Engineering Leadership Development Programs A Look at What is Needed and What is Being Done

Lesia Crumpton-Young, Pamela McCauley-Bush, Luis Rabelo,Katherine Meza, Ana Ferreras, Betzaida Rodriguez, Angel Millan, David Miranda, Misha Kelarestani

University of Central Florida

Abstract

"The Engineer of 2020: Visions of Engineering in the New Century," published by the National Academy of Engineering (NAE), discusses the importance of current and future engineering graduates possessing skills needed to solve business challenges. To ensure that future engineering graduates are adequately prepared, several universities and corporations are currently providing programs and workshops that educate engineering professionals and students in the theory and practice of leadership. This paper summarizes findings of surveys administered to identify key concepts critical to developing leadership qualities and skills. Also, this paper provides a summary of the current engineering leadership development efforts within Colleges of Engineering in the U.S. as well as an overview of the academic and professional programs available for engineers. Detailed information on the curriculum and course modules being used to teach engineering leadership that may prove useful to other educators are also included in this review paper.

Key words: Engineering leadership, academic and professional development

Introduction

The future continued success of U.S. businesses and industry rests upon having more practicing engineers with knowledge in topics such as: Principles of Leadership and Management, Global/International Impact, Ethical Standards, Cultural Diversity, Conflict Resolution, and Communication Skills (National Academy of Engineering, 2004). Therefore, it is critical for U.S. competitiveness that future engineering graduates possess strong technical engineering skills as well as other developmental skills such as leadership and management. To be effective leaders, engineers must possess skills such as written and oral communication, customer relations, personal initiative, teamwork abilities, organizational knowledge, and decision making that will facilitate the development of solutions to business challenges (Newport and Elms, 1997). Engineering Leadership is the ability to lead a group of engineers and technical personnel responsible for creating, designing, developing, implementing, and evaluating products, systems, or services. To appropriately prepare engineering leaders of the future, it is imperative to be aware of the necessary skills required to successfully complete engineering leadership roles, responsibilities, and positions.

Analysis of Engineering Leadership Surveys

To further understand the skills needed for successful engineering leadership development, a research study was conducted with engineering students and professionals. The study consisted of developing and distributing surveys to obtain feedback from engineering students and professionals on key topics related to engineering leadership. The Professional survey consisted of sections addressing demographics questions such as age group, gender, ethnic background and highest level of education completed; employment details such as position title and years of experience; leadership views and expectations; and leadership development opportunities. The Student survey included sections addressing demographics (age group, gender, ethnic background, highest level of education, leadership roles held, and number of semesters of leadership experience), leadership opportunities and education, leadership expectations, views and understanding of leadership, perception of self as a leader, and leadership expectations in career. The developed surveys were validated by SMEs and are consistent with academic course and program evaluation survey questions. Surveys were administered to student and professional members of engineering organizations during various professional conferences. Responses from the surveys administered provide insight on skill-sets pertinent to the success of engineers performing leadership roles.

Professional Survey Responses

Practicing engineering participants were surveyed to obtain feedback on engineering leadership. The professional participants' data sample has a total of 264 participants from all racial/ethnic backgrounds and consisted of 30.3% males and 69.7% females, of which 249 of the participants had at least a bachelor's level degree in engineering. The majority of participants were in the 25-45 age group.

Figure 1 is a graphical representation of the professional participants' years of experience in engineering as well as in performing leadership roles, responsibilities or positions. The data reveals that approximately 100 participants fall within the 3-5 and 6-9 years of experience categories, 80 participants fall in the 10 years and above and approximately 30 participants had experience in practicing engineering but no experience in professional leadership/management positions.

Figure 2 illustrates the leadership capabilities perceived important by professional engineers. The participants prioritized the leadership capabilities from 1-3, where 1 is the most important and 3 is the least important. The re-

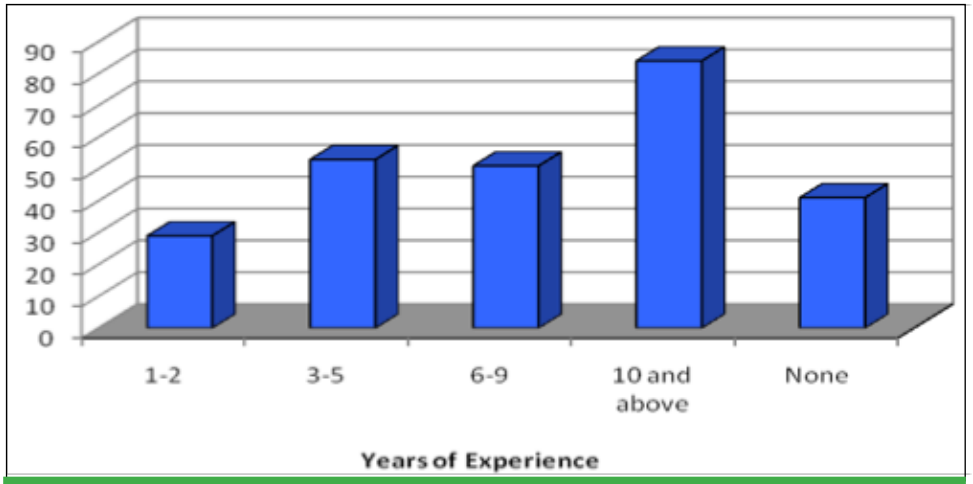


Figure 1. Years of professional Leadership/Management experience

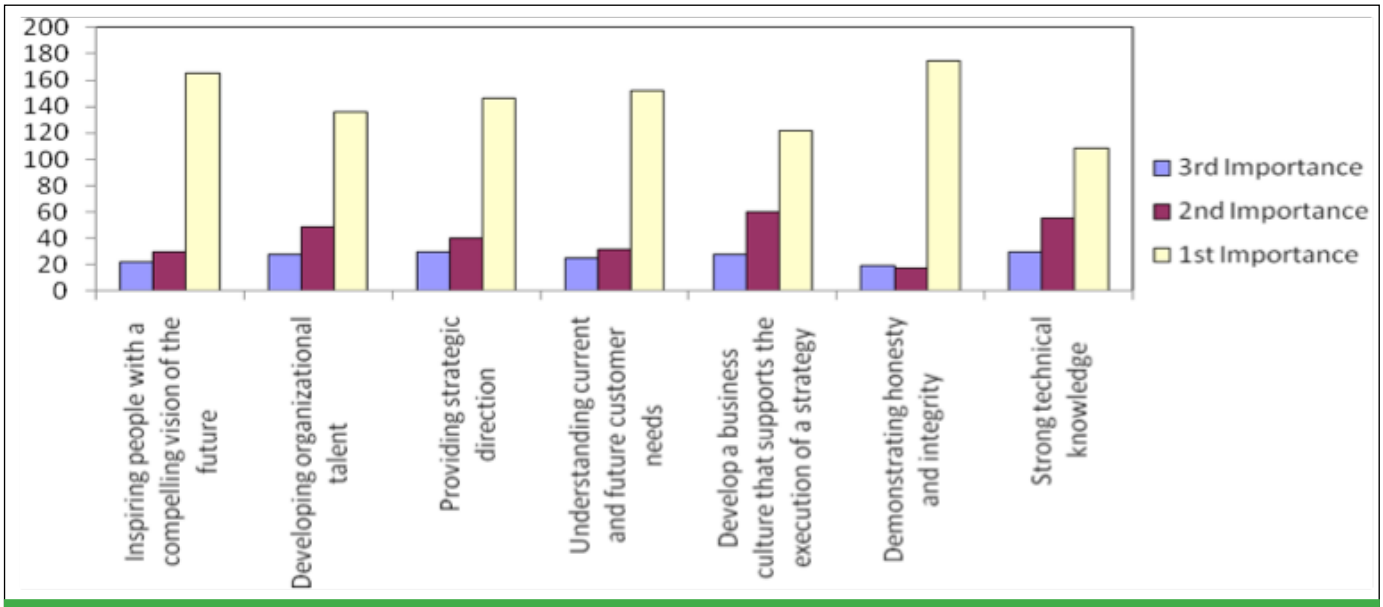


Figure 2. Leadership capabilities professionals perceive to be important

sults show that professionals perceive the most important leadership capabilities as demonstrating honesty and integrity, inspiring people with a compelling vision of the future, and understanding current and future customer needs, respectively. The participants also identified knowing how to develop a culture that supports the execution of strategy as less important.

Engineering professionals rated the skills or tools believed to be the most useful when accepting a leadership position. The participants prioritized the useful leadership skills from 1-3, where 1 is the most important and 3 is the least important. Figure 3 illustrates that the participants believe team-building/teamwork, personal development/continual learning, and communication skills to be the most useful in a leadership position and business management skills as less useful than other skills.

Figure 4 shows how professionals rate the engineering leadership characteristics they possess. The participants rated their leadership characteristics using a scale of 1-3, where 1 is best and 3 is least. Based on the survey results, the following characteristics were rated highest: honorable, credible, and determined. The professional engineers also rated their skills as a visionary or networker abilities as lowest.

Figure 5 displays how professionals rate their performance of some identified engineering leadership characteristics. The participants rated their perception of leadership abilities they can perform using a scale of 1-3, where 1 is best and 3 is least. The professional engineers group was most confident in their personal abili-

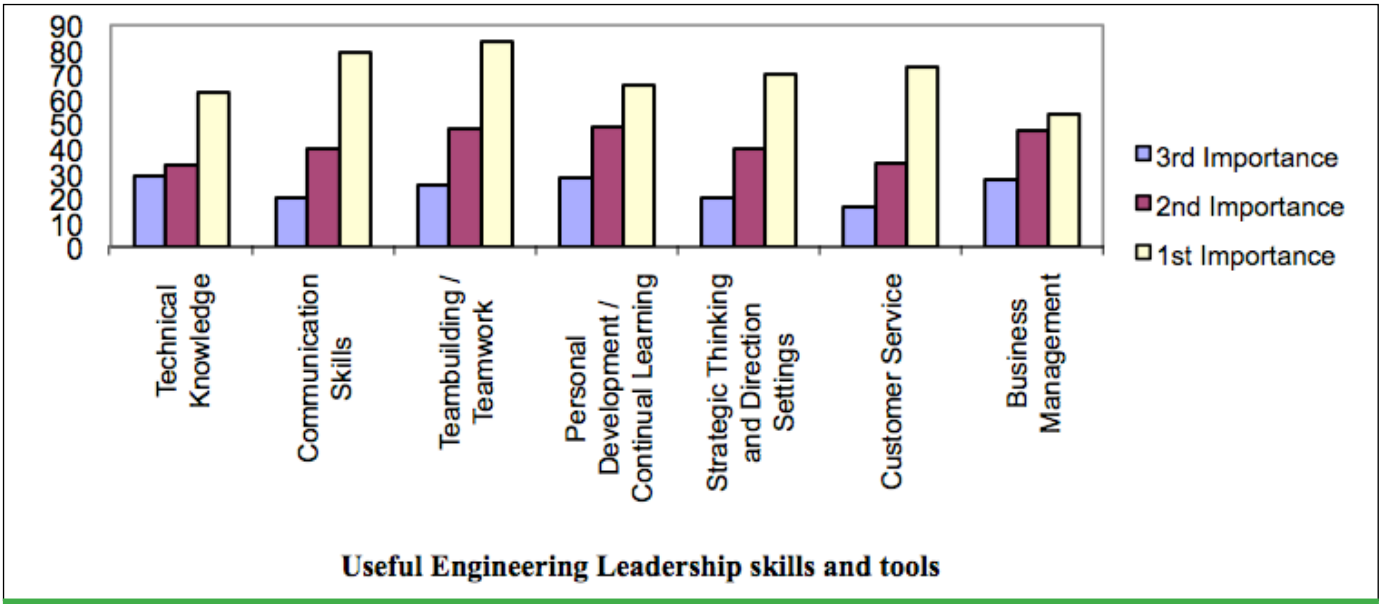


Figure 3. Useful Engineering Leadership skills and tools identified by professionals

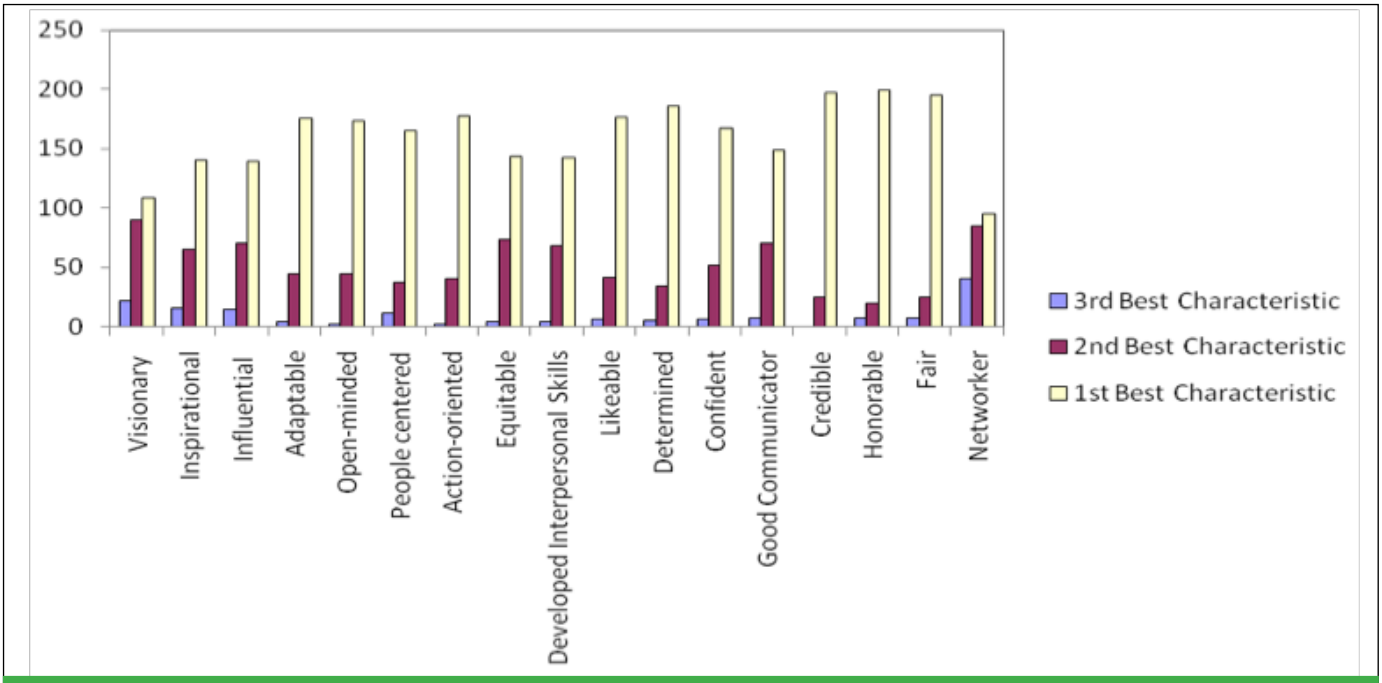


Figure 4. Engineering professionals' perception of leadership characteristics they embody

ties to accept other's opinions, solve problems, and listen to others. The professional engineers were least confident in their abilities to write a technical paper, give an oral presentation, and control a group.

Figure 6 illustrates the engineering professionals' level of interest in learning more about some of the identified engineering leadership topics. When asked which subjects were of interest to them, participants expressed the least interest in politics, societal issues, and administration, but were most interested in learning about several of the identified topics such as costs/finances, management, leadership, and conflict resolution among others.

Engineering Student Survey Responses

Engineering Student participants were surveyed to obtain feedback on desired engineering leadership skills. The student data set has a total of 213 respondents consisting of 44% males and 56% females from all racial/ethnic backgrounds.

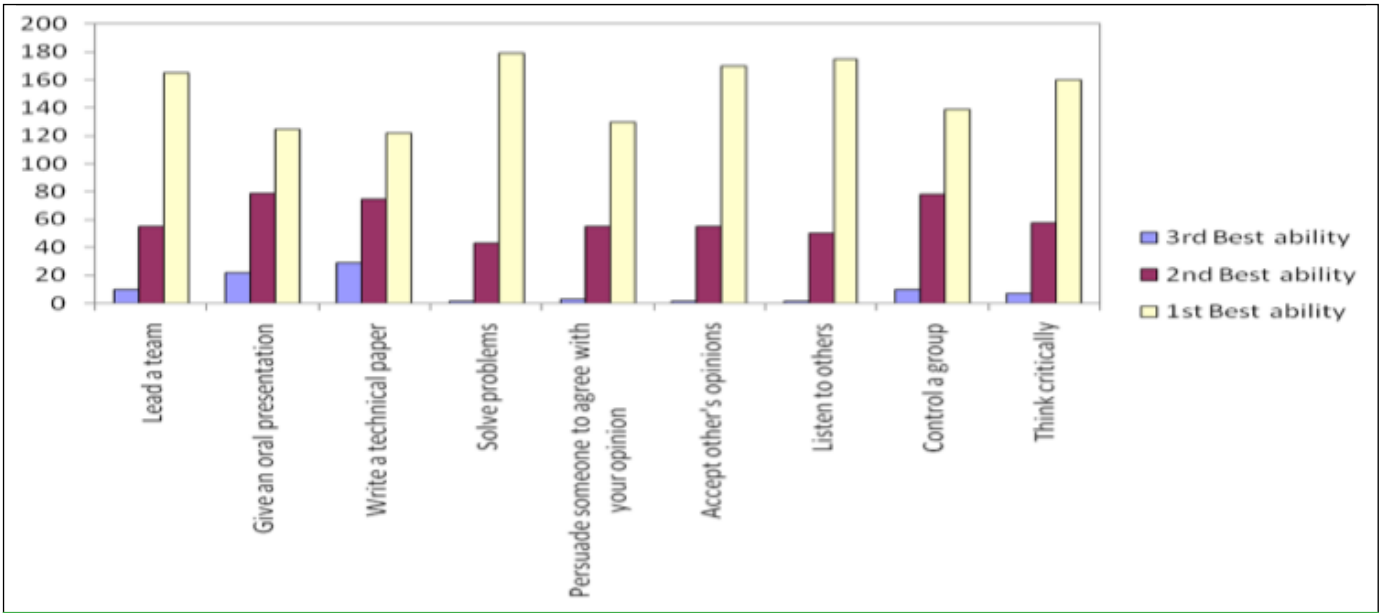


Figure 5. Engineering professionals' perception of leadership abilities they can perform

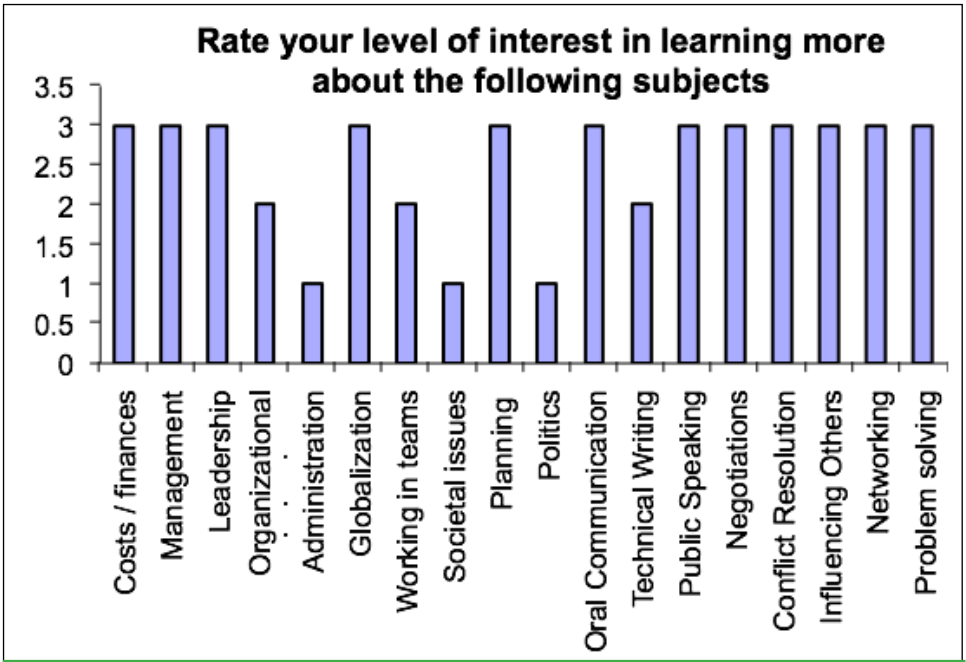


Figure 6. Engineering professionals' level of interest in learning more about various engineering leadership topics

Figure 7 shows the various areas in which the students have previously or currently performed leadership roles. These results show that the majority of the students that participated in the study have performed leadership roles within academia, the community, in sports activities, and professional societies.

Students were asked to rate the top 3 benefits gained as a result of working in a leadership/management position. Figure 8 shows that the most important incentives in performing a leadership role are: academic and professional growth, ability to make decisions and cause change, an increase in responsibility, and the exposure to different roles/experience. Results also show that a pay increase was the least important incentive to performing leadership roles.

Students were asked to rate the top the capabilities that they perceive is important for an engineer within a leadership role or position to possess.

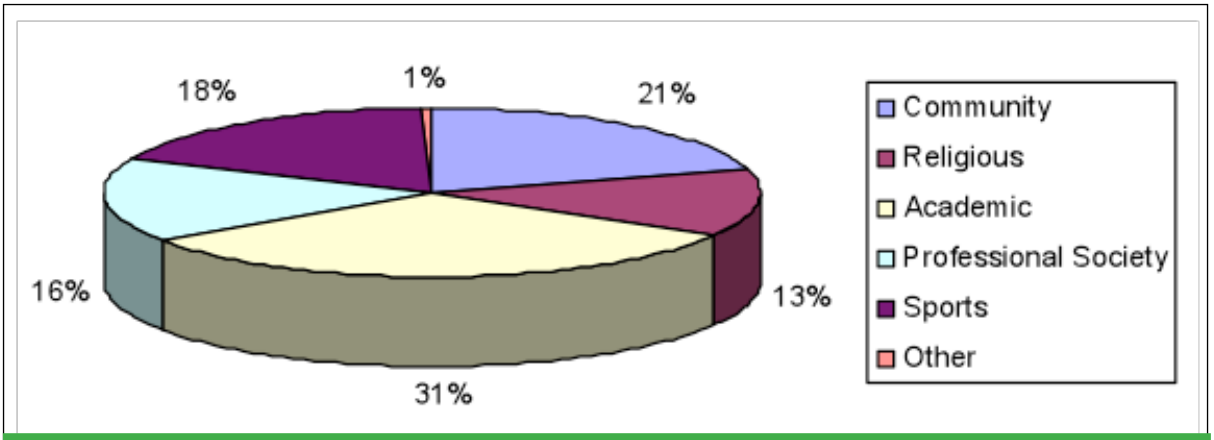


Figure 7. Student participant leadership roles experienced

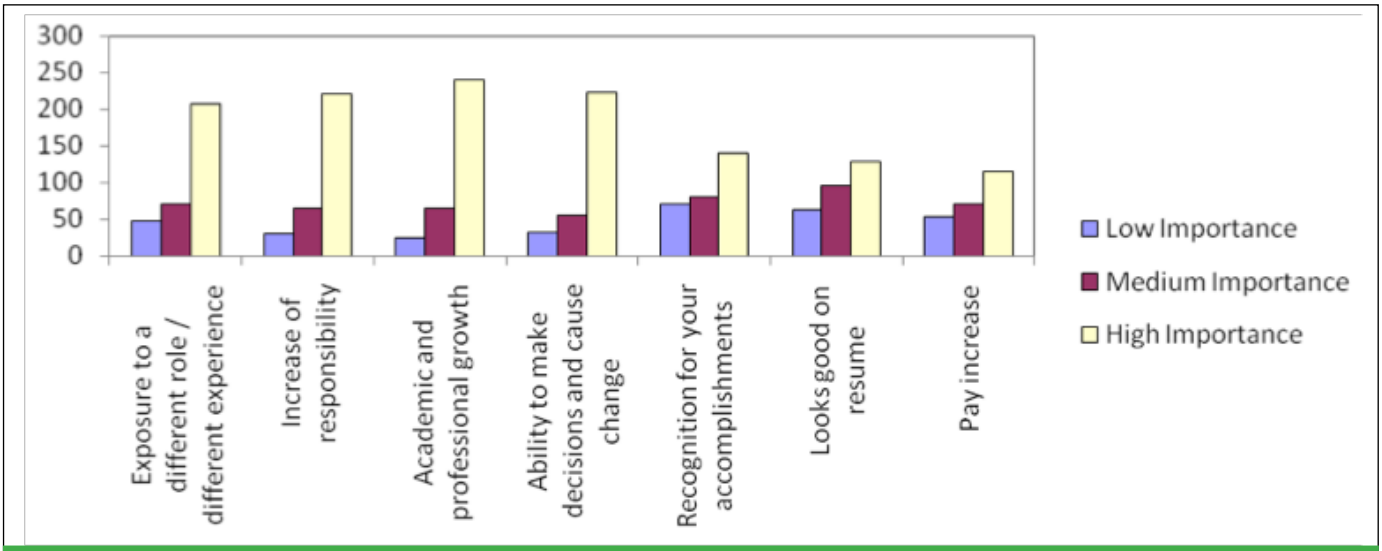


Figure 8. Benefits students expect in a leadership/management position by priority

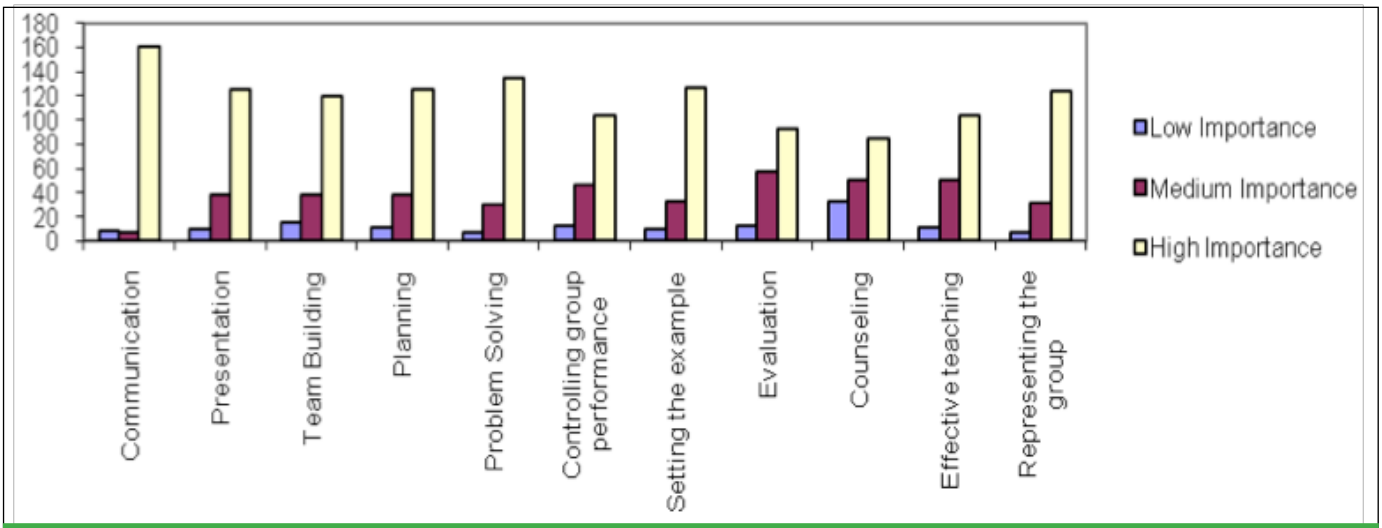


Figure 9. Leadership capabilities students perceive to be important

Data in figure 9, suggests that student participants believe communication, problem solving, setting the example, and ability to represent the group well are the most important skills for a leader to possess. These responses suggest

that counseling, and controlling group performance were identified to be the least useful of the desired skills of leaders.

Engineering Leadership Programs

There are several Engineering Leadership Development programs available for current professional engineers and engineering students.

Professional Engineers

Engineering Leadership programs are offered by various industry leaders such as Lockheed Martin, National Instruments, Raytheon, GE, NASA and Northrop Grumman.

Lockheed Martin, National Instruments, Raytheon, and GE offer a Leadership Development Program to qualified new engineering employees, focused on facilitating the transition from an academic to a corporate mindset and are composed of leadership training, rotational assignments, and career development. The main objective of these programs is the development of employees with a global understanding of business, skills in the most current technologies, and ability to solve various business challenges. Participants are required to solve technical issues in a creative and timely manner by working closely with each department in the company. The exposure to different company sectors facilitates the development of oral, written, interpersonal, leadership, and problem solving skills [18, 9, 14, 4].

The Lockheed Martin program consists of lectures, team projects, and Leadership Development Conferences designed to provide engineers with practical and strategic leadership and interpersonal skills ("Lockheed Martin Leadership Development Program", 2005). The Engineering Leadership Development Program (ELDP) at Raytheon is available for current engineering employees, and a Rotational Engineering Leadership Development Program (RELDP) is designed for recently graduated engineers with Masters Degrees ("Raytheon's Engineering Leadership Development Program (LDP)", 2006). GE offers several Engineering Leadership Programs that focus on the company's lifelong learning goal for its employees. One of the entry level programs for engineers is the Edison Engineering Development Program, which provides experience in global process, material design and development, manufacturing, marketing and product management. The second entry level program for engineers is the Operations Management Leadership Program, where participants are given assignments in environmental health and safety, manufacturing/process engineering, quality, materials management and supply chain management. This program provides business training in project management, negotiation, career management, business writing, and presentation skills ("GE Leadership Development Programs", 2009).

Additional programs are offered at the Masters and Corporate levels for more experienced engineers by GE, NASA, Northrop Grumman, the American Council of Engineering Companies of Indiana (ACEC), BAE Systems, and the Women in Engineering Leadership Institute (WELI). Some of these programs combine rotational assignments through different sectors of the company, and provide classroom courses to supplement the experiential learning [12, 1, 25, 4, 16]. Similar to the previously mentioned programs for entry-level engineers, the Engineering Leadership Development Program (ELDP) at BAE Systems attempts to guide the company's employees, business, and products into new areas of growth through engineering excellence, superior teamwork, and outstanding leadership. The program achieves this goal through diverse work rotations, educational coursework, and leadership training. ELDP participants rotate across several sectors of BAE Systems, work in teams, and therefore gain corporate experience in various technical areas of interest. The educational coursework is a combination of technical learning and team building, requiring collaboration between engineers of varying technical backgrounds. Through leadership training, participants practice and improve presentation and teamwork skills while developing individual leadership and communication styles, situational awareness and emotional intelligence. Additionally, participants are educated on how to manage conflicts and effectively lead and motivate team members ("BAE Systems Engineering Leadership Development Program", 2009). The Manufacturing and Leadership Development Program at Northrop Grumman focuses on developing leaders across emerging, foundation, and executive groups. In this program, retirees serve as consultants to ensure knowledge transfer to less experienced members. Program candidates are high-potential designers and engineers who receive advanced training to expand their knowledge base and skill-sets ("Northrop Grumman Electronic Systems Best Practice", 2006).

The NASA Academy of Program/Project

and Engineering Leadership (APPEL) focuses on enabling individual and team excellence of its systems engineers, project, and program managers by providing knowledge and skills in project management, systems engineering, communications and leadership, as well as NASA Specific topics. Participants are offered individual assistance, focused workshops, and group sessions in team building, planning and scheduling, program control analysis, systems integration support, risk management, and software management ("NASA Academy of Program/Project and Engineering Leadership", 2009). In 2008 NASA solidified its efforts towards the development of engineering leadership skills through the development of an agency-wide pilot program, Systems Engineering Leadership Development Program (SELDP). The engineering leadership program developed by The American Council of Engineering Companies of Indiana (ACEC) however, is geared towards training engineering firm managers. This program offers a detailed view of several management areas such as marketing, sales, public relations, ethics in engineering, leadership training, human resources, technology, legal, risk management, finance, and politics. Additional workshops are also provided on personal development topics, where participants are involved in hands-on activities, discussions and interactive workshops ("ACEC Indiana Engineering Leadership Program", 2006). The Women in Engineering Leadership Institute (WELI) have also hosted a leadership workshop for mid-career women in engineering that plan to attain leadership positions at universities. One of the goals of the workshop is to provide information on leadership opportunities, as well as the challenges and rewards of assuming leadership positions in academia. The workshop supports the formation of a network of colleagues and mentors that help participants evaluate future leadership opportunities to succeed in the academia. Specific topics discussed in the workshop include media training, negotiation skills, budget management skills, networking and legal issues in academia ("Women in Engineering Leadership Institute", 2006).

Engineering Students

Similar to the programs available for engineering professionals, several academic institutions offer Engineering Leadership programs for future professional engineers (current engineering students). The programs available in universities focus on educating engineering students in leadership and team building skills before they enter the workforce (Ferreras, 2006). Many of the programs, whether they are individual courses, minors or certificate programs are divided into the same basic components: coursework, team projects, and industry experience. Although these programs share some similarities, each of them provides something unique. The following is a summary of the engineering leadership programs available for engineering students.

The Society of Automobile Engineers (SAE) sponsored the Leadership Development Program, a two-and-a-half day event in Orlando, Florida in January 2007. The Leadership Development Program (LDP) was offered in conjunction with the Section Officers Leadership Seminar (SOLS) to eligible engineering student members. The seminar included team work exercises, opportunities to network with leaders, sessions to improve professional and leadership skills, an exercise to promote volunteering in classrooms, career development sessions, industry speakers, and self assessment activities ("SAE International Leadership Development Program", 2009). The Leadership Minor at Lehigh University consists of two components: enrollment in the information and systems curriculum, and a leadership-development experience in which the student engages in real-world problem solving and project leadership. In addition, students in this program closely interact with industry leaders to acquire experience ("Lehigh University Information Systems & Engineering Leadership Program (ISELP)", 2009).

The Georgia Institute of Technology's Institute for Leadership and Entrepreneurship, the Northeastern University's Gordon Engineering Leadership Program, and the Gordon-MIT Engineering Leadership Program assist students in becoming skilled, ethical, and visionary leaders of the 21st century. The three programs are considered to be interdisciplinary in the course requirements, and provide students with specialized training in ethics, organizational and global leadership, as well as the development of key skills such as teamwork and communication. These programs allow the students to analyze the social, political, economic, cultural, global, and technical dimensions of leadership, while having the opportunity to gain practical work experience through internships [20, 5, 6].

The Engineering Global Leadership Honors Program at the University of Michigan, the Systems Engineering and Leadership Program (SELP) offered by Loyola Marymount Universi-

ty, and the Engineering Leadership and Entrepreneurism Program (ELEP) at the University of Houston focus on educating working engineers and scientists in the engineering and business disciplines to make them industry leaders. Students are required to complete a traditional engineering curriculum in addition to courses in marketing, accounting, finance, history, economics, foreign language and political science. The programs educate students on how to perform systems engineering, lead systems engineering activities and manage interdisciplinary teams of engineers and scientists, while applying business fundamentals [10, 24, 21].

The engineering leadership programs offered by the University of Kansas and Iowa State University, which partnered with 3M developed an engineering leadership scholarship that allows students to create a personal leadership portfolio to track their skills development progress [22, 7]. The University of Kansas' Engineering Leadership and Entrepreneurship program plans to expand and refine leadership, managerial, interpersonal, business, entrepreneurial and engineering skills. In addition, participating students will be mentored and have access to workshops, seminars and other leadership opportunities ("University of Kansas Engineering Leadership and Entrepreneurship Program Launched", 2007). The Iowa State University Program is designed to be student centered and student led, where the scholars are responsible for the design, implementation, and continuous improvement of the program. The program consist of a leadership retreat, a credit bearing seminar class, a service learning project, a common reading experience, networking and skills development events and weekly reflection journals ("Iowa State University Engineering Leadership Program", 2004).

Pennsylvania State University, the University of Maryland, and the University of Central Florida have each developed an Engineering Leadership Minor where students develop skills through experiential learning or service learning projects. The Engineering Leadership Development Minor (ELDM) at Pennsylvania State University provides students with real-life leadership and project management experience while making a positive impact on issues affecting worldwide. Some of the engineering leadership skills and topics covered in this minor include teamwork, innovation, and important aspects of leadership in an organization. Due to the continuous advances in technology and the importance of business management and development, the program also emphasizes on the education of topics such as public policy, ethics, business issues, finance, marketing, and investment ("Pennsylvania State University (ELDM)", 2008). The minor at the University of Maryland focuses more on communication, global awareness, project management, understanding oneself and working effectively with others. The program is geared towards the application of mentoring and networking activities, in addition to performing leadership roles on campus and in the community ("University of Maryland Engineering Leadership Programs", 2008).

The Industrial Engineering and Management Systems (IEMS) department at the University of Central Florida offers an Engineering Leadership and Management Minor. This minor is available to engineering and computer science undergraduates. It includes coursework that focuses on providing basic understanding in project engineering, engineering administration, team effectiveness, and financial engineering coupled with a Leadership Development Institute that provides experiential learning activities, through a capstone course. This program focuses on management and leadership principles, practices, tools and techniques as they pertain to engineering venues. It initiates and facilitates the development of sound ethical engineering practices and helps develop a baseline for the study of engineering leadership and management principles, practices, and techniques. Furthermore, it focuses on the development of effective communication and negotiation skills, and interpersonal skills needed to succeed in a global environment.

Discussion

The research findings presented in the above sections of this paper, focus on presenting the feedback from both engineering professionals as well as current engineering students. Surveys were distributed at different conferences, resulting in obtaining responses from over 500 participants.

Significant results obtained include:

- Professional engineers indicated that they are most confident in their ability to solve problems, lead a team, and listen to others. They were least confident in their ability to give oral presentations, write technical papers, and be persuasive.
- Students consider themselves proficient at listening to others and thinking critically but rated themselves lowest on writing techni-

cal papers and public speaking. Overall, communication and problem solving skills were considered to be the most useful when performing in a leadership position, while counseling and controlling group performance were identified as the least useful.

- Communications skills were identify by both the students and professional participants as one of the most important skills for engineering leaders
- The most important areas to prepare for leadership roles were identified as: knowing where to fit within the organization, mentoring, people skills, negotiation skills, understanding team limits, time management, communication skills, resource leverage, being open minded, the ability to develop a vision, and being a good listener. Survey results reveal that the most beneficial areas of leadership training were: people skills – dealing with different people and personalities, team dynamics, ethics, project management, cross-functional projects, globalization, planning, facilitation and communication skills, strength discovery, conflict resolution, cross-cultural communication and learning from mistakes.

Conclusion

Due to the competitive nature of businesses, industry is demanding not only technically proficient engineers for their companies but also engineers that are prepared to take on leadership positions. To be effective leaders, engineers must possess the soft skills necessary to solve business challenges. These skills include written and oral communication, self initiative, teamwork abilities, customer relations and decision making. To meet this current need, new engineering leadership programs have been emerging from universities and corporations. The programs available at universities are focused on educating engineering students in leadership and team building skills before entering the workforce. Many of the programs, whether individual courses, minors or certificate programs are divided into the same basic components: coursework, team projects, and industry experience.

To properly prepare engineers, the coursework of these programs consist of a combination of engineering and business curricula. In the engineering leadership program offered by the University of Michigan, cultural learning is even included as an important element of engineering leadership, due to the global nature of the economy. Team projects help students sharpen their interpersonal skills, and industry experiences by providing the practical knowledge and mentoring that engineering students do not receive in the classroom. Engineering leadership programs at professional organizations concentrate on training and familiarizing new engineers in the processes and products of their particular companies. These programs are typically composed of coursework, workshops, seminars, and rotational assignments. The coursework in these programs are specific to each corporation's needs, as opposed to the general approach of the university programs' coursework. Workshops and seminars keep professional engineers abreast of current industry issues and new technologies necessary for them to be effective leaders in their profession. The rotational assignments provided by these programs also allows for engineers to gain interdisciplinary skills, thus making them well rounded employees.

Engineers and future engineering graduates are needed to assume leadership positions "from which they can serve as positive influences in the making of public policy and in the administration of government and industry." (National Academy of Engineering, 2004). Current engineering leadership programs, along with those currently under development will need to include additional topics. The need to develop a holistic Engineering Leadership program that entails the aforementioned skills such as the ability to control a group, critical thinking, how to be a visionary, inspirational, influential, adaptable, open-minded, people-centered, action-oriented, equitable, interpersonal, likeable, determined, confident, good communicator, credible, honorable, fair, and a networker have been identified within this research as capabilities and characteristics essential to ensure that engineering professionals and future engineers are prepared to flourish as leaders.

References

ACEC Indiana Engineering Leadership Program (2006). Retrieved July 17, 2009, from http://www.acecindiana.org/content/PDF/Leadership0506.pdf.

BAE Systems Engineering Leadership Development Program (2009). Retrieved July 17, 2009, from http://www.baesystems.com/Careers/CareersinYourCountry/US/Leadership Development/Engineering-LeadershipDevelopmentProgram/index.htm.

Ferreras, A., Crumpton-Young, L., Rabelo, L., Williams, K. and Furterer, S. (2006) Work in Progress: Developing a Curriculum that Teaches Engineering Leadership & Management Principles to High Performing Students, 36th Frontiers in Education Conference, San Diego, CA.

Graham, R., Crawley, E., Medelsohn, B. (2009). Engineering leadership education: A snapshot review of international good practice. Retrieved March 15, 2010, from http://web.mit.edu/gordonelp/elewhitepaper.pdf

General Electric (GE) Leadership Development Programs (2009). Retrieved July 17, 2009, from http://www.gepower.com/about/careers/en/leadership_programs/index.htm.

Georgia Tech Institute for Leadership and Entrepreneurship (ILE) (2009). Retrieved July 17, 2009, from http://ile.gatech.edu/.

Gordon-MIT Engineering Leadership Program: Building Engineering Leaders. Retrieved July 17, 2009. http://web.mit.edu/gordonelp

Iowa State University Engineering Leadership Program (2004). Retrieved July 17, 2009, from http://www.eng.iastate.edu/leadership/directorbios.asp.

Lehigh University Information Systems & Engineering Leadership Program (ISELP). Retrieved July 17, 2009, from http://www.lehigh.edu/~inleader/curriculum.html.

Lockheed Martin Leadership Development Program (2005). Retrieved February 27, 2007, from http://www.lockheedmartin.com/wms/findPage.do?dsp=fec&ci=12964&sc= 400, 2005.

Loyola Marymount University Systems Engineering and Leadership (SELP) (2009). Retrieved July 17, 2009, from http://www.lmu.edu/Page24244.aspx.

National Academy of Engineering (NAE). The Engineer of 2020: Visions of Engineering in the New Century. (2004) ISBN-10: 0-309-09162-4

NASA Academy of Program/Project and Engineering Leadership (2009). Retrieved July 17, 2009, from http://www.nasa.gov/offices/oce/appel/home/index.html.

NASA Systems Engineering Leadership Development Program (SELDP). (2008) Retrieved July 17, 2009 http://www.nasa.gov/offices/oce/appel/seldp/index_prt.htm

National Instruments Engineering Leadership Program. Retrieved February 27, 2007, from http://digital.ni.com/jobs.nsf/$$opportunitiesalpha/C61A6084C59DFCDB862572730057EA74?OpenDocument, 2007.

Newport, C.L., Elms, D.G (1997). Effective Engineers. International Journal of Engineering Education. Vol 13, No 5, p 325-332. .http://www.ijee.dit.ie/articles/Vol13-5/ijee996.pdf.

Northrop Grumman Electronic Systems Best Practice: Manufacturing and Engineering Leadership Development Program (2006). Retrieved July 17, 2009 http://www.bmpcoe. org/bestpractices/internal/nges/nges_31.html

Pennsylvania State University The Engineering Leadership Development Minor (ELDM) (2008). Retrieved July 17, 2009, from http://www.eldm.psu.edu/.

Raytheon's Engineering Leadership Development Program (LDP) Targets High-Potential Employees (2006). Retrieved July 17, 2009, from http://www.raytheon.com/feature/ new06_ldp

SAE International Leadership Development Program (2009). Retrieved July 17, 2009, from http://students.sae.org/awdscholar/awards/leadershipdev/index.htm.

The Gordon Engineering Leadership Program at Northeastern University (2009). Retrieved July 17, 2009, from http://www.censsis.neu.edu/gordonfellows.

University of Houston Cullen College of Engineering First Jacket Institute for Engineering Leadership and Entrepreneurism Program (2009). Retrieved July 17, 2009, from http://www.egr.uh.edu/news/1003/?e=elep

University of Kansas Engineering Leadership and Entrepreneurship Program Launched (2007). KU News Release. Retrieved July 17, 2009, from http://www.news.ku.edu/2007/ january/8/selfprogram.shtml.

University of Maryland Engineering Leadership Programs (2008). Retrieved July 17, 2009, from http://www.ursp.umd.edu/leadership/index.html

University of Michigan Engineering Global Leadership Honors Program (EGL) (2009). Retrieved July 17, 2009, from http://www.engin.umich.edu/students/support/egl.

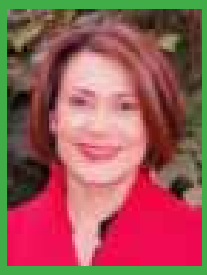
Women in Engineering Leadership Institute WELI Leadership Workshop (2006). Retrieved July 17, 2009, from http://www.weli.eng.iastate.edu/Conferences/SWE2006/SWE-WELI%20flyer%202006.pdf.

Lesia Crumpton-Young, is the president and CEO of PowerfulEducation Technologies LLC, author of the "You've Got the Power" workbook series and professor on Industrial Engineering at the University of Central Florida. She received her Ph.D. in Industrial Engineering from Texas A&M University, as well as her Master of Science and Bachelor of Science from Texas A&M University. Prior to becoming the president and CEO of her consulting company, she held the position of of Associate Dean of Engineering at Mississippi State University (MSU), and served as the developer and director of the Ergonomics/Human Factors Program and Experimentation Laboratory during her tenure at Mississippi State University and later served as the Department Chair of Industrial Engineering and Management Systems at The University of Central Florida. Currently, Dr. Crumpton-Young serves as the Director of the Center for Engineering Leadership and Learning as well as Co-Director of the NSF Industry/University Cooperative Research Center for e-Design. She is a member of the Engineering Advisory Committee for the National Science Foundation, The US Army Science Board and the Engineering Education advisory board of the National Academy of Engineering. She has published over 150 scholarly publications, and has worked on many industrial research projects with companies such as UPS, IBM, Caterpillar, Intel, Garan Manufacturing, Southwest Airlines, and Lockheed Martin. Dr. Crumpton-Young's research has been supported by organizations such as NSF, ONR, NASA, and DOE.

Dr. Pamela McCauley Bush is a tenured Associate Professor of Industrial Engineering and Management Systems at the University of Central Florida. From January 1997 to June 1999 she held the position of Martin Luther King, Jr. Visiting Associate Professor of Aeronautics and Astronautics at the Massachusetts Institute of Technology (MIT). A native of Oklahoma, Dr. McCauley Bush obtained Bachelors, Masters, and Doctor of Philosophy degrees industrial Engineering from the University of Oklahoma. In Fact, in 1993 Dr. McCauley Bush became the first known African-American female to be granted a Ph.D. in the field of Engineering in the state of Oklahoma. Her engineering related research focus includes evaluation of development of human factors, expert systems development, fuzzy set theory, and the human impact in information security. She has received federal and state funding to conduct. She is the author of over 60 technical papers, book chapters, and conference proceedings.

Dr. Luis Rabelo, is an Associate Professor in the Department of Industrial Engineering and Management Systems in the College of Engineering and Computer Science at the University of Central Florida. He received dual degrees in Electrical and Mechanical Engineering from the Technological University of Panama and Master degrees from the Florida Institute of Technology and the University of Missouri-Rolla. He received a Ph.D. in Engineering Management from the University of Missouri-Rolla in 1990 where he also did Post-Doctoral work in Nuclear Engineering. He also holds dual MS degrees in Aerospace Systems Engineering & Management from the Massachusetts Institute of Technology. He has over 240 publications and three international patents.

Dr. Katherine Meza is a winter 2010 Policy Fellow with the Center for Advancement of Scholarship on Engineering Education (CASEE) at the National Academy of Engineering (NAE). She holds a Ph.D. in Industrial Engineering (IE) from the University of Central Florida (UCF); her doctoral research focused on developing Tools and Models to Characterize and Quantify User-Centered Design Considerations in Product and System Development. She also holds a B.S. and M.S. in Industrial Engineering, a Six-Sigma Green-Belt Certification and a Project Engineering Certificate from the University of Central Florida. During her doctoral research, she assisted the IE Department at UCF in the development of new programs and research centers such as the Center for e-Design and the Center for Engineering Leadership and Learning (CELL). Dr. Meza received the Modern-Day Technology Leader Award in 2007; and is a member of the National Scholars Honor Society, and the Delta Epsilon Iota Academic Honor Society.



Dr. Ana M. Ferreras, a Program Officer supporting the U.S. National Committees for the mathematics, math instruction, crystallography, and physics, joined BISO's staff in 2008. Dr. Ferreras holds a Ph.D. in Industrial Engineering (IE) at the University of Central Florida (UCF). She also holds an M.S. in Engineering Management from the Florida Institute of Technology and a B.S. in Electrical Engineering from UCF. During her doctoral research, she assisted the IE Department at UCF in reengineering the undergraduate curriculum by developing a national model, new programs, experiential laboratories, and research centers. Prior to joining BISO's staff, she was a winter 2008 Christine Mirzayan Policy Graduate Fellow with the Center for Advancement of Scholarship on Engineering Education (CASEE) at the National Academy of Engineering (NAE).

Angel Millan is currently a Ph.D. candidate at the Department of Industrial Engineering and Management System in the University of Central Florida (UCF). His areas of research and interest are ergonomics, human factors, system safety and human computer interaction. He earned a Bachelor degree in Aeronautical Engineering from the Universidad Nacional Experimental de la Fuerza Armada (Venezuela) in 1999 and a Master of Science in Aeronautics with safety and management specializations from Embry-Riddle Aeronautical University in 2004. While working toward his Doctorate, he has been a Graduate Research Associate with appointments as director in Dr. Lesia Crumpton-Young research team and later as program manager and researcher for the NSF Center for e-Design. He is also working with Powerful Education Technology in developing web based applications to enhance learning through collaboration. Angel Millan is a member of the International Society of Air Safety Investigators, American Society of Safety Engineers, Institute of Industrial Engineering and the Society of Hispanic Professional Engineers. He is also an active member of Tau Beta Pi Engineering Honor Society where he is the chapter's graduate coordinator and a lecturer for the MindSet program.

David Miranda is a NASA Simulation Engineer at the Kennedy Space Center. He received his Bachelors in Aerospace Engineering, Masters in Industrial Engineering, and Masters in Business Administration from the University of Central Florida. During his career he has worked on multiple discrete event simulation projects for the space agency in support of the NASA Constellation project.

Misha Kelarestani received her Bachelors in Biology and Masters in Business Administration from the University of Central Florida. She is currently working as a performance management analyst at the Bogdahn Group.