al., 2012).

## **MISTI-SLI PRE-DEPARTURE TRAINING**

Although all MISTI programs require some pre-departure training, MISTI-SLI’s pre-departure curriculum and educational requirements were designed to incorporate specific educational goals developed from Parkinson’s (2007) “best practices for engineering study abroad” and Komives and Wagner’s (2009) Social Change Model of student leadership development (Fisher et al., 2012). From Fisher, et al. (2012), the 2012 pre-departure training curriculum for the inaugural MISTI-SLI cohort consisted of 10 training modules (as indicated in Table 7-1 on page 90) as well as an academic course requirement on East Asia (language or culture).

| <b>Session</b>                                       | <b>Weeks Before Departure</b> | <b>Content Goals</b>                                                                                                                                                                                                                                                                                                           |
|------------------------------------------------------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Opening Welcome                                      | 18 weeks                      | <ul style="list-style-type: none"> <li>• Introduce students to key staff members and fellow participants in casual, celebratory environment</li> <li>• Provide background information on cross-cultural communication in China and Southeast Asia</li> </ul>                                                                   |
| Asia Travel Health Information                       | 16 weeks                      | <ul style="list-style-type: none"> <li>• Instruct students regarding health and safety issues inherent to travel in China and Southeast Asia</li> <li>• Answer student questions regarding vaccination procedures, travel advisories, and related issues</li> </ul>                                                            |
| Singapore's History                                  | 14 weeks                      | <ul style="list-style-type: none"> <li>• Provide background information regarding Singapore's history from the colonial period to present-day</li> </ul>                                                                                                                                                                       |
| Singapore's Culture                                  | 12 weeks                      | <ul style="list-style-type: none"> <li>• Introduce participants to Singapore's youth culture and best practices in interacting with Singaporean students</li> <li>• Provide MIT students with information regarding living in Singapore, particularly in regards to housing, transportation, and popular activities</li> </ul> |
| Introduction to the MIT-SUTD Collaboration           | 10 weeks                      | <ul style="list-style-type: none"> <li>• Provide students with background on the history of the MIT-SUTD Collaboration</li> <li>• Convey the importance of student life initiatives to the SUTD campus vision</li> </ul>                                                                                                       |
| SUTD Faculty Joint Reception                         | 10 weeks                      | <ul style="list-style-type: none"> <li>• Introduce students to visiting faculty from SUTD</li> <li>• Convey to SUTD faculty the importance of student life at MIT</li> </ul>                                                                                                                                                   |
| Leadership Session I: "The Leader as the Individual" | 9 weeks                       | <ul style="list-style-type: none"> <li>• Enable students to define and discuss their own personal leadership style and abilities</li> <li>• Facilitate student discussions of their roots and past influences to enable group bonding and discussion</li> </ul>                                                                |
| Leadership Session II: "Leading in a Team"           | 7 weeks                       | <ul style="list-style-type: none"> <li>• Provide a forum for students to work in teams to develop a long-term vision for SUTD student life</li> <li>• Enable students to develop team leadership strategies</li> </ul>                                                                                                         |
| Leadership Session III: "Leadership for Change"      | 5 weeks                       | <ul style="list-style-type: none"> <li>• Challenge students to examine their personal motivations for leadership</li> <li>• Provide a forum for students to discuss their own personal values and the values of MIT and SUTD as institutions</li> </ul>                                                                        |
| Initiation of MIT/SUTD Student Communication         | 2 weeks                       | <ul style="list-style-type: none"> <li>• Introduce MIT and SUTD student pairings before departure to begin relationship formation for cultural exchange</li> </ul>                                                                                                                                                             |

**Table 7-1: Overview of timing and content goals of MISTI-SLI pre-departure training sessions (Fisher et al., 2012).**

### *Preparation for Study Abroad: Parkinson's Best Practices*

Developed through an analysis of international programs in engineering at 24 American colleges and universities, Parkinson's best practices for engineering study abroad incorporate programmatic elements at all levels of university administration, from top-level leadership strategies to specific elements at the program level (Parkinson, 2007). In the realm of student pre-departure preparation, Parkinson identifies four key issue areas for incorporation into student training before leaving the United States, as follows (Parkinson, 2007):

1. Cultural issues: cultural diversity, ethnocentrism, cross-cultural communication, etc.
2. Country issues: regional history, economy, and politics.
3. Study abroad issues: finances, safety, and health.
4. Globalization issues: trade policy, outsourcing, law, and emerging technologies.

Each of these four issue areas were incorporated into the pre-departure training curriculum for the MISTI-SLI students to ensure that students were adequately prepared for their international experience in Singapore (Fisher et al., 2012). The structure by which these components were incorporated into the curriculum is illustrated in Figure 7-1 below.



**Figure 7-1: Pre-departure curriculum components designed in support of Parkinson's key issue areas for study abroad preparation (Parkinson, 2007).**

### *Leadership Training: The Social Change Model*

In addition to the required preparation for traditional study abroad experience, the MIT-SUTD Collaboration team sought to prepare the inaugural cohort of MISTI-SLI students with leadership training relevant to their mentorship roles in Singapore (Fisher et al., 2012). Komives and Wager's Social Change Model (SCM) for student leadership development (2009) was



selected as a framework for this training due to its focus on community and societal change; the students selected for the inaugural MISTI-SLI cohort were responsible for creation of a revolutionary student leadership model in the context of the Singaporean educational system, and a change-based approach was deemed most appropriate to prepare students for this task (Fisher et al., 2012). The two primary goals of the SCM of student leadership development are as follows:

1. To foster participant self-knowledge and leadership competence to enhance student learning and development and
2. “To facilitate positive social change at the institution or in the community.” (Komives & Wagner, 2009, p. xiii)

Within the SCM, these two goals are addressed in the context of three distinct dimensions: the individual, the group, and the society or community (Komives & Wagner, 2009). The three leadership sessions designed for the MISTI-SLI pre-departure curriculum—The Leader as the Individual, Leading in a Team, and Leadership for Change—were constructed with a focus on each of these dimensional areas, applying the broad goals of the SCM to these three distinct issue areas (Fisher et al., 2012).

## **THE SUTD-MIT 5<sup>TH</sup> ROW LEADERSHIP PROGRAMME**

The 2012 SUTD-MIT 5<sup>th</sup> Row Leadership Programme (5RLP) was designed as an initiative to develop co-curricular and extracurricular—known at SUTD as “5<sup>th</sup> Row”—activities at SUTD in its inaugural year. Through this program, MIT and SUTD students were brought together through a three-day orientation and weekly Monday evening “Leadership Sessions” to work together to develop personal and organizational leadership within the SUTD and MIT communities. At the conclusion of the program, Collaboration staff worked with current SUTD students to coordinate a “5<sup>th</sup> Row Activities Showcase” as a culminating event based on the curriculum and outcome goals of the 5RLP.

### *SUTD Participant Recruitment and Team Introductions*

After the initial cohort of SUTD freshmen began classes on May 6, 2012, the MIT-SUTD Collaboration staff began an advertising campaign to recruit participants for a joint summer program with the visiting MISTI-SLI students. After accepting and reviewing applications, 54 SUTD students were accepted to enroll in the inaugural “SUTD-MIT 5<sup>th</sup> Row Leadership Programme” (5RLP) at SUTD. Those accepted were then organized into groups of 3-4 students with similar co-curricular and extracurricular interests and assigned to a MISTI-SLI student mentor with relevant leadership experience. This “core” of 4-5 students was then paired with another core, to form a team of 6-8 SUTD and 2 MIT students. Before MIT students departed for Singapore, the Collaboration staff coordinated e-mail introductions between MIT and SUTD



students to connect 5RLP “cores” before the formal start of the program. Within these exchanges, MIT students were instructed to both facilitate introductions within their groups and use their SUTD counterparts resources in preparing for their time in Singapore, thereby gaining insight into both cultural and practical aspects of Singapore before their arrival.

### *Orientation*

Upon arrival in Singapore, the 18 members of the 2012 MISTI-SLI cohort were given several days to explore the city and adjust to life in Southeast Asia, beginning formal campus leadership activities during the three-day 5RLP orientation from June 15-17, 2012. The educational objectives for the 5RLP were to introduce SUTD and MIT students within their cores and teams and to lay the educational groundwork for the Monday evening Leadership Sessions. A full description of Orientation activities is in Table 7-2 below.

| <b>Date</b>       | <b>Activities</b>                                                                                                                                                                                                                                                                                |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Friday, June 15   | <ul style="list-style-type: none"> <li>• Guest speaker on personal and professional leadership skills</li> <li>• Staff introductions and overview of program expectations and guidelines</li> <li>• Large group icebreakers</li> </ul>                                                           |
| Saturday, June 16 | <ul style="list-style-type: none"> <li>• Team scavenger hunt across Singapore</li> <li>• Team challenge: communication and problem solving</li> <li>• Personal leadership style diagnostic and group discussion</li> <li>• Individual leadership reflection and team discussion</li> </ul>       |
| Sunday, June 17   | <ul style="list-style-type: none"> <li>• 5<sup>th</sup> Row organization development: mission and vision</li> <li>• Campus visioning: building the ideal university</li> <li>• Personal mission and vision brainstorm</li> <li>• Weekend synthesis activity: creating your “Facebook”</li> </ul> |

**Table 7-2: Overview of 2012 5<sup>th</sup> Row Leadership Programme Orientation, June 15-17.**

### *Leadership Sessions*

After the conclusion of the 5RLP orientation, the remaining program “Leadership Sessions” were held weekly on Monday nights from 7-9pm. During these sessions, MIT and SUTD students were brought together to participate in practical, applied activities designed to address the challenges inherent to forming a new student organization. Although the first 4 sessions were designed based on the student organization experience of the program facilitators, the July 23, July 30, and August 6 sessions were designed based on the needs and requests of the participating students (as identified in the Orientation and mid-summer evaluation results). A full curriculum overview of the summer Leadership Sessions is in Table 7-3 below.

| <b>Date</b> | <b>Session Topic(s)</b>                                          | <b>Activities</b>                                                                                                                                                                                                                                                                                                                        |
|-------------|------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| June 25     | Conflict Resolution, Documentation, and Pitching                 | <ul style="list-style-type: none"> <li>• Conflict brainstorming and discussion of group conflict resolution techniques</li> <li>• Breakout sessions to discuss creation of organizational documents: budgets, funding proposals, and practice pitching</li> </ul>                                                                        |
| July 2      | Recruiting and Building a Team                                   | <ul style="list-style-type: none"> <li>• Guest speaker and discussion on recruitment and building an organizational team</li> <li>• Discussion of recruitment and retention issues by student organization type (athletics, entrepreneurship, arts, etc.)</li> </ul>                                                                     |
| July 9      | The Power of Perception and Creative Advertising                 | <ul style="list-style-type: none"> <li>• Presentation of TED talk on the power of perception on consumer marketing</li> <li>• Group discussion on marketing and other video concepts</li> <li>• Challenge to create creative marketing for a campus activity</li> </ul>                                                                  |
| July 16     | Project Design and Management                                    | <ul style="list-style-type: none"> <li>• Guest speaker and discussion on project generation and creativity in design</li> <li>• Mini-workshop on project management methodologies</li> <li>• Discussion and work time divided by student organization type</li> </ul>                                                                    |
| July 23     | Management Techniques, Personal Well-Being, and Group Motivation | <ul style="list-style-type: none"> <li>• Exercise in priority mapping for organizational responsibilities</li> <li>• Personal stress management activity</li> <li>• Group discussion of motivation techniques divided by types (communicator, challenger, coordinator, contributor)</li> <li>• Individual and group work time</li> </ul> |
| July 30     | Transitions, Mentorship, and Communication                       | <ul style="list-style-type: none"> <li>• Guest speaker and discussion on mentorship and organizational leadership transitions</li> <li>• Leadership activities on team communication skills</li> <li>• Group discussion on communication challenges and applicability of activities</li> </ul>                                           |
| August 6    | Program Conclusion and Farewell Activity                         | <ul style="list-style-type: none"> <li>• Team/core goodbyes and yearbook signing</li> <li>• Group social</li> </ul>                                                                                                                                                                                                                      |

**Table 7-3: Overview of 2012 5<sup>th</sup> Row Leadership Programme Monday Leadership Sessions.**

### *SUTD 5<sup>th</sup> Row Activities Showcase*

In collaboration with the SUTD Pro-Tem Student Council, the 5RLP coordinating team sponsored and co-organized a “5<sup>th</sup> Row Activities Showcase” to serve as the culminating event for the summer 2012 5RLP. Held on July 25, 2012, this event featured student organization recruitment booths, artistic and musical performances, student-led workshops, and a “pitching” session for new groups to request funding from the Pro-Tem Student Council. Designed to model the annual MIT “Activities Midway” (MIT Association of Student Activities, n.d. b) and similar events at other American universities, this event provided a forum in which SUTD students could highlight their extracurricular and co-curricular accomplishments during the first academic term. 25 campus organizations registered for tables at this event, through which they recruited new members and showcased their activities during SUTD’s inaugural semester. In addition, six SUTD arts organizations—as well as a pair of visiting MIT students—presented musical and dance performances for the students, faculty, and staff in attendance.



**Figure 7-2: MIT and SUTD students watch performances at the Inaugural 5<sup>th</sup> Row Activities Showcase, July 25, 2012.**

### *Program Outcomes*

During both the pre-departure training sessions and the summer programming in Singapore, MIT and SUTD students (when applicable) were asked to complete written and online evaluations regarding program content and execution. Although these evaluations did include some variation at the level of evaluation of specific activities, reviews from students were generally positive overall, citing the programs as both enjoyable and worthwhile in terms of organizational leadership development. In addition, several 2012 MISTI-SLI participants have remained in communication and collaboration with their Singaporean counterparts, illustrating the strength of many of the student relationships developed throughout the course of the program.

SUTD and MIT student friendship and camaraderie was a primary learning objective of the summer 5RLP, and these enduring relationships illustrate achievement of this program goal.

The primary challenge to the success of the inaugural 5RLP was the attrition of SUTD student participants over the course of the eight-week program; as the academic pressures of the first undergraduate semester became more intense, fewer students attended Monday evening leadership sessions or participated in outside activities. For the 2013 iteration of the MISTI-SLI and 5RLP activities, Collaboration staff members are working to design a more formal incentive structure for student participation, thereby encouraging more prolonged and in-depth participation of SUTD students.

## **APPLICABILITY TO STUDENT SKILL DEVELOPMENT**

Given its position as a brand-new higher education institution, SUTD presents a unique opportunity to study the impact of co-curricular and extracurricular activities on undergraduate student development, specifically in science, technology, engineering, and mathematics fields. In future iterations of the MISTI-SLI and 5RLP programs, implementation of rigorous evaluation methodologies may aid in evaluation of program outcomes, providing valuable data on how student involvement and leadership programs affect undergraduates. Further discussion of additional student involvement research opportunities at SUTD can be found in Chapter 8.

## Chapter 8: Conclusions

---

In the previous chapters, a two-dimensional framework of student skill development through co-curricular involvement was developed and validated using two different validation methodologies; in addition, broad strategies to promote undergraduate student involvement were discussed, as well as specific programs implemented to promote student organization development at the new Singapore University of Technology and Design (SUTD). In this chapter, a final validated framework is presented in addition to a discussion of project limitations, applicability, and opportunities for future research.

### **FINAL 2D FRAMEWORK OF VALIDATED SKILLS**

After the validation criteria of Chapters 4 & 5 were imposed on the Chapter 3 framework, 19 of the 20 original skills relevant to the practice of the engineering profession remained as applicable skills developed through participation in co-curricular and extracurricular activities at the undergraduate level; “memory” was the only Chapter 3 skill not validated by either technique. These skills are illustrated in Table 8-1 on pages 98-99, and this final framework is recommended as a starting point for educational institutions when considering the impact of student involvement in the context of the education of undergraduate engineers. In this table, skills validated by both validation methodologies (both employer interviews and ABET requirements) are indicated in grey, with skills validated by only one methodology indicated in white. Because of broad beliefs in the importance of employer requirements and accreditation specifications to the outcomes of undergraduate engineering education, comparison to these validation data sets confirms the importance of the framework skills to the practice of the engineering profession.

While most key skills identified in Chapter 3 appeared in either the interview or ABET analyses, several skills identified in the validation data sets do not appear in the final framework on pages 98-99. These skills include—but are not limited to—flexibility, self-awareness, ability to give and accept criticism, tenacity, and lifelong thirst for knowledge. Despite the exclusion of these skills from the framework presented in this thesis, many of these skills are likely to be developed through campus involvement, and future research efforts (such as those described on pages 100-102) may seek to incorporate these skills into subsequent iterations of the 2D Framework.

|                             | Academic/Professional | Academic Competitions | Advocacy | Arts | Athletics | Campus Community | Culture | Department Groups | Energy & Environment | Games & Hobbies | Greek Life |
|-----------------------------|-----------------------|-----------------------|----------|------|-----------|------------------|---------|-------------------|----------------------|-----------------|------------|
| Civic Responsibility        |                       | ✓                     | ✓        |      |           | ✓                | ✓       |                   | ✓                    |                 |            |
| Creativity                  |                       |                       |          | ✓    |           |                  |         |                   |                      | ✓               |            |
| Critical Thinking           |                       | ✓                     | ✓        | ✓    |           | ✓                | ✓       |                   |                      | ✓               |            |
| Cross-Cultural Skills       |                       |                       | ✓        |      | ✓         | ✓                | ✓       |                   |                      |                 |            |
| Disciplinary Knowledge      | ✓                     | ✓                     | ✓        |      |           |                  |         | ✓                 | ✓                    |                 |            |
| Ethics                      |                       | ✓                     |          |      |           |                  |         | ✓                 |                      |                 |            |
| Global Awareness            |                       | ✓                     |          |      |           | ✓                | ✓       |                   | ✓                    |                 |            |
| Humanitarianism             |                       | ✓                     | ✓        |      |           | ✓                |         |                   |                      |                 |            |
| Interpersonal Communication | ✓                     | ✓                     | ✓        | ✓    | ✓         | ✓                | ✓       | ✓                 | ✓                    | ✓               | ✓          |
| Networking                  | ✓                     | ✓                     | ✓        |      |           | ✓                | ✓       | ✓                 |                      |                 |            |
| Organizational Management   | ✓                     | ✓                     | ✓        | ✓    |           | ✓                | ✓       | ✓                 | ✓                    | ✓               | ✓          |
| Problem Solving             |                       |                       |          | ✓    |           |                  | ✓       | ✓                 | ✓                    | ✓               |            |
| Public Speaking             | ✓                     | ✓                     | ✓        | ✓    |           | ✓                |         | ✓                 | ✓                    |                 |            |
| Self-Confidence             | ✓                     | ✓                     |          | ✓    | ✓         |                  |         | ✓                 |                      |                 | ✓          |
| Self-Direction              |                       | ✓                     |          | ✓    | ✓         |                  |         | ✓                 |                      |                 | ✓          |
| Strategy                    |                       | ✓                     | ✓        |      |           | ✓                |         |                   | ✓                    | ✓               |            |
| Teamwork                    | ✓                     | ✓                     | ✓        | ✓    | ✓         | ✓                | ✓       | ✓                 | ✓                    | ✓               | ✓          |
| Time Management             |                       | ✓                     |          |      |           |                  |         |                   |                      |                 |            |
| Written Communication       |                       |                       |          | ✓    |           |                  | ✓       |                   | ✓                    |                 |            |

**Table 4-1: Final 2D Framework of student skill development (Part 1 of 2).**

|                             | Honor Societies | Housing Communities | Innovation/Entrepreneurship | Martial Arts | Media | Professional Org. Chapters | Project Teams | Recreation | Religious Groups | Service Organizations | Student Governance |
|-----------------------------|-----------------|---------------------|-----------------------------|--------------|-------|----------------------------|---------------|------------|------------------|-----------------------|--------------------|
| Civic Responsibility        | ✓               | ✓                   |                             |              | ✓     |                            |               |            |                  | ✓                     | ✓                  |
| Creativity                  |                 |                     |                             |              | ✓     |                            | ✓             |            |                  |                       |                    |
| Critical Thinking           |                 | ✓                   |                             |              | ✓     |                            | ✓             |            |                  | ✓                     | ✓                  |
| Cross-Cultural Skills       |                 |                     |                             |              | ✓     |                            | ✓             |            |                  | ✓                     |                    |
| Disciplinary Knowledge      |                 |                     | ✓                           |              |       |                            | ✓             |            |                  | ✓                     |                    |
| Ethics                      |                 | ✓                   |                             |              | ✓     |                            | ✓             |            |                  | ✓                     | ✓                  |
| Global Awareness            |                 | ✓                   |                             |              |       |                            | ✓             |            |                  | ✓                     | ✓                  |
| Humanitarianism             |                 | ✓                   |                             |              | ✓     |                            | ✓             |            |                  | ✓                     |                    |
| Interpersonal Communication | ✓               | ✓                   |                             | ✓            | ✓     | ✓                          | ✓             | ✓          | ✓                | ✓                     | ✓                  |
| Networking                  | ✓               |                     | ✓                           |              |       | ✓                          | ✓             |            |                  |                       | ✓                  |
| Organizational Management   | ✓               |                     | ✓                           | ✓            | ✓     | ✓                          | ✓             | ✓          | ✓                | ✓                     | ✓                  |
| Problem Solving             |                 |                     |                             |              |       |                            | ✓             |            |                  | ✓                     | ✓                  |
| Public Speaking             |                 |                     | ✓                           | ✓            | ✓     | ✓                          | ✓             | ✓          |                  | ✓                     | ✓                  |
| Self-Confidence             |                 |                     | ✓                           | ✓            | ✓     | ✓                          | ✓             |            |                  | ✓                     |                    |
| Self-Direction              |                 |                     | ✓                           | ✓            | ✓     |                            | ✓             |            |                  | ✓                     | ✓                  |
| Strategy                    | ✓               |                     | ✓                           |              | ✓     |                            | ✓             |            |                  |                       | ✓                  |
| Teamwork                    | ✓               |                     | ✓                           |              | ✓     |                            | ✓             | ✓          | ✓                | ✓                     | ✓                  |
| Time Management             |                 |                     |                             |              |       |                            | ✓             |            |                  | ✓                     | ✓                  |
| Written Communication       | ✓               | ✓                   | ✓                           |              | ✓     |                            | ✓             |            |                  | ✓                     | ✓                  |

**Table 4-1: Final 2D Framework of student skill development (Part 2 of 2).**



## **PROJECT LIMITATIONS**

### *Limitations of Existing Student Involvement Research*

For many of the Organizational Categories reviewed in Chapter 3, a substantive body of literature relevant to student skill development could not be found, limiting the extent to which peer-reviewed research could be employed to acquire lists of student skills developed. In these cases, other documents—such as organizational websites or charters—were used in lieu of journal or conference publications. Although these publications did provide relevant information regarding the activities of students participating in particular categories of clubs or organizations, consistency in source material may have yielded a slightly different preliminary framework.

### *Variations in Cultural Context*

Although this framework was developed within the context of the Singapore University of Technology and Design, most relevant student affairs literature cited in Chapter 3 was written with an American perspective of higher education. Although papers from international publications were included in the analysis when available, the vast majority of relevant student affairs literature is published in the United States, limiting the scope of analysis for this project. This limited distribution of geographic contexts may or may not limit the applicability of this framework for engineering students worldwide, and international institutions should seek to interpret these framework findings within the cultural context of their student bodies.

## **OPPORTUNITIES FOR FUTURE RESEARCH**

### *Additional Validation Methodologies*

For the purposes of this thesis, two validation methodologies—employer interviews and comparison with ABET, Inc. criteria—were used to determine the relevance of the key skills identified in Chapter 3 to the practice and responsibilities of the engineering profession. In future research projects, these two validation methods could be supplemented by additional validation criteria; for example, the Industry Competency Models of the U.S. Department of Labor’s Competency Model Clearinghouse could be used to adjust the 2D Framework for applicability to specific engineering and technical disciplines (State of Minnesota, 2013). These discipline-specific frameworks could further inform policymakers within higher education institutions, strengthening the case for support of particular categories of student organizations given the academic profile of a particular institution.

### *Cross-Comparison of Validation Criteria*

Each set of potential framework validation criteria is related to the study and practice of engineering; however, each validation methodology views the realities of the engineering



profession through a particular lens. Future research in engineering education could include a qualitative cross-comparison of these validation criteria in an effort to answer research questions such as the applicability of ABET standards to the practical needs of employers. Should additional validation methodologies such as the Industry Competency Models also be used, additional research questions—such as the relevance of the Industry Competency models to employer needs or ABET-mandated education requirements—may also arise. Although not directly related to the 2D Framework developed in this thesis, these research questions are of interest within the broad scope of undergraduate engineering education.

### *Longitudinal Studies of Student Skill Development*

After completion of this framework, the next logical research step would be the development and execution of a longitudinal study of engineering undergraduates either at SUTD or another higher education institution. In this study, a control group of uninvolved students would be compared to an experimental group of students involved in each organization type indicated in Chapter 2 to determine if organizational involvement does result in the development of indicated skills. Given the nature of student development during college, this study would be longitudinal in nature, following students from their undergraduate matriculation to graduation and beyond.

The key challenge in executing this type of study—in addition to time and resource requirements—is the development of relevant indicators to measure student skill development. Given this project's scope, survey-based data collection would most likely be used, and in this format it is difficult to assess ambiguous concepts such as student leadership or self-direction. Although student self-reports are an option for data collection in this case, self-reports are often unreliable in the social science research context, and different indicator methodologies are thereby viewed as preferable to this method (Babbie, 2012).

### *Student Life and Online Education*

Given the rise of massive open online courses (MOOCs) and other Internet-based higher education trends, it is likely that over the next few decades greater and greater numbers of students worldwide will be educated in some capacity through online methods. In the case of these students, club and organization activities will be vitally important, as student involvement may be one of few methods online institutions can have to facilitate peer-to-peer in-person interaction. Future research may seek to examine how MOOC communities may foster collaboration and teamwork within their membership to promote skill development in the areas identified by this study. Although the future of the online higher education landscape remains unclear, early research in this area may identify methodologies to foster communities in Internet-based education.

### *Impacts of Different Policy Mechanisms*

In Chapter 6, a wide variety of university, governmental, and private mechanisms to promote undergraduate student involvement were presented and discussed. Although all of these methodologies are likely to impact student involvement in some way, rigorous research regarding the impacts of specific activities in this realm has yet to be performed. The impact of social media on student engagement outside of the classroom is of particular research interest given its timeliness in today's landscape of higher education; however, additional research questions regarding student affairs organization structures, the impacts of legislation and other governmental initiatives, and the relevance of challenges could also be of interest for further research in the student involvement field.

### **FRAMEWORK APPLICABILITY**

Numerous stakeholders can apply this framework in a variety of educational settings in institutional systems of higher education. These stakeholder groups may include students seeking support for independent projects, faculty seeking funding for broader impacts initiatives, or staff members organizing administrative support systems for student groups. Additionally, this research may be especially relevant given the rise of MOOCs and other online learning systems; as higher education becomes increasingly digital, clubs and other student organizations may become increasingly important in development of student "soft skills" at the undergraduate level.

# References

---

- ABET. (2011). History. *About ABET*. Retrieved from <http://www.abet.org/History/>
- ABET. (2012). *Criteria for Accrediting Engineering Programs*. Baltimore, MD: ABET.
- Amadei, B., Sandekian, R., & Thomas, E. (2009). A Model for Sustainable Humanitarian Engineering Projects. *Sustainability*, 1, 1087-1105.
- Aries, E., McCarthy, D., Salovey, P., & Banaji, M.R. (2004). A Comparison of Athletes and Non-Athletes at Highly Selective Colleges: Academic Performance and Personal Development. *Research in Higher Education*, 45(6), 577-602.
- Asel, A.M., Seifert, T.A., & Pascarella, E.T. (2009). The effects of fraternity/sorority membership on college experiences and outcomes: A portrait of complexity. *Oracle: The Research Journal of the Association of Fraternity/Sorority Advisors*, 4(2), 1-15.
- ASME. (2013). *Student Professional Development Conference (SPDC)*. Retrieved from <http://events.asme.org/SPDC/>
- Astin, A.W. (1984). Student Involvement: A Developmental Theory for Higher Education. *Journal of College Student Personnel*, 25(4), 297-308.
- Astin, A.W. & Sax, L.J. (1998). How Undergraduates Are Affected by Service Participation. *Journal of College Student Development*, 39(3), 251-263.
- Athreya, K.S., Rover, D., Walter, S., Mickelson, S.K., McGrath, G., Kalkhoff, M., Rasmussen, T., Starns, G., Wiley-Jones, R., Saunders, K., & Shelley, M. (2007). Work in Progress – Progression of an Engineering Leadership Program for the Future. 37<sup>th</sup> ASEE/IEEE Frontiers in Education Conference. Milwaukee, Wisconsin, USA.
- Babbie, E.R. (2012). *The Practice of Social Research* (13<sup>th</sup> ed.). Belmont, CA: Wadsworth.
- Bagiati, A., Fisher, D.R., & Sarma, S.E. (2012). Using student internship programs as a vehicle to international campus culture transfusion. *World Engineering Education Forum*. Buenos Aires, Argentina.
- Bambenek, J.J. & Sifton, S. (2003). Student Government Development and Use of Comprehensive University Planning Documents. *College Student Journal*, 37(1), 63-67.
- Barbe, D.F., Magids, S.A., & Thornton, K.S. (2003). Holistic approach for technology entrepreneurship education in engineering. 33<sup>rd</sup> ASEE/IEEE Frontiers in Education Conference. Boulder, Colorado, USA.
- Bartanen, K. (1995). Developing Student Voices in Academic Debate through a Feminist Perspective of Learning, Knowing, and Arguing. *Contemporary Argumentation and Debate*, 16, 1-13.
- Beck, J., Buckner, B., & Nikolova, O. (2007). Using Interdisciplinary Bioinformatics Undergraduate Research to Recruit and Retain Computer Science Students. *ACM SIGCSE Bulletin*, 39(1), 358-361. *Journal of Natural Resources & Life Sciences Education*, 36, 107-111.

- Becker, K. (2005). Cutting-edge research by undergraduates on a shoestring?. *Journal of Computing Sciences in Colleges*, 21(1), 160-168.
- Biondi, R.L., Vasconcellos, L., & Menezes-Filho, N. (2012). Evaluating the Impact of the Brazilian Public School Math Olympics on the Quality of Education. *Economia*, 12(2), 143-175.
- Blomstrom, S. & Tam, H. (2009). How and to what extent does a service-learning pedagogy enhance communication and collaborative skill learning among first-year students? *Proceedings of the ASEE Annual Conference and Exposition*. Austin, Texas, USA.
- Bonczek, J.L., Snyder, L.U., & Ellis, L.R. An Academic Club Service Learning Project as a Demonstration of Experiential Teaching Tools. *Journal of Professional Issues in Engineering Education and Practice*, 134, 178-185.
- Borg, J.P. & Zitomer, D.H. (2008). Dual-Team Model for International Service Learning in Engineering: Remote Solar Water Pumping in Guatemala.
- Broido, E.M. (2000). The Development of Social Justice Allies During College: A Phenomenological Investigation. *Journal of College Student Development*, 41(1), 3-18.
- Buchko, K.J. (2004). Religious Beliefs and Practices of College Women as Compared to College Men. *Journal of College Student Development*, 45(1), 89-98.
- Burt, B., Carpenter, D., Finelli, C., Harding, T., Sutkus, J., Holsapple, M., Bielby, R., & Ra, E. (2011). Outcomes of engaging engineering undergraduates in co-curricular experiences. *Proceedings of the ASEE Annual Conference and Exposition*, Vancouver, Canada.
- Case, K.A., Kanenberg, H., Erich, S., & Tittsworth, J. (2012). Transgender Inclusion in University Nondiscrimination Statements: Challenging Gender-Conforming Privilege through Student Activism. *Journal of Social Issues*, 68(1), 145-161.
- ChallengePost, Inc. (n.d.). *About Challenge.gov*. Retrieved from <http://challenge.gov/about>
- Change.org Inc. (2013). *Online petition tools*. Retrieved from <http://www.change.org/petition>
- Chavez, V. & Soep, E. (2005). Youth Radio and the Pedagogy of Collegiality. *Harvard Educational Review*, 75(4), 409-434.
- Clinton Global Initiative University. (n.d.). *About Us*. Retrieved from <http://www.cgiu.org/about/>
- Constantine, M.G., Miville, M.L., Warren, A.K., Gainor, K.A., & Lewis-Coles, M.E.L. (2006). Religion, Spirituality, and Career Development in African American College Students: A Qualitative Inquiry. *The Career Development Quarterly*, 54(3), 227-241.
- Cowen, L. (1960). Student Participation in Law School Administration. *Journal of Legal Education*, 13, 214-229.
- Coyle, E.J., Jamieson, L.H., & Oakes, W.C. (2005). EPICS: Engineering Projects in Community Service. *International Journal of Engineering Education*, 21(1), 139-150.
- Cummings, N. (1992). Self-Defense Training for College Women. *Journal of American College Health*, 40(4), 183-188.

- Davis, M.L. & Masten, S.J. (1996). Design competitions: does “multidisciplinary” contribute to the team building experience?. *Proceedings of the IEEE 26<sup>th</sup> Annual Frontiers in Education Conference*. Salt Lake City, Utah, USA.
- Duffy, J.J., Tsang, E., & Lord, S. (2000). Service-Learning in Engineering: What, Why, and How? *Proceedings of the ASEE Annual Conference and Exposition*. St. Louis, Missouri, USA.
- Dugan, J.P. (2008). Exploring relationships between fraternity and sorority membership and socially responsible leadership. *Oracle: The Research Journal of the Association of Fraternity Advisors*, 3(2).
- Dugan, J.P. & Komives, S.R. (2007). *Developing leadership capacity in college students: Findings from a national study*. A Report from the Multi-Institutional Study of Leadership. College Park, MD: National Clearinghouse for Leadership Programs.
- Dutson, A.J., Todd, R.H., Magleby, S.P., & Sorensen, C.D. (1997). A Review of Literature on Teaching Engineering Design Through Project-Oriented Capstone Courses. *Journal of Engineering Education*, 86, 17-28.
- Drwencke, J. (2012). *About the Conference*. Retrieved from <http://www.mblgtacc2013.org/about-the-conference>
- Edwards, L.-J. & Muir, E.J. (2005). Promoting entrepreneurship at the University of Glamorgan through formal and informal learning. *Journal of Small Business and Enterprise Development*, 12(4), 613-626.
- Extejt, M.M. & Smith, J.E. (2009). Leadership Development through Sports Team Participation. *Journal of Leadership Education*, 8(2), 224-237.
- Finelli, C.J., Holsapple, M.A., Ra, E., Bielby, R.M., Burt, B.A., Carpenter, D.D., Harding, T.S., & Sutkus, J.A. (2012). An Assessment of Engineering Students’ Curricular and Co-Curricular Experiences and Their Ethical Development. *Journal of Engineering Education*, 101(3), 469-494.
- Finkenberg, M.E. (1990). Effect of participation in taekwondo on college women’s self-concept. *Perceptual and Motor Skills*, 71, 891-894.
- Fisher, D.R., Bagiati, A., & Sarma, S.E. (2012). “Student Ambassadors”: Developing an Older Student Cohort. *European Society for Engineering Education 40<sup>th</sup> Annual Conference*. Thessaloniki, Greece.
- Fox, H. (2002, February 19). MIT Announces Tuition Hike, Required Student Activity Fee: New Fee to Support Activities Fund, Zesiger Athletics Center. *The Tech*, pp. 1, 22).
- Frankel, B.G. & Hewitt, W.E. (1994). Religion and Well-Being among Canadian University Students: The Role of Faith Groups on Campus. *Journal for the Scientific Study of Religion*, 33(1), 62-73.
- Freyss, S.F. (2006). Learning Political Engagement from the Experts: Advocacy Groups, Neighborhood Councils, and Constituency Service. *Political Science and Politics*, 39(1), 137-145.

- Gayles, J.G. & Hu, S. (2009). The Influence of Student Engagement and Sport Participation on College Outcomes among Division I Student Athletes. *The Journal of Higher Education*, 80(3), 315-333.
- Georgia Institute of Technology. (2012). *2012-2013 Tuition and Fee Rates Per Semester*. Retrieved from [http://www.bursar.gatech.edu/student/tuition/Fall\\_2012/Fall12-all\\_fees.pdf](http://www.bursar.gatech.edu/student/tuition/Fall_2012/Fall12-all_fees.pdf)
- Gibson, M.A., Bejinez, L.F., Hidalgo, N., & Rolon, C. (2004). Belonging and School Participation: Lessons From a Migrant Student Club. *School Connections: US Mexican Youth, Peers, and School Achievement*, 129-149.
- Gonzales, R.G. (2008). Left Out But Not Shut Down: Political Activism and the Undocumented Student Movement. *Northwestern Journal of Law & Social Policy*, 3(2), Article 4.
- Goodhart, F.W., Hsu, J., Baek, J.H., Coleman, A.L., Maresca, F.M., & Miller, M.B. (2006). A View Through a Different Lens: Photovoice as a Tool for Student Advocacy. *Journal of American College Health*, 55(1), 53-56.
- Gould, D. & Carson, S. (2008). Life skills development through sport: current status and future directions. *International Review of Sport and Exercise Psychology*, 1(1), 58-78.
- Grier-Reed, T.L., Madyun, N.H., & Buckley, C.G. (2008). Low Black Student Retention on a Predominantly White Campus: Two Faculty Respond with the African American Student Network. *Journal of College Student Development*, 49(5), 476-485.
- Guiffrida, D.A. (2003). African American Student Organizations As Agents of Social Integration. *Journal of College Student Development*, 44(3), 304-319.
- Hansen, E.W. (2006). Technological Expertise with Liberal Education: The Dartmouth College A.B. in Engineering Sciences. *36<sup>th</sup> ASEE/IEEE Frontiers in Education Conference*. San Diego, California, USA.
- Harms, P.D., Woods, D., Roberts, B., Bureau, D., & Green, A.M. (2006). Perceptions of Leadership in Undergraduate Fraternal Organizations. *Leadership Institute Faculty Publications*, Paper 3.
- Healea, C.D. (2005). Character education with resident assistants: A model for developing character on college campuses. *The Journal of Education*, 186(1), 65-77.
- Heiberger, G. & Harper, R. (2008). Have You Facebooked Astin Lately? Using Technology to Increase Student Involvement. *New Directions for Student Services*, 124(2), 19-35.
- Hetland, L. & Winner, E. (2004). Cognitive transfer from arts education to non-arts outcomes: Research evidence and policy implications. *Handbook of Research and Policy in Art Education*, 135-162.
- Hills, G.E. (1988). Variations in university entrepreneurship education: An empirical study of an evolving field. *Journal of Business Venturing*, 3, 109-122.
- Holzweiss, P., Rahn, R., & Wickline, J. (2007). Are All Student Organizations Created Equal? The Differences and Implications of Student Participation in Academic versus Non-Academic Organizations. *College Student Affairs Journal*, 27(1), 136-150.

- Hurtado, S. & Carter, D.F. (1997). Effects of College Transition and Perceptions of the Campus Racial Climate on Latino College Students' Sense of Belonging. *Sociology of Education*, 70(4), 324-345.
- Huryn, J.S. (1986). Debating as a Teaching Technique. *Teaching Sociology*, 14(4), 266-269.
- IEEE-HKN. (2011). *About HKN and IEEE-HKN*. Retrieved from <http://www.hkn.org/about/index.asp>
- IHTFP Hack Gallery. (2011). Welcome to the IHTFP Gallery!. *Interesting Hacks to Fascinate People: The MIT Gallery of Hacks*. Retrieved from <http://hacks.mit.edu>.
- Inkelas, K.K. (2004). Does Participation in Ethnic Cocurricular Activities Facilitate a Sense of Ethnic Awareness and Understanding? A Study of Asian Pacific American Undergraduates. *Journal of College Student Development*, 45(3), 285-302.
- Inkelas, K.K., Soldner, M., Longerbeam, S.D., & Leonard, J.B. (2008). Differences in Student Outcomes by Types of Living-Learning Programs: The Development of an Empirical Typology. *Research in Higher Education*, 49(6), 495-512.
- InnoCentive, Inc. (2013). *What We Do*. Retrieved from <https://www.innocentive.com/about-innocentive>
- Institutional Research, Office of the Provost. (n.d.). *Students*. Retrieved from <http://web.mit.edu/ir/pop/students/index.html>
- Jonides, J. (2008). Musical skills and cognition. *Learning, Arts, and the Brain: The Dana Consortium Report on Arts and Cognition*, 11-16.
- Kaufman, J. & Gabler, J. (2004). Cultural capital and the extracurricular activities of girls and boys in the college attainment process. *Poetics*, 32(2), 145-168.
- Kelley, D.R. (2008). Leadership development through the fraternity experience and the relationship to career success after graduation. *Oracle: The Research Journal of the Association of Fraternity Advisors*, 3(1).
- Kelly, B.B. (2005). Basic Training: An Assertion of Principles for Coaching Oral Interpretation for Intercollegiate Forensics Competition. *National Forensic Journal*, 23(1), 25-31.
- Kennedy, R. (2007). In-Class Debates: Fertile Ground for Active Learning and the Cultivation of Critical Thinking and Oral Communication Skills. *International Journal of Teaching and Learning in Higher Education*, 19(2), 183-190.
- Kerpelman, L.C. (1969). Student Political Activism and Ideology: Comparative Characteristics of Activists and Nonactivists. *Journal of Counseling Psychology*, 16(1), 8.
- Khorbotly, S. & Al-Olimat, K. (2010). Engineering Student-Design Competition Teams: Capstone or Extracurricular? *Proceedings of the 40<sup>th</sup> ASEE/IEEE Frontiers in Education Conference*. Washington, DC, USA.
- Kimbrough, W.M. & Hutcheson, P.A. (1998). The Impact of Membership in Black Greek-Letter Organizations on Black Students' Involvement in Collegiate Activities and Their Development of Leadership Skills. *The Journal of Negro Education*, 67(2), 96-105.
- Kokotsaki, D. & Hallam, S. (2007). Higher education music students' perceptions of the benefits of participative music making. *Music Education Research*, 9(1), 93-109.

- Komives, S.R. & Wagner, W. (2009). *Leadership for a Better World: Understanding the Social Change Model of Leadership Development*. San Francisco, CA: John Wiley & Sons, Inc.
- Kuh, G.D. (1995). The Other Curriculum: Out-of-Class Experiences Associated with Student Learning and Personal Development. *The Journal of Higher Education*, 66(2), 123-155.
- Kuh, G.D., Cruce, T.M., Shoup, R., Kinzie, J., & Gonyea, R.M. (2008). Unmasking the Effects of Student Engagement on First-Year College Grades and Persistence. *The Journal of Higher Education*, 79(5), 540-563.
- Kurasawa, I. & Nagatomi, A. (2007). Study-Abroad and Internship Programs: Reflection and Articulation for Lifelong Learning. *Global Business Languages*, 11, Article 4.
- Lakes, K.D. & Hoyt, W.T. (2004). Promoting self-regulation through school-based martial arts training. *Applied Developmental Psychology*, 25, 283-302.
- Lattuca, L.R., Terenzini, P.T., & Volkwein, J.F. (2006). *Engineering Change: A Study of the Impact of EC2000*. Baltimore, MD: ABET, Inc.
- Lewis, K.M. & Rice, T.W. (2005). Voter Turnout in Undergraduate Student Government Elections. *Political Science & Politics*, 38(4), 723-729.
- Lin, C. (2006). Culture Shock and Social Support: An Investigation of a Chinese Student Organization on a US Campus. *Journal of Intercultural Communication Research*, 35(2), 117-137.
- Lohmann, J.R., Rollins, Jr., H.A., & Hoey, J.J. (2006). Defining, developing and assessing global competence in engineers. *European Journal of Engineering Education*, 31(1), 119-131.
- Mabrouk, P.A. & Peters, K. (2000). Student perspectives on undergraduate research experiences in chemistry and biology. *Council on Undergraduate Research Quarterly*, 21(1), 25-33.
- Markus, G.B., Howard, J.P.F., & King, D.C. (1993). Integrating Community Service and Classroom Instruction Enhances Learning: Results From an Experiment. *Educational Evaluation and Policy Analysis*, 15(4), 410-419.
- May, W.P. (2010). The History of Student Governance in Higher Education. *College Student Affairs Journal*, 28(2), 207-220.
- McFarland, D.A. & Thomas, R.J. (2006). Bowling Young: How Youth Voluntary Associations Influence Adult Political Participation. *American Sociological Review*, 71(3), 401-425.
- McIntosh, D. (2001). The Uses and Limits of the Model United Nations in an International Relations Classroom. *International Studies Perspectives*, 2, 269-280.
- McNeeley, M.E. (2007). Title IX and Equal Educational Access for Pregnant and Parenting Girls. *Wisconsin Women's Law Journal*, 22, 267-288.
- Melendez, M.C. (2007). The influence of athletic participation on the college adjustment of freshmen and sophomore student athletes. *College Student Retention*, 8(1), 39-55.
- Mero, T. (2011). How Students Are Influencing The Sustainability Curriculum. *Sustainability: The Journal of Record*, 4(6), 277-283.
- Meyer, N.J. (1989). Assuring Freedom for the College Student Press After Hazelwood. *Valparaiso University Law Review*, 24(1), 53-76.



- MIT \$100K. (2013). *About the MIT \$100K Entrepreneurship Competition*. Retrieved from <http://www.mit100k.org/general/>
- MIT Alumni Association. (2013). *Infinite Connection Alumni Directory* [Database]. Retrieved from <https://alum.mit.edu/>
- MIT Association of Student Activities. (2013). *MIT Student Groups* [Database]. Retrieved from <https://asa.mit.edu/groups/>
- MIT Association of Student Activities. (n.d. a). *About ASA*. Retrieved from <http://web.mit.edu/asa/about/index.html>
- MIT Association of Student Activities. (n.d. b). *Advertising/Publicity*. Retrieved from <http://web.mit.edu/asa/publicity/midway.html>
- MIT Association of Student Activities. (n.d. c). *ASA Recognition Procedures*. Retrieved from <http://web.mit.edu/asa/start/pdf/recognition-procedures.pdf>
- MIT Association of Student Activities. (n.d. d). *Group Resources*. Retrieved from <http://web.mit.edu/asa/resources/group-funding.html>
- MIT Clean Energy Prize. (2013). *Prize Structure*. Retrieved from <http://cep.mit.edu/competition/structure/>
- MIT Division of Student Life. (n.d.). *About DSL*. Retrieved from <http://studentlife.mit.edu/about>
- MIT Eta Kappa Nu. (2012). *About Eta Kappa Nu*. Retrieved from <http://hkn.mit.edu/about.php>
- MIT Gordon Engineering Leadership Program. (2011). *Capabilities of Effective Engineering Leaders*. Cambridge, MA: Bernard M. Gordon-MIT Engineering Leadership Program.
- MIT Graduate Student Council. (n.d.). *MIT Graduate Student Council (GSC) Overview*. Retrieved from <http://gsc.mit.edu/about-gsc/overview/>
- MIT International Science and Technology Initiatives. (n.d. a). *Frequently Asked Questions*. Retrieved from <http://web.mit.edu/misti/students/faqs.html>
- MIT International Science and Technology Initiatives. (n.d. b). *What is MISTI?* Retrieved from <http://web.mit.edu/misti/what.html>
- MIT Mass Beta. (2012). *MIT Tau Beta Pi*. Retrieved from <http://web.mit.edu/tbp/www/information.shtml>
- MIT Student Financial Services. (n.d.) *Undergraduate Expenses*. Retrieved from [http://web.mit.edu/sfs/afford/undergraduate\\_expenses.html](http://web.mit.edu/sfs/afford/undergraduate_expenses.html)
- Montelongo, R. (2002). Student Participation in College Student Organizations: A Review of Literature. *Journal of the Indiana University Student Personnel Association*, 2, 50-63.
- Moore, J., Lovell, C.D., McGann, T., & Wyrick, J. (1998). Why Involvement Matters: A Review of Research on Student Involvement in the Collegiate Setting. *College Student Affairs Journal*, 17(2), 4-17.
- Muldoon, Jr., J.P. (1995). The Model United Nations Revisited. *Simulation & Gaming*, 26, 27-35.

- Museus, S.D. (2008). The Role of Ethnic Student Organizations in Fostering African American and Asian American Students' Cultural Adjustment and Membership at Predominantly White Institutions. *Journal of College Student Development*, 49(6), 568-586.
- NASPA. (2012). *What is Student Affairs?*. Retrieved from <http://www.naspa.org/career/whatis/default.cfm>
- National Academy of Sciences. (2004). *The Engineer of 2020: Visions of Engineering in the New Century*. Washington, DC: National Academies Press.
- National Academy of Sciences. (2005). *Educating the Engineer of 2020: Adapting Engineering Education to the New Century*. Washington, DC: National Academies Press.
- National Association of Engineering Student Councils. (2011). *About Us*. Retrieved from <http://naesc.org/about/>
- National Collegiate Athletic Association. (2013). *About the NCAA*. Retrieved from <http://www.ncaa.org/wps/wcm/connect/public/ncaa/about+the+ncaa/membership+new>
- National Science Foundation. (2013). Chapter II – Proposal Preparation Instructions. *Grant Proposal Guide*. Retrieved from [http://www.nsf.gov/pubs/policydocs/pappguide/nsf13001/gpg\\_2.jsp#IIC2d](http://www.nsf.gov/pubs/policydocs/pappguide/nsf13001/gpg_2.jsp#IIC2d)
- National Society of Black Engineers. (2013). *About NSBE*. Retrieved from <http://www.nsbe.org/Aboutus.aspx>
- National Women's Law Center. (2012). *The Battle for Gender Equity in Athletics in Colleges and Universities*. Retrieved from [http://69.36.173.42/sites/default/files/pdfs/battle\\_for\\_gender\\_equity\\_in\\_college\\_athletics.pdf](http://69.36.173.42/sites/default/files/pdfs/battle_for_gender_equity_in_college_athletics.pdf)
- New America Foundation. (2012). Federal Higher Education Programs – Overview. *Federal Education Budget Project*. Retrieved from <http://febp.newamerica.net/background-analysis/federal-higher-education-programs-overview>
- Nor, N.M., Rajab, N., & Ismail, K.M. (2008). Educating the Engineer of 2020: Malaysian Scenario. *International Conference on Engineering Education 2008*. Budapest, Hungary.
- O'Keefe, S. & Sarma, S.E. (2011). A Proposal for the Governance and Extra-curricular Structure of the Singapore University of Technology and Design.
- Oliver, W. & Hearn, C.P. (2008). Dance Is for All Ages. *Journal of Physical Education, Recreation & Dance*, 79(4), 6-8.
- ONE. (2012). *About ONE Campus*. Retrieved from <http://campus.one.org/about>
- Parkinson, A. (2007). Engineering Study Abroad Programs: Formats, Challenges, Best Practices. *Online Journal for Global Engineering Education*, 2(2), Article 2.
- Pike, G.R. (2000). The Influence of Fraternity or Sorority Membership on Students' College Experiences and Cognitive Development. *Research in Higher Education*, 41(1), 117-139.
- Prados, J.W., Peterson, G.D., & Lattuca, L.R. (2005). Quality Assurance of Engineering Education through Accreditation: The Impact of Engineering Criteria 2000 and Its Global Influence. *Journal of Engineering Education*, 94(1), 165-184.

- Purdie, II, J.R. & Rosser, V.J. (2011). Examining the academic performance and retention of first-year students in living-learning communities and first-year experience courses. *College Student Affairs Journal*, 29(2), 95-112.
- Regents of the University of Michigan. (2013). *Tuition and Registration Fees*. Retrieved from <http://www.ro.umich.edu/tuition/tuition-fees.php#otherfees>
- Reyhner, J. & Dodd, J. (1995). Factors Affecting the Retention of American Indian and Alaska Native Students in Higher Education. *Expanding Minority Opportunities: First Annual National Conference*. Tempe, Arizona, USA.
- Riley, D.M. (2012). Aiding and ABETing: The Bankruptcy of Outcomes-Based Education as a Change Strategy. *Proceedings of the ASEE Annual Conference and Exposition*. San Antonio, Texas, USA.
- Roddam, H., McCandless, P., Thewlis, D., & McDonald, K. (2009). Judging the evidence with confidence: the student experience of an undergraduate journal club. *The UCLAN Journal of Pedagogic Research*, 1, 29-33.
- Rompelman, O. & de Vries, J. (2002). Practical training and internships in engineering education: educational goals and assessment. *European Journal of Engineering Education*, 27(2), 173-180.
- Rowold, J. (2006). Transformational and Transactional Leadership in Martial Arts. *Journal of Applied Sport Psychology*, 18(4), 312-325.
- Sakhrani, V., Bagiati, A., Sarma, S., & de Neufville, R. (2012). Institutional Transplantation in Education – Cultural Transfusion to a New Institution. *World Engineering Education Forum*. Buenos Aires, Argentina.
- Sarin, S. (2000). Quality Assurance in Engineering Education: A Comparison of EC-2000 and ISO-9000. *Journal of Engineering Education*, 89(4), 495-501.
- Sauls, S.J. (1998). The Role of Alternative Programming in College Radio. *Studies in Popular Culture*, 20(1).
- Savage, R.N., Chen, K.C., & Vanasupa, L. (2007). Integrating project-based learning throughout the undergraduate engineering curriculum. *Materials Engineering*, 1.
- Schafer, A.I. & Richards, B.S. (2007). From Concept to Commercialization: Student Learning in a Sustainable Engineering Innovation Project. *European Journal of Engineering Education*, 32(2), 143-165.
- Schmalzbauer, J. (2007). Campus Ministry: A Statistical Portrait. *SSRC Web Forum*.
- Schwartz, M.K., Axtman, K.M., & Freeman, F.H. (Eds.). (1998). *Leadership education: A sourcebook of courses and programs* (7<sup>th</sup> ed.). Greensboro, NC: The Center for Creative Leadership.
- Schweitzer, T.A. (2000). “A” Students Go To Court: Is Membership in the National Honor Society a Cognizable Legal Right?. *Syracuse Law Review*, 50, 63-107.
- Scott, D. (2004). Are campus leadership programs developing the leaders society needs? *Netresults*.

- Serow, R.C. (1991). Students and Voluntarism: Looking into the Motives of Community Service Participants. *American Educational Research Journal*, 28(3), 543-556.
- Sharp, L. (2002). Green campuses: the road from little victories to systemic transformation. *International Journal of Sustainability in Higher Education*, 3(2), 128-145.
- Shepelak, N.J. (1996). Employing a Mock Trial in a Criminology Course: An Applied Learning Experience. *Teaching Sociology*, 24(4), 395-400.
- Shuman, L.J., Besterfield-Sacre, M., & McGourty, J. (2005). The ABET “Professional Skills” – Can They Be Taught? Can They Be Assessed?. *Journal of Engineering Education*, 94(1), 41-55.
- Stanford University. (2013). *Tuition, Fees, and Housing*. Retrieved from <http://exploreddegrees.stanford.edu/tuitionfeesandhousing/#feestext>
- State of Minnesota. (2013). *CareerOneStop: Competency Model*. Retrieved from <http://www.careeronestop.org/competencymodel/>
- Strauss, L.C. & Terenzini, P.T. (2007). The Effects of Students’ In- and Out-of-Class Experiences on Their Analytical and Group Skills: A Study of Engineering Education. *Research in Higher Education*, 48(8), 967-992.
- SUTD Student Government. (2013). *Student Initiatives at SUTD*. Retrieved from <http://council.sutd.edu.sg/si/>
- Tau Beta Pi. (2012). *2012-2013 Information Book*. Knoxville, TN: Tau Beta Pi Association, Incorporated.
- Texas State University. (n.d.) *Ideas for NSF Broader Impacts Statement*. Retrieved from <http://www.txstate.edu/research/Resources/develop-proposal/nsf.html>
- The White House. (n.d.). *About Vice President’s Biden Efforts to End Violence Against Women*. Retrieved from <http://www.whitehouse.gov/1is2many/about>
- TopCoder, Inc. (2012). *Enterprise Open Innovation*. Retrieved from <http://www.topcoder.com/whatiseoi/>
- Tremblay, R.W. (2003). A Delphi Study on the Future of College Radio. *Journal of Radio Studies*, 10(2), 170-185.
- UC Berkeley Office of the Registrar. (2012). *2012-2013 Registration Fees*. Retrieved from <http://registrar.berkeley.edu/Registration/feesched.html#campus>
- United Nations Educational, Scientific and Cultural Organization (UNESCO). (2005). *Educating for Creativity: Bringing the Arts and Culture into Asian Education*. Bangkok, Thailand: UNESCO.
- University of Illinois Board of Trustees. (2008a). *Fall 2013/Spring 2014 Undergrad Campus Fees*. Retrieved from [http://registrar.illinois.edu/financial/tuition\\_1314/Fall/ugrad\\_fees.html](http://registrar.illinois.edu/financial/tuition_1314/Fall/ugrad_fees.html)
- University of Illinois Board of Trustees. (2008b). *Tuition & Fee Details*. Retrieved from [http://registrar.illinois.edu/financial/tuition\\_details.html](http://registrar.illinois.edu/financial/tuition_details.html)

- University of Michigan College of Engineering. (2013). *Projects*. Retrieved from <http://www.engin.umich.edu/minors/multidisciplinarydesign/projects>
- U.S. Department of Education. (2013). *President's Interfaith and Community Service Campus Challenge*. Retrieved from <http://www2.ed.gov/about/inits/list/fbci/campus-challenge.html>
- Valo, M. (2000). Experiencing work as a communications professional: Students' reflections on their off-campus work practice. *Higher Education*, 39, 151-179.
- Vile, J.R. & Van Dervort, T.R. (1994). Revitalizing Undergraduate Programs through Intercollegiate Mock Trial Competition. *Political Science and Politics*, 27(4), 712-715.
- Volkwein, J.F., Lattuca, L.R., Terenzini, P.T., Strauss, L.C., & Sukhbaatar, J. (2004). Engineering Change: A Study of the Impact of EC2000. *International Journal of Engineering Education*, 20(3), 318-328.
- Ward, S.H. & Rude, B.J. (2010). Animal and Dairy Sciences Student Competitions. *Animal and Dairy Sciences*.
- Wilson, H.W. (1955). Student Incentive and the Freshman Writing Magazine. *College Composition and Communication*, 6(2), 96-99.
- Winship, L. (1950). Drama and Speech: For Friendly Separation. *Educational Theatre Journal*, 2(2), 134-138.
- Woodward, T.W. (2009). A Review of the Effects of Martial Arts Practice on Health. *Wisconsin Medical Journal*, 108(1), 40-43.
- Zagal, J.P., Rick, J., & Hsi, I. (2006). Collaborative games: Lessons learned from board games. *Simulation & Gaming*, 37(1), 24-40.
- Zhao, C.-M. & Kuh, G.D. (2004). Adding Value: Learning Communities and Student Engagement. *Research in Higher Education*, 45(2), 115-138.
- Zimmerman, K.S. & Halfacre-Hitchcock, A. (2006). Barriers to student mobilization and service at institutions of higher education: A greenbuilding initiative case study on a historic, urban campus in Charleston, South Carolina, USA. *International Journal of Sustainability in Higher Education*, 7(1), 6-15.
- Zuniga, X., Williams, E.A., & Berger, J.B. (2005). Action-Oriented Democratic Outcomes: The Impact of Student Involvement with Campus Diversity. *Journal of College Student Development*, 46(6), 660-678.
- Zydney, A.L., Bennett, J.S., Shahid, A., & Bauer, K.W. (2002). Impact of Undergraduate Research Experience in Engineering. *Journal of Engineering Education*, 91(2), 151-157.



# Appendix A: Coding Scheme for ASA-Registered Groups

---

The following coding scheme was used to classify student group entries in the January 2013 MIT Association of Student Activities (ASA) Database, available for public use at <https://asa.mit.edu/groups/>. If available, student group description information was used as the text to classify groups; when a description was not provided for a specific group, the informational page of the group's website was used as an alternate classification mechanism. In cases for which neither a description nor a group website were provided, groups were discarded as "Unclassifiable." When either more than one key term or no key terms were present in a group's description, classification was determined based on the researcher's best judgment. For a full analysis of the results of this classification, please refer to Chapter 2: Creating a Framework for Student Involvement.

| KEY TERM <sup>7</sup> | GROUP CLASSIFICATION    |
|-----------------------|-------------------------|
| "Academic"            | Academic & Professional |
| "A Capella"           | Arts                    |
| "Access"              | Advocacy                |
| "Activism"            | Advocacy                |
| "Advocacy"            | Advocacy                |
| "Allocate"            | Student Governance      |
| "Art" or <Art>        | Arts                    |
| "Awareness"           | Advocacy                |
| "Build"               | Project Team            |
| "Campus"              | Campus Community        |
| "Career"              | Academic & Professional |
| "Choral"              | Arts                    |
| "Comedy"              | Arts                    |

---

<sup>7</sup> Note that those terms denoted by carrots are categories rather than specific keywords used in coding. For example, <Art> denotes any type of generally accepted art form, including dance, drawing, painting, etc.

|                              |                             |
|------------------------------|-----------------------------|
| “Communicate”                | Advocacy                    |
| “Community”                  | Community Issues            |
| “Community Service”          | Service                     |
| “Council”                    | Student Governance          |
| <Cultural Identity>          | Cultural                    |
| “Dance”                      | Arts                        |
| “Development” (Global)       | Service                     |
| “Discussion”                 | Campus Community            |
| “Education”                  | Service                     |
| “Energy”                     | Energy & Environment        |
| “Engineering” and “Team”     | Project Team                |
| “Ensemble”                   | Arts                        |
| “Entrepreneurship”           | Innovation/Entrepreneurship |
| “Environment”                | Energy & Environment        |
| “Film”                       | Arts                        |
| <Food Type>                  | Games & Hobbies             |
| “Fraternity”                 | Greek Life                  |
| <Game>                       | Games & Hobbies             |
| <Gender>                     | Advocacy                    |
| <Geographic/Cultural Region> | Cultural                    |
| “Govern”                     | Student Governance          |
| <Health>                     | Service                     |
| <Hobby>                      | Games & Hobbies             |
| “Honor”                      | Honorary                    |
| “Identity”                   | Advocacy                    |
| “Improv”                     | Arts                        |
| “Innovation”                 | Innovation/Entrepreneurship |
| “Intellectual”               | Academic & Professional     |



|                                               |                                   |
|-----------------------------------------------|-----------------------------------|
| “Investing”                                   | Academic & Professional           |
| “Issue”                                       | Advocacy                          |
| “Journal”                                     | Media                             |
| “Magazine”                                    | Media                             |
| “Media”                                       | Media                             |
| “Meditation”                                  | Recreation                        |
| “Mentor”                                      | Service                           |
| <MIT Class Year>                              | Student Governance                |
| <MIT Department>                              | Departmental Group                |
| <MIT Housing Community>                       | Housing Community                 |
| “Movie”                                       | Media                             |
| “Music”                                       | Arts                              |
| <Musical Instrument>                          | Arts                              |
| <National/International Service Organization> | Service                           |
| <National Professional Organization>          | Professional Organization Chapter |
| “Newspaper”                                   | Media                             |
| <Physical Activity (Non-Olympic)>             | Recreation                        |
| “Non-Profit”                                  | Service                           |
| <Non-Technical Competition>                   | Academic Competitions             |
| <Olympic Sport>                               | Athletics                         |
| <Outdoor Activity>                            | Recreation                        |
| “Outreach”                                    | Advocacy                          |
| <Political Party>                             | Advocacy                          |
| “Politics”                                    | Advocacy                          |
| <Professional Field>                          | Academic & Professional           |
| “Radio”                                       | Media                             |
| <Religious Classification>                    | Religious                         |
| “Represent”                                   | Student Governance                |

|                         |                             |
|-------------------------|-----------------------------|
| “Research”              | Academic & Professional     |
| “Scholar”               | Honorary                    |
| “Service”               | Service                     |
| “Sing”                  | Arts                        |
| “Sorority”              | Greek Life                  |
| “Startup”               | Innovation/Entrepreneurship |
| “Sustainability”        | Energy & Environment        |
| “Teaching”              | Service                     |
| <Technical Competition> | Project Team                |
| “Theater”               | Arts                        |
| “Tutoring”              | Service                     |
| <Type of Martial Arts>  | Martial Arts                |
| “Volunteering”          | Service                     |
| “Writing”               | Arts                        |
| “Yearbook”              | Media                       |
| “Yoga”                  | Recreation                  |

# Appendix B: Skill Definition for Development Analysis

---

**Civic Responsibility:** Organizational types identified as increasing “Civic Responsibility” are characterized by students’ engagement in domestic or international political issues through activities such as community organizing, editorial writing, or lobbying. Through these activities, students develop their own ethical and political beliefs; additionally, they may attempt to affect policies or the views of other students or community members.

**Creativity:** Organizations promoting student “Creativity” encourage students to think “outside of the box” and develop innovative solutions to problems or challenges. Additionally, these activities may simply enable students to express themselves through art or writing.

**Critical Thinking:** Organizations categorized as developing “Critical Thinking” skills require students to analyze complex problems and situations. Example activities in these organizations may include analyzing problems and proposing solutions either within the organization or to an outside stakeholder.

**Cross-Cultural Skills:** Organizations promoting “Cross-Cultural Skills” require students to interact with individuals—either peers or mentors—hailing from different cultural origins.

**Disciplinary Knowledge:** Organizations shown to develop “Disciplinary Knowledge” promote students’ development of skills within their engineering discipline. Relevant activities may include performing academic research, programming, addressing design challenges, or engaging in an academic competition in a relevant field (such as science or mathematics).

**Ethics:** Activities promoting student “Ethics” present students with professional or personal dilemmas that they are required to address. Organizations promoting ethical development may require students to adhere to codes of competition or conduct, familiarize students with professional codes of ethics, or put students in difficult situations with no clear “correct” course of action (such as with many situations in undergraduate residence halls).

**Global Awareness:** Organizational types identified as increasing “Global Awareness” expose students to international geopolitical or cultural issues. Example activities within these groups may include participation in a global development project or investigative reporting or speechwriting on a geopolitical issue (past or present).

**Humanitarianism:** Organizations promoting “Humanitarianism” in students require participants to address issues of equity, social justice, identity, and engagement within their communities. Relevant activities may include social justice or identity training, engagement with underrepresented or disenfranchised communities, or introspective discussions with peers.

**Interpersonal Communication:** Organizations categorized as developing “Interpersonal Communication” require students to communicate with their peers, mentors, or—in some cases—mentees. In these clubs, strong communication among group members is often required for the organization to fulfill its stated mission or intended goals.

**Memory:** Organizations increasing “Memory” skills in students require memorization of large bodies of text or music.

**Networking:** Organizations identified as enabling student “Networking” require participating students to interact with individuals in their discipline or future professional field. This interaction can take place through mentorship activities or specific networking programs.

**Organizational Management:** “Organizational Management” skill development in student organizations takes place when participating members are required to coordinate personnel and tasks to accomplish event preparation or other club activities. This coordination may include planning of group logistics, delegation of responsibilities to other club members, or other complex administrative tasks.

**Problem Solving:** Organizations that promote “Problem Solving” within their membership are characterized by challenges presented to student members that they are required to overcome.

**Public Speaking:** Organizations categorized as those promoting “Public Speaking” require students to address large or small groups of individuals to communicate their or others’ ideas.

**Self-Confidence:** Organizations that develop student “Self-Confidence” often require participants to try new things, participate in public speech or performance, and empower themselves through other activities.

**Self-Direction:** Organizations identified as promoting “Self-Direction” require student participants to independently self-motivate, complete projects, and accomplish tasks. These groups require independent student motivation to accomplish their goals and progress as organizations.

**Strategy:** “Strategy” development in student organizations is defined as “political know-how” for the purposes of this study. In this definition, strategic students understand how to “get things done” in complex bureaucratic organizations through activities such as lobbying or political activism. These groups may also promote strategic thinking through game simulations or other similar activities.

**Teamwork:** Organizations promoting “Teamwork” within their membership require students to work together to execute program tasks or reach ultimate organizational goals.

**Time Management:** Organizations promote “Time Management” skills in students when firm deadlines—such as field operations or national/international competitions—constrain the schedule on which club activities are performed.

**Written Communication:** Organizations that develop students’ “Written Communication” skills require students to write group materials or presentations such as business plans, etc.



# Appendix C: Request for Interview Text

---

Dear Sir or Madam:

This email is an invitation to participate in a study entitled “Training the Engineers of the Future: Student Development through Co-Curricular Involvement.” You are being contacted to participate because of your professional experiences supervising graduates of undergraduate engineering programs in the workforce and your status as an alumnus(a) of the Massachusetts Institute of Technology (MIT).

In 2010, a collaboration was begun between MIT and the Singapore University of Technology and Design (SUTD), a new university seeking to educate and nurture technically-grounded leaders and innovators to serve the societal needs of the 21<sup>st</sup> century. As a component of this work, the MIT-SUTD Collaboration team working on this initiative seeks to study the qualities and competencies of entry-level engineers, specifically in regards to leadership, creativity, and communication skills.

This team seeks the participation of engineering management professionals who have supervised recent graduates of American engineering undergraduate programs within the last 5 years. Each participant will be interviewed via phone or in person by an MIT researcher, and respondents will not be compensated for their participation in this study. Participation is completely voluntary, and you can withdraw your participation at any time without penalty. Unless specific permission is granted by interview respondents, all results will remain anonymous and the identity of individual participants will not be cited.

Please respond promptly to schedule an interview session if you are willing to be included as a participant in this research effort. If you have any questions about this study, please feel free to contact me.

Thank you,

Dara Fisher

Graduate Research Assistant, MIT-SUTD Collaboration  
MIT Technology and Policy Program