Observations of the Application and Success of Leadership Development Tools with Undergraduate Engineering Education

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Dr. Santarelli retired from Pratt & Whitney Rocketdyne in 2007 after 27 years working on a variety of Propulsion and Power Programs including the Stage IV of the Peacekeeper, several "Star Wars" programs, Atlas, Delta, Space Shuttle Main Engines, and the International Space Station, the last 20 years being in management and leadership roles. He has also served as a commissioned officer in the NOAA Officer Corps and worked for ITT General Controls in the power, process, and pipeline industries. He is also a U.S. Air Force veteran having served in the Viet Nam conflict.

Dr. Santarelli has received numerous awards including the Boeing Leadership Excellence Award, NASA Space Flight Awareness Team and Appreciation Awards as well as Rocketdyne Outstanding Achievement Awards for various program activities. He is currently serving as a Director on the Antelope Valley Board of Trade and was the Honorary Commander of the 412th Electronic Warfare Group at Edwards AFB. Most recently, Dr. Santarelli was honored as the 2016 CSULB College of Engineering Distinguished Alumnus. He is also a member of several professional societies and has authored and co-authored several papers pertaining to the Antelope Valley Engineering Program.

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Abstract

This paper documents the purposeful design and results of the application of sets of leadership development tools to a unique cohort-based undergraduate upper division program. The program is *not* targeting high-GPA, honors track, or other special categories. It has been designed with the goal of transforming typical engineering transfer students into graduates capable of rapidly assimilating into high performing professional environments. The program design was informed by an industry/community needs assessment as well as the Accreditation Board for Engineering and Technology (ABET) standards. Program design addresses leadership, professionalism, and communication skill with equal importance to the engineering skills. The sets of tools applied include leadership development tools such a personality assessment, a proprietary strength finder tool, and curriculum tools such as active learning strategies, learning communities and technical presentation experiences. Expectations for professionalism and leadership are set at an academic orientation, while personal professional development and group dynamics are introduced during a cohort workshop. Personality and StrengthsFinder™ results exist for approximately130 incoming juniors in both mechanical and electrical engineering. Only the mechanical engineering students have been observed through senior design class and graduation. Assigning senior design project groups, rather than allowing self-selection, is another tool used to develop leadership within the cohort learning community. Over the span of six senior design courses with a total of 50+ mechanical engineering majors, students have been exposed to leadership development through group dynamics activities and leadership strategies through the Gallop Organization's Strengths-Based Leadership paradigm. Survey results from a leadership orientation for incoming juniors indicate strong self-efficacy in communication and leadership skills. Industry partners have reported very high satisfaction with both interns and alumni. One highlight of the program outcomes is a near 100% employment rate of students upon graduation and a 97%+ retention rate while matriculating.

Program Background and Motivation

The purpose of this paper is to document the baseline engineering leadership characteristics developed through unique baccalaureate degree completion programs for mechanical and electrical engineering. The programs are self-supporting, admitting a maximum of 25 junior-level transfer students with the appropriate pre-requisite coursework in each of the two majors each fall. Initiated in fall 2011, the programs reside 100 miles east of the main University campus and are administered through the University's College of Continuing and Professional Education. Curriculum, student advisement, and vetting of faculty are conducted through the University's College of Engineering. The University's WASC accreditation has been extended to include the extension programs, and the Accreditation Board for Engineering and Technology (ABET) certification was achieved in both disciplines in fall 2015. The majority of courses are taught through direct contact by a mixture of University faculty and industry-based adjuncts.

These two self-supporting degree completion programs are highly-structured and cohort-based with students taking all of their required classes together in sequence. Graduation is guaranteed in 5 semesters, if the student achieves grades of C or better in all coursework and maintains good standing with the University. Four cohorts, a total 65 individuals, have graduated from the programs and 54 students are currently enrolled in cohorts 5 and 6. The program plan was developed to include added value from pragmatic philosophical underpinnings and industry-based perspective that was informed by the local aerospace industry.[0] One of the value-added outcomes desired by the local employers supporting the programs is leadership and teamwork skills,' and ABET[2] accreditation criteria and engineering educational literature[1] also support the need for leadership skill student learning outcomes generally in engineering undergraduate programs. The pragmatic philosophical approach, or experimentalism, according to Creswell[3], facilitates understanding of specific problems, opens possibilities, different world-views, different assumptions, and allows alternatives for data collection and analysis. The program supports the application of active learning strategies, bench marking of industry practices, and provides a variety of tools to develop the desired student outcomes.

Leadership Development Design

The economics of running a small targeted program and the desire to graduate students in a timely manner necessitated that the programs progress students in a defined sequence taking as many classes as possible with no options to dilute the class size. The need to progress the admitted students through the programs together created the opportunity to add value above commodity engineering skills through instilling communications skills and self-awareness. However, requiring the students to stay together in a small cohort, all in the same sections of classes every semester, has the potential to create additional stress on the students, necessitating instruction in communications skills, development of self-awareness, self-management, and learning community to combat that stress. In addition to an academic orientation, the programs provide a cohort workshop designed to initiate learning community, instill professionalism, and introduce learning skills to the students.

The cohort workshop is presented through team instruction by the programs director, a professional engineer with 30 years' experience as an engineering hiring manager who represents the professional work environment to the students, the mechanical engineering faculty, a PE with 20 years' experience in industry, and a professor from the University's organizational behavior program in the department of psychology who represents professionalism and knowledge in fields outside of engineering needed in professional practice. The workshop covers the topics of professionalism, ethics, cohort norms, self-awareness, and communication. Self-awareness is developed by applying two different assessment instruments selected based on their acceptance and effectiveness in industry practice in developing high-performance teams. The Myers-Briggs Type Indicator (MBTI) and the *StrengthsFinder 2.0*[9] are administered to admitted students prior to the start of classes and the results collected and disseminated to the cohort during the cohort workshop. The results from these instruments are reinforced through continued use throughout the 5-semester program. One of the purposes of this paper is to collect and review the results of these instruments to investigate the student population to inform future research efforts. Therefore, the following results will summarize the general characteristics of the sample utilized in the evaluation of the success of the leadership development efforts by summarizing first the personality and strengths assessments, followed by the analysis of feedback from students regarding the usefulness of the activities and their individual perceptions of competence.

The MBTI is ubiquitous in industry for its varied organizational benefits. This self-reported assessment tool is currently among the most popular and widely used personality instruments in a variety of industries, primarily for personnel development purposes. The MBTI can examine communication processes, functional roles of group members, group dynamics and leadership and authority patterns[4]. The MBTI assessment is designed to assess individual differences and basic preferences. Specifically, through a series of items it assesses where people focus their attention, how they prefer to make decisions, how they process information and whether they prefer to plan their decisions[5]. Individuals are placed into one of 16 personality categories, which are represented by a four-letter combination. These categories are derived from four main groups, each with opposing personality preferences: extraversion (E) or introversion (I), sensing (S) or intuition (N), thinking (T) or feeling (F) and judging (J) or perceiving (P) [5]. Regardless of the results of the assessment, the MBTI provides individuals with an opportunity to identify strengths and preferences within themselves and within others to work more effectively. The usefulness of the MBTI is in its ability to allow individuals to become more knowledgeable of their psychological preferences[6]. Gaining self-knowledge enables individuals to look at themselves in relation to others, to their work, and to their overall environment[7].

The Program's pragmatic underpinnings support the application of any problem solution technique that can be proven effective. While the MBTI's use is ubiquitous in industry and education, its application, dominance, and success for its devotees is controversial. Therefore, the program's developers determined that application of more than one personality assessment was warranted. While Smalley animal personality test, Keirsey Temperaments, Emotional Intelligence, and Big Five personality tests have been suggested, there is a limit to the amount of self-assessment undergraduate engineering students are willing to undergo. So, only two significantly different assessments were desired. Because of its acceptance as a leadership tool in industry and the success the program developers has in creating the program administration as a "strengths-based organization", the program chose to apply the Gallop organization's

StrengthsFinder. Similar to the MBTI, StrengthsFinder talent results can be used as a scaffold for identifying differences in preferences and behaviors, as a means of supporting teamwork, avoiding conflict and obviating stereotype threat.

The StrengthsFinder 2.0[9] instrument has been used in executive development programs, for personal development, and as tool in developing high-performance teams in aerospace, education, finance, and other enterprises since its publication in 1998. The instrument examines 177 item pairs rated by the respondent on a continuum scale. Time taken to respond factors into responses. The development of scoring is proprietary to the Gallup Organization[10]. The purpose of the themes is to identify innate talents that, through the acquisition of knowledge and the development of skills, can be turned into reliable strengths. The 34 talents can be grouped into performance categories that are considered necessary to leadership in the workplace[11]. As with other personality assessments, The Clifton Strengths Finder has its detractors. The proprietary nature of the assessment and distortion effects due to the number of items[8] detract from general acceptance of the results. However, as a pragmatic tool for discussing differences between individuals that are not apparent by observation, the assessment is effective for the program.

Knowledge obtained from the personality assessments like the MBTI can provide individuals with greater insight into their energy sources, information gathering, decision-making and personal lifestyle[6]. Information from the MBTI provides individuals with a better understanding about general areas of life, or careers, in which they are more likely to be interested, motivated and successful[12]. For instance, McCaulley[13] asserts individuals are more likely to choose career paths in line with interests and judgments. Other benefits of the MBTI may include improved communication and time management skills, greater flexibility to handle change, and a better understanding of conflict and how to deal with it effectively[5]. The MBTI has even been shown to be an indicator of the level of persistence an individual exerts towards tasks[12].

One of the most extensive uses for the MBTI within an organizational context is team building[15]. The assessment provides greater insight to how individual personalities influence overall team functioning and outcomes. If teams can identify individual differences and strengths among members, it can help reduce conflict by reframing potential sources of misunderstanding[15]. Organizations may administer the MBTI to teams to provide members with feedback in regards to how each team member is more alike or different from one another[14]. By providing team members with a better understanding of each other, team members can learn to appreciate how those differences can be used as a source of strength within the team. Diversity in perceptual preferences and cognitive orientations may lead to increased overall team performance by avoiding perceptual errors[16]. Information from the MBTI would allow individuals to structure teams with an equal representation of personality types to improve teams' functional success. Knowledge of team member personality types helps to better understand member behavior and manage team dynamics[17]. Ultimately, the MBTI can be used to help facilitate the development of more productive and cohesive teams through the appreciation of individual differences[18]. However, the current program does not use the MBTI results exclusively in creating seniors design teams.

The usefulness of MBTI categorization in the current program stems from students being exposed to this popular industry standard to increase their educational experience and outcomes. As almost every career readiness study and collegiate accreditation report now views competencies including teamwork, as imperative to educational preparedness. Workshops included in personality and strength identifications develop skills represented in at least half of the career readiness competencies as defined by the National Association of College and Employees[19] (i.e., Oral Communication, Teamwork, and Leadership). It is expected these activities should then directly relate to academic and career success.

Applying the MBTI and StrengthsFinder™ assessments begs the questions of whether the students display any subset of results relative to the general population, which represented our first major assessment question. The StrengthsFinder™ talents can be used as scaffolding framework to obviate stereotype threat and develop group organizational strategies leading to high team performance in a mechanical engineering senior design experience class. Further, we sought to identify whether using the MBTI as a framework for communicating and relating group differences in a mechanical engineering senior design experience class could help students develop recognized leadership behaviors such as teamwork and communications skills. The purpose of this paper is to present the data gathered during the first five years of program to investigate the effectives of the cohort workshop and using self-assessments as tools for developing leadership in engineering students.

Methodology and Results

The program uses the MBTI form M Self-Scoring College Edition instrument from CPP, Inc implemented by a certified MBTI professional. Students take the assessment during cohort workshop and are presented with a general overview of the instrument's development along with some anecdotal discussion of types. There are two issues to address when using a tool as pervasive as the MBTI with undergraduate engineering students: misconceptions and prejudices. One issue is recognizing that the students may come into the desired experience with misconceptions or prior experience with the assessment. Self-help websites like SimilarMinds.com make Jungian type assessments similar to the MBTI available to anyone with internet access at no cost. Career counselors, learning behaviorists, organizational psychologists, and many other people apply the MBTI as a routine part of their practice. Misconceptions can be corrected by maintaining the consistency of purpose for the educational experience. The program uses the MBTI for two reasons. The primary reason is to help create a scaffold or framework for discussing personal preferences and communication behaviors without triggering stereotype threat. The second reason for using MBTI is to introduce students to its proper use and limitations because it is highly likely they will see it again in their careers. Experience with web-based assessment that implies career preferences based on MBTI-like results has shaken student confidence near to graduation[20].

The MBTI Personality Tool

Table 1 shows sets of MBTI results for 70 program students from 2010 to 2016. The table is structured, as typical for MBTI tables, with the 16 grouping of the four dichotomies

arranged in a grid by first and last letter attitude, or orientation grouping, top to bottom and functional pair, the middle two letters, left to right. The table represents several sets of information. The information is intended to investigate the question of whether the program data is within family for the general populations or if it fits with other published observations. The first entry in each grid is the four-letter personality type identified by the MBTI assessment. The second value is the range of general population exhibiting that personality type. These values are reported on Wikipedia[21] and attributed to the Myers-Briggs Foundation website[22]. The third and fourth values are the raw numbers and percent population for the program. Values from two categories of students from another study on university students are also provided for comparison. The comparison set of literature data is from 6280 undergraduate students and 368 hard science and engineering students at Elon University in North Carolina over a 9-year period from 1998 to 2007[23]. The Keirsey Temperament label[24] is also included.

Analyzing the results is difficult without data on statistics of the comparison data. And the 70 data points in this study cannot be generalized to a general student or engineering populations. The Myers and Briggs Foundation indicates that the NT trait functional group is associated with engineering and technical work[25]. While that trend appears to be similar in the local engineering student population, 84% of the AVEP student population exhibits solely the "thinking" characteristic. The "thinking" decision basis characteristic is expected at a maximum of 47% in the broader population. However, the NT functional grouping is seen at only 36% within the student population while the ST grouping, associated with practical careers like business and the military, appears at 48%. The SF, associated with teaching, health care, and personal services, and NF functional pairs appear in 7% and 9% of the AVEP student propulsion, respectively. The ISTJ personality type is represented at 33% among the program when it is expected at no more than 14% in the general population. Only the ISFP personality type is not represented in the program population when it is assessed at 5 to 9 % in the general population. Both the current our study and the comparison literature sources have all the personality types represented among engineering and technical students, unlike the implication forwarded by the Myers and Briggs Foundation website.

While Introverts and extraverts are evenly represented in the general population, 67% of the program students are introverted. Cohort 1 had only one of its ten students assessed as extraverted. While only 36% of the program students assess with the NT function pair, 84% of the program are T types, driven to make decisions through technical data, rather than through emotional response, 56% greater than expected in the general population. The other single letter results are within the ranges of what to expect from the general population.

Table 1 MBTI personality assessment results for the current sample

	Sensing Types		Intuitive Types		
MBTI Result	**ISTJ**	**ISFJ**	**INFJ**	**INTJ**	Introverts
% in General Population	11-14%	9-14%	1-3%	2-5%	
Keirsey Temperament	Inspector	Protector	Counselor	Mastermind	
Number AVEP students	23	2	1	8	
% in AVEP population	**32.9**	**2.9**	**1.4**	**11.4**	
Elon General student	6.6	6.5	2.5	1.5	
Elon hard science	10.9	7.5	4.4	3.9	
MBTI Result	**ISTP**	**ISFP**	**INFP**	**INTP**	
% in General Population	4-6%	5-9%	4-5%	3-5%	
Keirsey Temperament	Crafter	Composer	Healer	Architect	
Number AVEP students	3	0	3	7	
% in AVEP population	**4.3**	**0.0**	**4.3**	**10.0**	
Elon General student	3.6	3.6	4.8	2.7	
Elon hard science	7.8	3.9	3.9	5.2	
MBTI Result	**ESTP**	**ESFP**	**ENFP**	**ENTP**	Extroverts
% in General Population	4-5%	4-9%	6-8%	2-5%	
Keirsey Temperament	Promoter	Performer	Champion	Inventor	
Number AVEP students	3	1	1	2	
% in AVEP population	**4.3**	**1.4**	**1.4**	**2.9**	
Elon General student	6.6	8.3	15.4	7.2	
Elon hard science	3.1	3.3	3.2	3.2	
MBTI Result	**ESTJ**	**ESFJ**	**ENFJ**	**ENTJ**	
% in General Population	8-12%	9-13%	2-5%	2-5%	
Keirsey Temperament	Supervisor	Provider	Teacher	Field Marshal	
Number AVEP students	5	2	1	8	
% in AVEP population	**7.1**	**2.9**	**1.4**	**11.4**	
Elon General student	9.2	11.9	6.5	2.8	
Elon hard science	3.1	3.4	3.3	3.3	

The StrengthsFinder™ Tool for Professional Development

As of this writing, data for 107 AVEP students has been collected for the six cohorts that have been enrolled in the program. The results have been sufficiently positive to stimulate research interest beyond that which the Gallup Organization may have envisioned. The first concern addressed resulted from the small population of AVEP student respondents, which is composed entirely of transfer students in Mechanical and Electrical Engineering majors. The effort focused on determining if this small (107 samples), possibly unique, population was significantly different from a large general population. Global strengths frequency data from 2013[26] for 8,648,767 respondents was found and is identified as Gallup Data in Table 2. The themes are grouped according to four leadership quadrants[11] thus providing an additional opportunity to identify significant differences.

Table 2: Strengths Finder 2.0 Talents in the current sample

Executing					**Influencing**				
Gallup Data			**AVEP Data**		**Gallup Data**			**AVEP Data**	
Achiever	2727101	32%	39	36%	Activator	891557	10%	5	5%
Arranger	1200009	14%	6	6%	Command	416971	5%	7	7%
Belief	988026	11%	9	8%	Communication	1117881	13%	10	9%
Consistency	945318	11%	15	14%	Competition	940947	11%	20	19%
Deliberative	914366	11%	21	20%	Maximizer	1383488	16%	12	11%
Discipline	576140	7%	5	5%	Self-Assurance	458361	5%	7	7%
Focus	1008332	12%	14	13%	Significance	551990	6%	8	7%
Responsibility	2485170	29%	27	25%	Woo	1122719	13%	5	5%
Restorative	1369954	16%	18	17%					
Category Total	12214416	28%	154	29%	Category Total	6883914	16%	74	14%
Relationship Building					**Strategic Thinking**				
Gallup Data			**AVEP Data**		**Gallup Data**			**AVEP Data**	
Adaptability	1488933	17%	15	14%	Analytical	1033470	12%	36	34%
Developer	1308294	15%	5	5%	Context	755097	9%	9	8%
Connectedness	1049037	12%	9	8%	Futuristic	949322	11%	22	21%
Empathy	1557007	18%	1	1%	Ideation	1183739	14%	21	20%
Harmony	1663252	19%	18	17%	Input	1751998	20%	18	17%
Includer	1023751	12%	15	14%	Intellection	1017291	12%	20	19%
Individualization	1166626	13%	13	12%	Learner	2458134	28%	53	50%
Positivity	1340062	15%	7	7%	Strategic	1974885	23%	22	21%
Relator	2424607	28%	23	21%					
Category Total	13021569	30%	106	20%	Category Total	11123936	26%	201	38%

In the general population, talents in the Influencing category appear the least frequently at only 16% of the population, where Relationship Building talents appear at 30%. In the AVEP population, Relationship Building talents appear at a rate of 20%. Talents in the Strategic Thinking category appear at 38% in the AVEP population while they appear at 26% in the general population. Differences in specific talents are more easily recognized in the graphical presentation for each leadership quadrant shown in the following four charts.

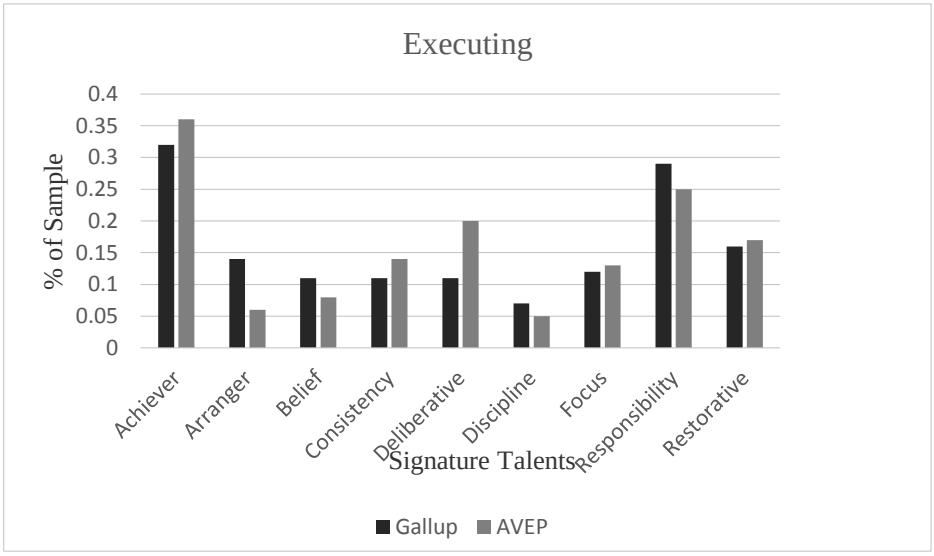

Chart 1: Strength Finder talents in the Executing group

Chart 1 illustrates that the student population appears to show similar trends to the general population for talents in the execution grouping. All the talents in this group exist in the programs' student population and at rates similar to those seen in the greater population.

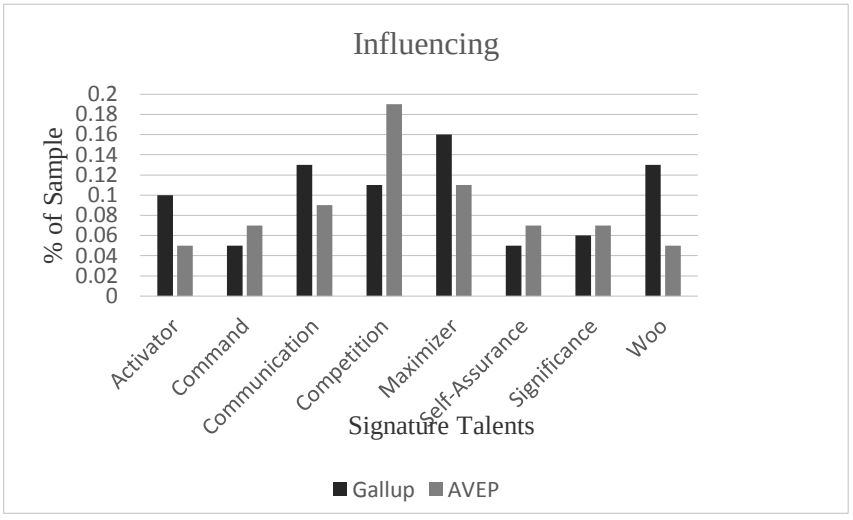

Chart 2: Strength Finder talents in the Influencing group

Except for the WOO (Winning Over Others) talent, the student population appears to show similar trends to the general population for talents in the influencing talent grouping. While WOO appears at a rate of only 5% in the student population, it appears at a rate of 13% in the general population. However, this difference is not significant, per statistical analysis of the data. It is interesting to note that all of the students exhibiting WOO talent also exhibit extroversion in the MBTI results.

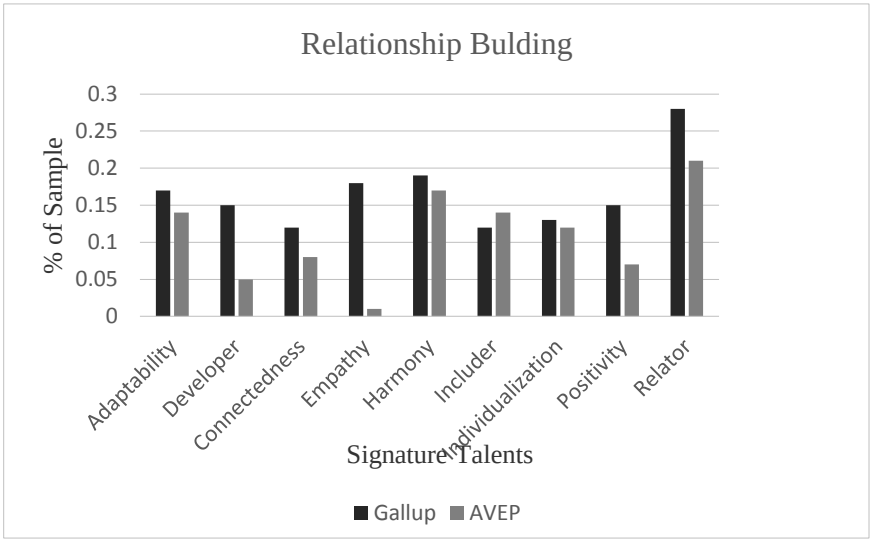

Chart 3: Strength Finder talents in the Relationship Building group

The Programs' student population displays talents in the relationship building grouping at a rate 10 percentage points lower than displayed in the general population. This difference is significant according to a two sample T test used to compare the sample means. NCSS[27] was used to accomplish the analysis of the data in each of the leadership quadrants and for the total population. The only talent whose appearance is significantly different from its occurrence in the general talent resides in this grouping: the empathy talent. The Empathy talent, appears at a rate 180% lower in this engineering student population than in the general population. All talents, except the Includer talent, in this grouping occur less frequently in the student population than in the general population.

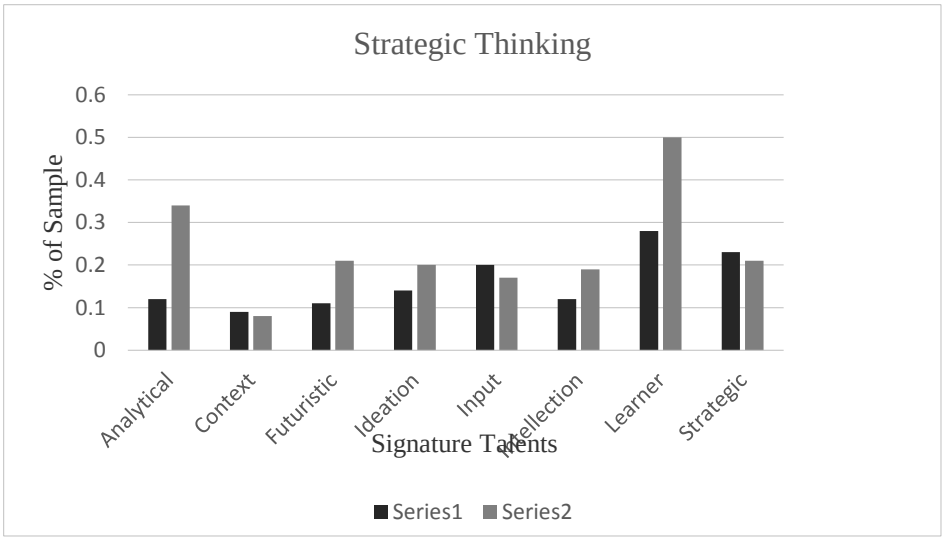

Chart 4: Strength Finder talents in the Strategic Thinking group

Chart 4 displays the talent results for the Strategic Thinking talents. While the student group exhibits talents in this group at a higher rate than the general population, this difference is not significant per a two sample T test on NCSS. The Leaners and Analytical talents are exhibited at rates 22 percentage points greater than in the general population.

It is also interesting to note that three students, one each from cohorts one, two, and three refused to take the StrengthsFinder assessment throughout their programs. Each failed at least one class and, for that reason, did not graduate with their initial cohort. Two of them were set back two cohorts. Not all the students who did not graduate with their initial cohort refused to take the assessments, but all who refused did step back a cohort. Two students, one from cohort 3 and one from cohort 5, were vocal during the cohort orientation in expressing distain for personality assessment in general and incredulity at the requirement to be assessed for an engineering program. These two vocal students participated in the assessments and sharing of assessment results despite their well-argued philosophical objections and both stayed with their initial cohorts.

Consistent data collection for the Programs needs to continue as new cohorts are enrolled each fall. On one hand, the acceptance of significant difference for the Relationship Building Leadership Quadrant may only be a result of an insufficient sample. On the other hand, additional data may continue to produce similar test results. The incidence of reported empathy talent bears attention to determine if this is actually a characteristic of individuals who select Mechanical or Electrical Engineering as a degree objective.

Results of Cohort Workshop

To investigate the effectiveness of the cohort workshop, drive the leadership exercises to conclusion, and help the students think reflexively about their experience, a survey is conducted at the end of the cohort workshop. Specific items assessing students' attitudes and perceptions in regards to the efficacy and success of the program are addressed. Each item represents a unique

dimension, or learning objective, where positive gains indicate improvements prior to and after participation in the program. Results indicated positive, statistical change in four out of six intended dimensions: students' confidence, self-awareness, and ability to recognize their strengths and weaknesses were all significant, as was the students' perception of the success of the program. Analysis of the remaining two dimensions, students' preparedness to work in teams and student's ability to perceive the value in cooperation for group success, also indicated improvement in the intended direction. These results reflect an all-around improvement in students' perceptions of their own competence.

The cohort workshop survey results from cohort 6, admitted in Fall 2016, are typical of the results from other cohorts. A total of 31 new students were utilized as respondents, but due to missing data four were eliminated from the analyses. Therefore, the sample of this report consists of 27 engineering students who were new to the engineering degree completion program. These students were asked to indicate the extent to which they agreed with six items on a 5-point Likert-Type Scale that ranged from (1) strongly disagree to (5) strongly agree. Each of the items below were asked in a confidential and anonymous fashion pre and post the orientation program, where higher scores indicate more positive results.

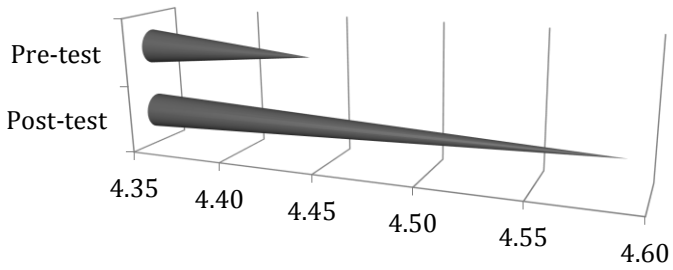

Chart 5: I feel confident moving forward in this program.

The students responded positively to the question assessing confidence, or self-efficacy, in regard to progressing in the engineering program after participating in the orientation. While the initial confidence scores were high ($M = 4.44$, $SD = .892$), they did increase significantly by the end of the day [$M = 4.59$, $SD = .844$, $t(26) = -2.126$, $p = .043$]. This change indicates that the students felt more confident in their abilities to move forward and find success in the program. Possessing a high level of confidence and self-efficacy towards tasks is very beneficial to students, and can contribute to their future academic and professional success.

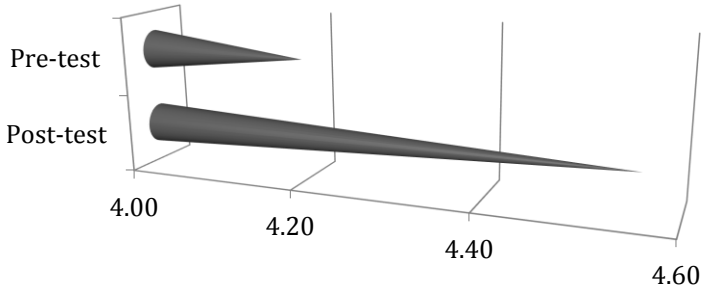

Chart 6: I know myself better as a result of today.

The students also responded positively to the question assessing self-awareness. Initial ratings of self-awareness (M = 4.19, SD = 1.00) increased significantly by end of day [M = 4.56, SD = .974, t(26) = -3.06, p = .005]. These findings suggest that as a result of participation in the orientation, students could better recognize elements of their internal selves. By gaining such an understanding, students are better able to interact in teams and the world around them.

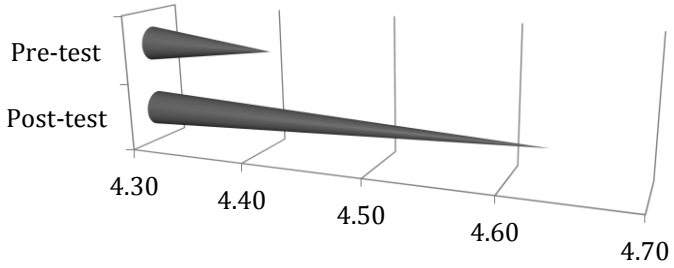

Chart 7: I feel prepared to interact with others on team projects.

In regards to self-perception of preparedness for teamwork, initial ratings (M = 4.41, SD = .888) increased with a trend toward statistical significance by end of day [M = 4.63, SD = .884, t(26) = -2.00, p = .056]. It is possible that with a larger sample size, this increase may have reached statistical significance. Regardless, this change indicates the majority of students felt more prepared to interact with others on team projects, or succeed in a team-based environment at the end of the program. Like self-efficacy, team-efficacy is a key ingredient in team and individual success, and an important outcome of the orientation.

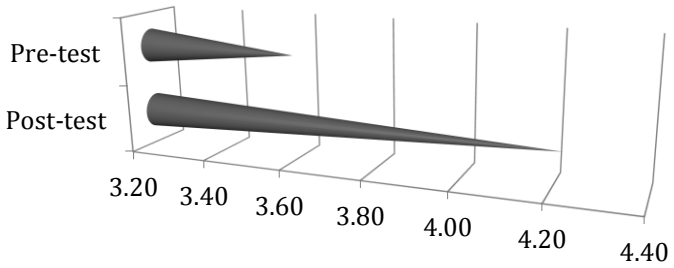

Chart 8: I can identify my strengths and weaknesses.

In regards to self-identification of strengths and weaknesses, initial ratings (M = 3.59, SD = 1.083) increased significantly by end of day [M = 4.22, SD = .892, t(26) = -3.90, p = .001]. This was the largest increase in ratings across all items, suggesting the program had a large impact on student's abilities to identify their strengths and weaknesses. This ability is incredibly useful for students as it allows them to determine where they will best succeed, and what areas they may need to seek out help in.

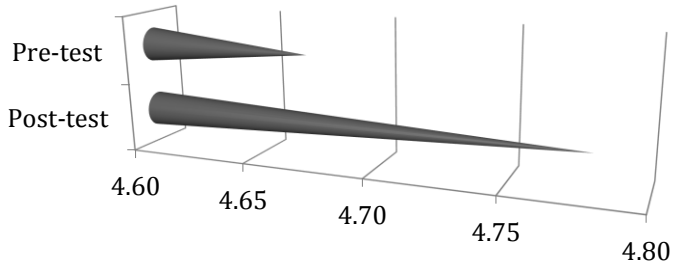

Chart 9: I can see more clearly how cooperation might affect group success.

Students initially responded very positively to the question assessing whether students could see the value in cooperation for group success (M = 4.67, SD = .832). In examining descriptive statistics there was a small increase in these ratings by end of day (M = 4.78, SD = .847), however, this change did not result in statistical significance [t(26) = -1.363, p = .185). This may be due to the unusually high rating students provided at the start of the program. This indicates that participants were already able to recognize that working together and having cooperative goals helped to promote individual and group success, and reflected understanding of the importance of this program.

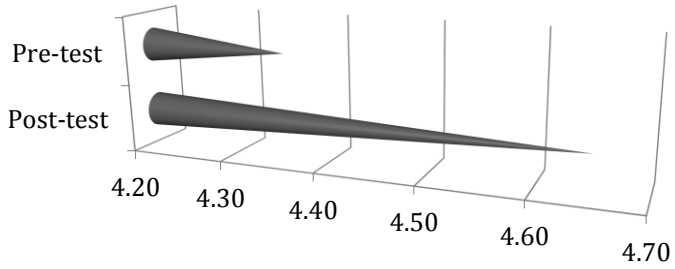

Chart 10: Today was an overall success.

Finally, the question asking whether students thought the day was a success overall demonstrated very positive results, with an initial ratings (M = 4.35, SD = .977) increasing significantly [M = 4.65, SD = .846, t(26) = -2.309, p = .029]. This change indicates that students acknowledged the importance of the program and understand that the knowledge and skills they learned will lead them to future success in their coursework and future careers. This item also indicates that the respondents perceived the orientation as being an overall success and meeting its proposed goals.

Across all dimensions, students showed improvement in the intended direction. Statistically significant positive change was observed across the majority of dimensions measured, with only two dimensions failing to reach significance. Of the two, one dimension was trending towards statistical significance ($p = .056$). These results were obtained despite the high initial ratings provided by participants. Gains in the students' confidence, self-awareness, and ability to recognize their strengths and weaknesses were all significant, as was the students' perception of the success of the program. This speaks to the importance of the orientation in increasing students' abilities and preparing them for their futures. This also suggests that the students themselves recognize the importance of the orientation as a tool to help them succeed.

As the primary goal of the orientation was to create a supportive environment for the remote program, these results are encouraging, especially for group and team-based endeavors. The two dimensions that failed to reach statistical significance were students' preparedness to work in teams, and student's ability to perceive the value in cooperation for group success. The first of these, preparedness to work in teams, marginally missed reaching statistical significance ($p = .056$). This may be due to the relatively small sample size of 26 students. Regardless, based on this finding, it is suggested that more emphasis be placed on pushing the students' out of their comfort zones and increasing team interaction within the orientation. As the ability to work successfully in a team is a skill organizations increasing look for in their engineers, it is paramount that more team exercises be incorporated in future incantations of the orientation. This will better prepare students for success when they look for employment following completion of their schooling. The second dimension that failed to reach significance was students' ability to perceive the value in cooperation for group success. One possible explanation for this is the unusually high initial ratings students provided, suggesting that a sense of importance in cooperation was already instilled in this particular sample even before the start of the orientation. The students' perceptions were also garnered by open-ended questions. The students' answers generally emphasized that they were most excited about working in groups and networking with other individuals. They were mostly concerned about time management, cost of the orientation, and specific skills in their programs, such as math.

To date, the Programs have enabled the awarding of 41 BS degrees in Mechanical Engineering and 24 in Electrical Engineering. While the persistence rate of transfer students in engineering is about 60% on the main campus, retention rate for the Programs is 98.7%. 83% of the mechanical engineering students graduated after 2.5 years and 17% after 3.5 years. 92% of the Electrical Engineering admissions graduated after 2.5 years and 8% after 3.5 years. The graduation rate after 4 years for main campus transfer students into engineering was 56% in 2015 and 60% in 2016. The employment rate of graduates within three months of their December graduation is 98%. Only one graduate is not employed in an engineering position. Many graduates are enrolled in graduate programs with one individual from cohort 1 winning and NSF fellowship and passing his comprehensive examinations for doctoral level work. Data collection is just beginning on program alumni. Anecdotal evidence and reports from individuals indicate some program graduates are advancing rapidly in their chosen professions while several who were employed at graduation have either changed jobs or become unemployed. One student has returned to the local area from non-military employment overseas. At least one has been promoted to a position out of the local area. None of the programs' graduates have chosen uniformed military service despite the local Air Force influence. At least six graduates are now

civilian employees of the federal government with either NASA or the Air Force. The Programs are currently developing an organized alumni survey assessing long-term program success.

Conclusions and Future Research Directions

The results of the above described efforts to inculcate leadership development into an engineering program seem encouraging for similar programs, and engineering education in general. One of the questions considered in the design phase of the cohort workshop was whether the engineering student population displayed any noticeable personality traits distinct from the general population. The transfer student population is small for this cohort-based, extension degree completion program in mechanical and electrical engineering, but the students included do not appear to be significantly different from the general population according to either the MBTI or StrengthsFinder, with the exception of the empathy talent. Some differences can be noted like a slight tendency toward introversion among the students and a strong tendency toward data-driven decision making according to the MBTI results. The personality assessments were utilized primarily as leadership development tools aimed at increasing communication and collaboration among students. These efforts, at least in terms of student perceptions from the orientation where most activities occurred, were successful in terms of overall levels of satisfaction and increases in satisfaction and confidence in participants from start to finish.

Applying these instruments during the cohort workshop appears to be successful in helping the students develop confidence both in interpersonal communication and completing the program, according to the survey results from the workshop. The Program, because of its small size and structured organization, provides a well-defined student population for studying the effectiveness of leadership interventions in engineering education. The Programs were originally established to impart leadership and teamwork skills in its students through a cohort workshop which applies to teamwork and leadership self-assessments common in industry. The MBTI instrument and Clifton StrengthsFinder™ are used to scaffold discussions of diversity and personal preference in high performance teams. Although long-term gains are largely unknown, the graduation rate and employment statistics for the program are impressive, near 100% on both accounts. Further, all the metrics of the success at the orientation illustrate positive responses from students. Finally, preliminary qualitative analysis of the student work and teamwork seem promising. However, the small size of samples of students and lack of a well-defined comparison population makes generalization of conclusions difficult.

There are three directions envisioned for future research. The first direction investigates efficacy of different interventions within the program itself. Active learning strategies, project-based learning, and a high percentage of instructors with significant industry experience have been discussed as contributing to developing leadership skills in the students. Future research needs to investigate these contributions. A second research direction would compare the transfer-only upper-division program students against results for native students in a four-year program. The question of whether the current results are generalizable to a larger engineering student population needs to be studied. The larger challenge of developing a consistent assessment of leadership skills desired by the programs' industry partners presents a third direction for future research. Because many of the program's graduates are employed by industry partners local to

the programs, the ability to conduct longer term longitudinal studies of graduate's success is significant.

Therefore, in future iterations of the program system evaluations of student performance and long term alumni data gathering, it is imperative to analyze the utility of leadership development in engineering education. First, not only must student affective reactions to the team building and personality assessments be collected, but trained raters of student deliverables should evaluate the quality of student work based on some comparison or referent point. Collaborations with courses where students were not exposed to leadership development would be ideal. Additionally, students who have graduated and moved into industry should be surveyed for their perceptions of the most beneficial aspects of the program, as well as looking to see whether their experiences in the program resulted in higher pay or better employment outcomes. Although different levels of leadership development exist, and are able to be accomplished based on variations in program funding, the types of activities and results demonstrated here speak to the usefulness of incorporating such tools for student success.

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