AC 2011-2417: ASSESSING THE ENTREPRENEURIAL MINDSET WITHIN ENGINEERING PROGRAMS

Cynthia C. Fry, Baylor University

Sr. Lecturer of Computer Science, Assistant Dean of the School of Engineering & Computer Science

David Pistrui, Acumen Dynamics, LLC

David Pistrui, Ph.D., serves as the Managing Director of Acumen Dynamics, LLC, a strategy-based education, training, and research firm that focuses on practical knowledge and skills that help organizations align vision and strategy with execution and performance. Working as an independent scholar, thought leader and advisor to corporations, family foundations, academic institutions, government agencies and global think tanks Dr. Pistrui's activities include strategy development, business succession, assessment modeling, technology transfer, executive education and social science research. This includes programs and activities in the United States, Europe, the Middle East and Asia.

Dr. Pistrui has held several scholarly appointments in the US and Europe, including the Coleman Foundation Chair in Entrepreneurship at the Illinois Institute of Technology, Chicago. He served as the founding Managing Director of the Wharton Enterprising Families Initiative at the Wharton School of the University of Pennsylvania. In addition, Dr. Pistrui held the Raymond Chair in Family Business and served as the Founding Director of the Center for Family Business and Entrepreneurial Leadership at Alfred University.

Dr. Pistrui is an active researcher focusing on the growth and societal impact of entrepreneurship, family business, and enterprise development. He is the co-author of groundbreaking work including Growth Intentions and Expansion Plans of New Entrepreneurs in the Former Soviet Bloc, (Ashgate, 1997), Family and cultural forces shaping entrepreneurship and SME development in China, (Elgar, 2006), New Venture Financing: An Empirical Investigation of Chinese Entrepreneurs, (Cambridge, 2009), and Family and Cultural Factors Impacting Entrepreneurship in War Time Lebanon, (Interscience, 2010).

Dr. Pistrui serves on the editorial boards of the Journal of Developmental Entrepreneurship, and the Journal of Engineering Entrepreneurship. He is also currently serving as a Special Issue Guest Editor of the International Journal of Entrepreneurship and Innovation Management.

Dr. Pistrui is a member of the Kern Family Foundation's Kern Entrepreneurship Education Network Advisory Board. In 2009 he was appointed as a Senior Fellow at the Austrian Economics Center in Vienna. He is also an honorary board member of the American Southeast Europe Chamber of Commerce. Dr. Pistrui served on the Board of Directors, Executive Committee, and was Vice President, of the Family Firm Institute (Boston, MA, 1998-2001). He served as Program Chair for the Family Firm Institute 2000 Annual Conference (Washington, DC).

Dr. Pistrui appears frequently on TV and radio programs. He often provides commentary to business publications and has appeared in Crains' Chicago Business, Family Business, MEED, CNN, CNBC INC. Magazine, Entrepreneur, Los Angeles Business Journal, Chicago Tribune, Bahrain Tribune, Alwasat, Gulf Business, Gulf News, Khaleej Times, Profil, Format, Der Standard, Die Presse, Wirtschaft Blatt and Ekonmist and many other news and media outlets.

Dr. Pistrui holds a Ph.D. in Business Administration (Cum Laude) in Entrepreneurship, Strategy, and Management from Universitat Autonoma de Barcelona, Spain, and a Ph.D., in Sociology from the University of Bucharest, Romania. He earned a Master of Arts in Liberal Studies degree from DePaul University (Chicago) and a Bachelor of Business Administration in Marketing and Economics from Western Michigan University.

Assessing the Entrepreneurial Mindset within Engineering Programs Across the Kern Entrepreneurship Education Network (KEEN)

Abstract

In the last sixty years, engineering education has emphasized the theory deemed necessary to be a valuable and successful engineer. This shift, in the very dense engineering degree plans, has precluded, in many instances, the opportunity for creativity and hands-on innovation in the classroom. One of the stated goals of the Summit Series on the Grand Challenges of the National Academy of Engineering is to "enhance student interest in engineering, science, and technology entrepreneurship." Of particular interest to engineering programs trying to integrate the entrepreneurial mindset – a combination of technical skills, business savvy, team building and team management, and high-integrity leadership – is how to assess the methods by which we measure our success in these programs. There is a great deal of literature describing the various methods used and their levels of success.

In a network of twenty schools across the nation, a combination of three well-known and vetted assessments is being conducted in the hopes of being able to determine the effectiveness of the assessment in measuring our abilities to teach and integrate the entrepreneurial mindset into our degree plans. This paper will document the selection of the assessment instrument, its deployment, and an initial analysis of the results in how they impact retention, professional development, and the entrepreneurial mindset of the students at these institutions.

Introduction

In many engineering programs in the United States and around the world, it is no longer sufficient to adequately train engineers with excellent left-brain skills – analysis, logical thinking, and quantitative thought. According to Dean Julio M. Ottino of the Robert R. McCormick School of Engineering and Applied Science at Northwestern University, solving problems is not enough. He states, "There is no prize for solving correctly what may turn out to be the incorrect problem. It is important to acquire the skills to solve the correct problem behind the perceived problem, and this entails more than left-brain thinking alone."[1] In fact, these right-brain skills, which include competitive differentiation, business adaptability, innovation and the development of a growth culture, and strategic thinking, are the "key competencies required to differentiate business in the next two to five years." [2]

As engineering programs strive to meet the challenge of "Educating the Engineer of 2020", we must acknowledge that the next several decades will offer more opportunities for engineers, and as educators, we must make a shift in our thinking. Instead of permitting engineering education to lag technology and society, "Should the engineering profession anticipate needed advances and prepare for a future where it will provide more benefit to humankind?"[3]

So the question becomes, how do we train engineers to be more entrepreneurially minded?

What is an Entrepreneurially Minded Engineer?

According to Dawn Tabat, Chief Operating Officer of Generac Power Systems (and a group of the company's engineering executives), Entrepreneurially Minded Engineers (EMEs) "act like a product manager within their engineering discipline". In other words, "EMEs are not just working on what someone is asking for, but really are defining what the problem is that their firm should be solving."[4]

EMEs are the drivers of U.S. innovation and competitiveness and are unique and distinctive.[5] EMEs have not necessarily started a new business (although they may have), they are, most often, working in established small and medium sized firms, many work in Fortune 1000 firms.[6] EMEs possess an entrepreneurial mindset centered on opportunity orientation. They are scanning the horizon searching to identify opportunities to define and solve real world problems. They view technology as an enabler used to create value to customers in the marketplace.

EMEs are a unique group of people. According to the Generac executive team "EMEs are concerned about the value that their design or project brings to serving their customer." Accordingly, "the EME demonstrates their value to the organization because they understand the business and what is required to serve, support or push forward the corporate agenda." According to Tabat, "the EME wants to make sure they are defining the problem or situation correctly and then providing the project leadership to push the development to the point of use." [7]

Characteristics of Entrepreneurially Minded Engineers[8]

1. **Opportunity Orientation** – searching to identify and solve real world problems that improve people's lives through value creation
2. **Technical Empowerment** – view technology as an enabler used to solve problems and create value for customers in a dynamic and changing global marketplace
3. **Business Fundamentals** – understanding the business and industry the firm is in and support the advancement of the corporate agenda
4. **Interpersonal Dynamics** - clear understanding of given situations and providing projects with leadership and teamwork through good communication
5. **Forward Thinking** – intellectual and personal curiosity in the form of looking for "what's next" and effectively and economically applying new methods

Overview of the KEEN-TTI Performance DNA Assessment Tool

Currently, the Kern Entrepreneurship Education Network (KEEN) in partnership with TTI Performance Systems, Ltd., are undertaking a national study to gain further insights into skills practicing EMEs possess, their behavioral characteristics, and the values that motivate them. The central objective of this undertaking is to help KEEN network schools develop innovative educational programs and measures to further support the development of a new class of young EMEs. Modeling, replicating and producing a new emergent class of young EMEs is imperative if the US is to sustain global competitiveness, freedom and quality of life.

KEEN - Developing a New Class of Entrepreneurially Minded Engineers

"The mission of KEEN is not to teach students how to start their own businesses, but to prepare them to think entrepreneurially, particularly more broadly and deeply about how their ideas fit

into the growth of the organizations with which they are involved." [9] Within this wisdom, KEEN is guided by the central objective to change engineering education in order to empower, encourage, and enable engineers to be active contributors to a free enterprise system, their companies and the communities in which they live and work. This new breed of engineers must be considered within a global context in terms of whom they will be helping and with whom they are competing.

The KEEN EME model is grounded in developing a new class of engineers through educational reform and new co-curricular and extra-curricular programs and experiences that infuse and blend the following core components associated with an engineering entrepreneurial mindset:

Technical Fundamentals - EMEs possess both an understanding of the scientific theory and the ability to apply this theory in creative and innovative ways through proof-of-concept designs, design verification, characterization, qualification, validation and standardization for long-term sustainability.

Customer Awareness – EMEs first think in terms of product benefits for the internal and external customers before they think in terms of design features. Thus, customer awareness is the focus of EMEs. They actively engage the market and know how to ask probing questions and, more importantly, how to actively listen.

Business Acumen – EMEs have the necessary business acumen to support the organization in which they work. This includes understanding the basics of financial management along with organizational management including cross-functional team effectiveness, interpersonal communication skills and conflict resolution.

Societal Values - EMEs value and help promulgate the free enterprise system. They promote high standards of engineering and business ethics. EME's also possess personal character attributes typical of entrepreneurs: intuition, integrity, tenacity, courage, and honesty. [10]

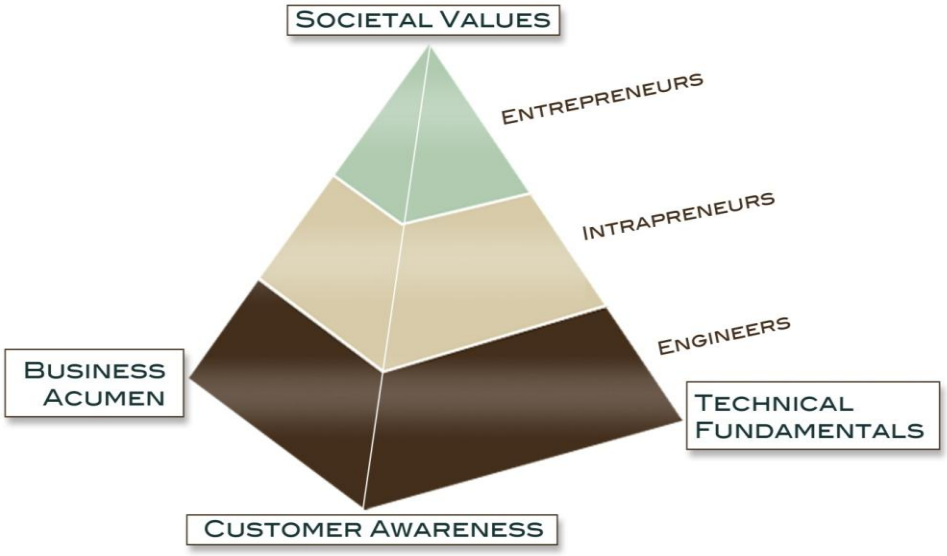


Figure 1, The KEEN Pyramid

Assessing the Impact of KEEN Programs on Engineering Education Reform
As the KEEN network develops new programs and undertakes engineering education reform both challenges and opportunities arise. One of the most important questions is how does the Kern Family Foundation (KFF) and KEEN assess and measure the impact of investments made in engineering education reform?

This question is most challenging because the vast majority of the skills, values and behaviors associated with an entrepreneurial mindset are new domain to engineering educators, and rooted in the social sciences. Terms like "acumen", "awareness" and "values" involve human behavior within environmental and cultural contexts unlike a controlled laboratory or "bench setting".

Moreover, EMEs combine their passion for science with an aptitude and capacity to develop and apply so called "soft skills" associated with personal and professional competencies and capabilities. These skills are primarily learned through human interaction and must be practiced outside of a classroom setting.

To address this question an assessment sub committee comprised of KEEN faculty, KFF staff and an outside firm, TTI Performance Systems, Ltd., (TTI) a world leader in personal and professional assessment were assembled to work on developing an assessment framework and methodologies.

In December 2009 the assessment subcommittee identified seven KEEN learning outcomes that students should be able to demonstrate based on their participation in KEEN programs.[11] The assessment subcommittee recommended that students encountering a KEEN program should be able to:

Seven KEEN Learning Outcomes

1. Effectively collaborate in a team setting
2. Apply critical & creative thinking to ambiguous problems
3. Construct & effectively communicate a customer "appropriate value proposition"
4. Persist through and learn from failure
5. Effectively manage projects through appropriate commercialization or final delivery process
6. Demonstrate voluntary social responsibility
7. Relate personal liberties and free enterprise to entrepreneurship

With this benchmark of seven learning outcomes established KEEN worked with TTI to develop specific methods and frameworks to measure: 1- student demonstration of the seven KEEN learning outcomes, 2 - retention of students in undergraduate engineering programs, and 3 – assessment of grantee outcomes.

KEEN – TTI Assessment Project and Performance DNA
Through the collaborative efforts of KEEN faculty, KFF staff and TTI executives a comprehensive assessment framework is being developed and implemented across the network.

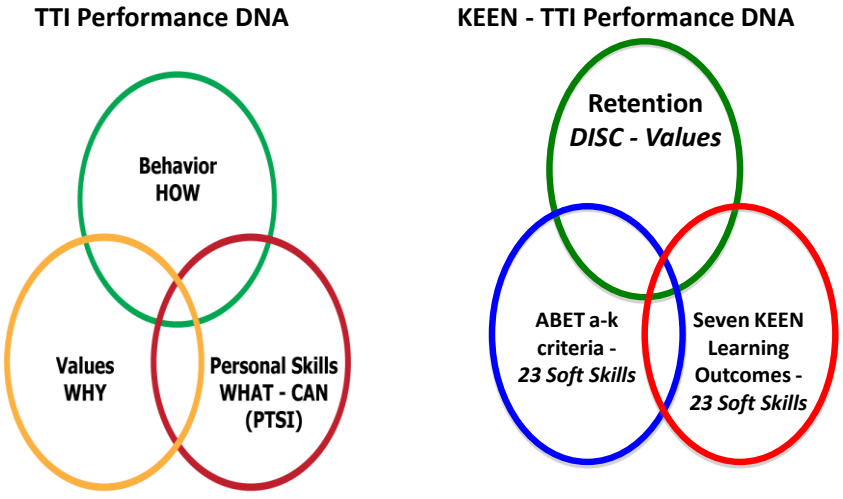
The following summary of events and activities encapsulates the strategy and tactics employed to conceive, build and launch the KEEN – TTI Performance DNA methodology and frameworks.

KEEN – TTI Assessment Project Milestones as of December 2010:

- Creation of the seven KEEN learning outcomes and rubrics
- Review of portfolio of TTI methodologies, frameworks, benchmarks and experience
- KEEN faculty pilot testing, TTI debriefings and faculty feedback loop
- Selection of the TTI Performance DNA methodology and Executive Coaching Report
- Meetings (Calvin – June 2010, Milwaukee – November 2010, LTU – November 2010)
- Set up of web based portal including e-learning modules, procedures and resources
- Mapping the seven KEEN learning outcomes and the 23 TTI DNA competencies
- Launch Fall 2010 – Winter 2011 KEEN – TTI Performance DNA Assessment Project
- Results as of 12/9/10 – 17/18 active KEEN schools participating in the program
- Working with TTI to develop benchmark of entrepreneurially minded engineers
- Assessment session scheduled with TTI at KEEN winter conference 1/6/11
- The Journal of Engineering Entrepreneurship will have a special issue on assessment

The TTI Performance DNA methodology was designed to increase the understanding of an individual's talents. The report provides insight to three distinct areas: competencies, behaviors and motivators. Understanding strengths and weaknesses in each of the three areas will lead to personal and professional development and a higher level of satisfaction.

The Complete Picture



Competencies

This area includes 23 key competencies and ranks them from top to bottom, defining person's major strengths. The skills at the top highlight well-developed capabilities and reveal where you are naturally most effective in focusing your time.

Behaviors
This section of the report is designed to help attain a greater knowledge of oneself as well as others. The ability to interact effectively with people may be the difference between success and failure in your work and personal life. Effective interaction starts with an accurate perception of oneself.

Motivations
This section of the report provides information on the why of one's actions, which with application and coaching, can tremendously impact your valuing of life. Once you know the motivations that drive your actions, you will immediately be able to understand the causes of conflict.

Using the KEEN – TTI DNA and Rubrics to Assess Student and Program Outcomes
The KEEN – TTI Performance DNA will employ three specific methods to assess student and program outcomes: 1 – The seven KEEN learning outcomes and TTI 23 DNA personal and professional competencies measurement model, 2 – Student retention and the TTI DISC universal language model, and 3 – KEEN learning outcomes rubrics assessment framework.

The KEEN Learning Outcomes and TTI 23 DNA Competencies Measurement Model
The primary measurement model used to assess student and program outcomes is the seven KEEN learning outcomes and TTI 23 DNA personal and professional competencies measurement model as depicted below. The seven KEEN learning outcomes were mapped with the 23 TTI competencies based on TTI's actual benchmarking of engineering jobs in industry along with the input of KEEN faculty and KFF staff.

Through participation in KEEN program activities including curricular, co-curricular and extra-curricular experiences we will measure the capacity of students (and programs) to develop and master various levels of the 23 personal and professional competencies over time. As the model depicts we are interested to measure students development of these skills at a minimum of three points in their education: 1 – Freshmen (benchmark), 2 – Sophomore/Junior (midpoint) and 3 – Senior (completion of degree).

Results of the 2010 Freshman, or Benchmark Point, at Baylor University
In fall 2010 KEEN and Target Training, International (TTI) took a data set (Baylor Freshmen, n = 245) and plotted students with an actual engineering job benchmark, an actual candidate for that job and the national mean. The actual engineering job benchmark refers to typical results for a person doing the job at the present time (referred to as "job" in the table below). The person numbers refer to the typical results for a new graduate who is a candidate for the job (referred to as "person" in the table below).

Aggregate data from Baylor students was approximately one standard deviation from the nation mean indicating a valid study design. Replicating this technique and tracking changes in student skill development over time will allow KEEN to measure and assess the impact of various

schools' program impact on developing and shaping students around the seven KEEN learning outcomes.

Table 1 shows an example of the results of the Baylor 2010 freshman class, with respect to the twenty-three personal and professional competencies. This is the benchmark for the Baylor study, and will continue longitudinally throughout the students' academic careers at Baylor.

The twenty-three personal and professional competencies on this assessment are: [12]

1. Self management (time and priorities): Demonstrating self control and an ability to manage time and priorities.
2. Customer service: Anticipating meeting and/or exceeding customer needs, wants, and expectations.
3. Written communication: Writing clearly, succinctly and understandably.
4. Goal orientation: Energetically focusing efforts on meeting a goal, mission or objective
5. Flexibility: Agility in adapting to change.
6. Persuasion: Convincing others to change the way they think.
7. Creativity/Innovation: Adapting traditional or devising new approaches, concepts, methods, models, designs, processes, technologies and/or systems.
8. Planning/Organizing: Utilizing logical, systematic and orderly procedures to meet objectives.
9. Interpersonal Skills: Effectively communicating, building rapport and relating well to all kinds of people.
10. Futuristic Thinking: Imagining, envisioning, projecting and/or predicting what has not yet been realized.
11. Presenting: Communicating effectively to groups.
12. Continuous Learning: Taking initiative in learning and implementing new concepts, technologies and/or methods.
13. Teamwork: Working effectively and productively with others.
14. Diplomacy: Effectively handling difficult or sensitive issues by utilizing tact, diplomacy and an understanding of organizational culture, climate and/or politics.
15. Analytical Problem Solving: Anticipating, analyzing, diagnosing, and resolving problems.
16. Personal Effectiveness: Demonstrating initiative, self-confidence, resiliency and a willingness to take responsibility for personal actions.
17. Empathy: Identifying with and caring about others.
18. Negotiation: Facilitating agreements between two or more parties.
19. Decision Making: Utilizing effective processes to make decisions.
20. Leadership: Achieving extraordinary business results through people.
21. Management: Achieving extraordinary results through effective management of resources, systems and processes.
22. Conflict Management: Addressing and resolving conflict constructively.
23. Employee Development/Coaching: Facilitating and supporting the professional growth of others.

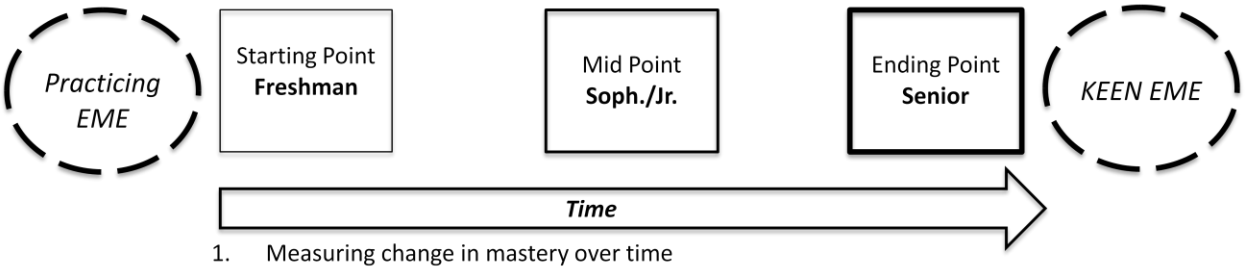
Table 1 Job Competencies Hierarchy Rated on a score of 0-10				
Question	National Mean	Person	Job	Mean for Baylor freshmen
Self management	4.4	9.0	9.5	4.5
Customer service	6.3	6.3	9.2	4.4
Written communication	5.4	7.3	8.9	3.3
Goal orientation	6.8	8.7	8.8	6.0
Flexibility	4.5	8.0	8.3	3.5
Persuasion	5.5	10.0	8.3	3.9
Creativity/Innovation	4.8	8.3	8.2	3.3
Planning/Organization	4.8	4.3	8.0	4.8
Interpersonal Skills	6.8	9.3	7.8	4.7
Futuristic Thinking	2.8	2.7	7.7	2.3
Presenting	6.1	6.0	7.6	3.7
Continuous Learning	6.1	4.7	7.5	5.9
Teamwork	6.3	2.0	7.2	5.2
Diplomacy	5.9	3.3	7.2	4.3
Analytical Problem Solving	4.7	1.0	6.5	4.6
Personal Effectiveness	5.5	7.0	6.5	5.3
Empathy	3.6	3.3	5.9	3.4
Negotiation	3.8	3.3	5.7	2.6
Decision Making	4.0	2.0	4.8	2.5
Leadership	6.1	1.0	4.7	2.9
Management	5.7	7.7	4.1	4.9
Conflict Management	5.2	1.3	3.3	3.9
Employee Development/Coaching	6.8	2.7	2.9	4.4

Overall our ABC university results compare reasonably well with the national average. They are lower than that of a person seeking an engineering job or performing in an engineering job. This is to be expected as the ABC results are for first semester freshmen.

Deployment of the KEEN-TTI Performance DNA Across the Network

As described in the model diagram following, there are a series of six measurement techniques that will be employed, developed and tested across the KEEN network. From a program standpoint we will be able to assess how curricular, co-curricular and extra-curricular initiatives and offering impact the development of professional competencies.

Seven KEEN Learning Outcomes and the TTI 23 DNA Personal and Professional Competencies (Soft Skills) Measurement Model



1. Measuring change in mastery over time
2. Measuring change in rank order over time
3. Benchmarking individual school with KEEN averages over time
4. Benchmarking students/schools/KEEN with practicing EMEs* over time
5. Comparative analysis with other assessment tools and techniques
6. Measuring KEEN program initiatives ability to instill the Seven KEEN Learning Outcomes

*EME = Entrepreneurial Minded Engineer | KEEN/TTI will build benchmark data base

It is not expected that students will master all 23 competencies at this early stage of their personal and professional development. According to TTI most jobs do not require mastery of more than seven. What is important is that these sets of so-called "soft skills" are job related and fundamental to entrepreneurially minded engineers. To further strengthen our methodology KEEN and TTI are building a new data set of practicing entrepreneurially minded engineers. This project, that kicks off in 2011 will allow us to capture greater detail and insights to fine both our methodology, but more importantly align KEEN programs around the professional competencies vital to success in industry.

As of December 2010 we have 1,467 data points with an estimate of a minimum of 1,600 for the academic year. This is a robust data set and has met our target estimates. This data set will also grow over time providing a rich data set for the longitudinal measurement and assessment of students and programs. Data analysis has already begun and results of our analysis will be to be presented at the KEEN Winter Conference 2011 in Phoenix.

KEEN faculty are already formulating research agendas including papers for conferences and journal submissions. In January 2011 the Journal of Engineering Entrepreneurship (JEEN) will announce a call for paper for a special issue devoted to assessment[13]. It is anticipated that the results of this research will have a transformational effect on KEEN and undergraduate engineering education for many years, and most importantly further strengthen the KEEN network's ability to develop a new class of EMEs.

Student Retention and the TTI DISC Universal Language Assessment Model

During a November 2010 meeting, Mercer University Associate Dean Michael Leonard indicated that on average 15% of freshmen engineering students drop out. If you take the KEEN network with eighteen active schools, with an average of 150 incoming freshman per school at a 15% drop out rate we are losing approximate 400 potential new engineers per year. What makes

this example even more disturbing is research conducted at the University Nebraska Lincoln on over 500 freshman engineering students employing the DISC Universal Language methodology documented that of the one-third who dropped out had behavioral styles most associated with entrepreneurial personality styles.

One may conclude from these examples that not only are we losing a significant number of undergraduate engineering students, but we are losing those students who might become the best entrepreneurially minded engineers. To address these challenges KEEN will employ the TTI DISC Universal Language Assessment Model to identify at risk freshmen and have faculty and administrators work together to retain these individuals.

Based upon the retention challenges and the objectives of the KEEN network the second dimension of the KEEN – TTI Assessment Project will address student retention. This phase of assessment will have all incoming freshman take the TTI Performance DNA using the results to: 1 – Identify at risk students as soon as possible, 2 - Engage these students with counseling and guidance, and 3 – Provide study habit behavioral guidelines to assist students. The assessment and measurement metrics will be in tracking retention rates of students engaged in KEEN schools at three points: 1 – Freshmen, 2 – Sophomore/Junior and 3 – Senior. Assessment measures will include the following:

<u>KEEN Student Retention Assessment Metrics:</u>

1. Measuring change in freshman retention over time
2. Measuring change in retention class year over time
3. Benchmarking individual school with KEEN retention averages over time

DISC is a four quadrant behavioral model based on the work of Marston (1928) to examine the behavior of individuals in their environment or within a specific situation. [14] It therefore focuses on the styles and preferences of such behavior. DISC is an acronym for:

1. **D**ominance/challenge: How you address problems and challenges.
2. **I**nfluence/contacts: How you handle situations involving people and contacts.
3. **S**teadiness/consistency: How you demonstrate pace and consistency.
4. **C**ompliance/constraints: How you respond to rules and procedures set by others.

This system of dimensions of observable behavior has become known as the universal language of behavior. [15] Research has found that characteristics of behavior can be grouped into these four major "personality styles" and they tend to exhibit specific characteristics common to that particular style. [16] All individuals possess all four, but what differs from one to another is the extent of each.

Understanding a person's natural way of operating in each of these areas gives a reliable indication of how they will tend to behave on the job - in this case, the job of being an engineering student. When students answer the questions in online assessment process, they have their own unique profile plotted on a graph, along with a full report of their unique profile. This insight into one's self will help ensure that students are making optimum choices about what to study and how to study, and choosing a profession that suits your natural inclinations.

Based on benchmarks of actual engineering jobs, the ideal behavioral pattern for engineering success is high 'S' and 'C' combined with low 'D' and 'I'. What this means is that being highly detail-oriented, adhering to established practices and following the rules or procedures (high 'C') is an important part of engineering work. Having a high 'S' means that the person is very consistent, can be relied upon to deliver the work at a predictably steady pace and will complete it in established ways. By the same token, behavioral patterns of high 'D' and high 'I' are most associated with entrepreneurs and marketing professional. Consequently these styles will most likely struggle in an engineering curriculum, yet have great potential to develop into EMEs provided they understand themselves and adapt their study habits and behaviors.

DISC can also be used by faculty and administrators to better understand, council and guide students. By understanding a person's behavioral style faculty advisors can help students adapt their learning styles, better understand how to interact with other behavioral patterns and therefore navigate the challenging world of engineering education leading to improvement in retention and performance.

KEEN Learning Outcomes Rubrics Assessment Framework

The third assessment method employs the KEEN Learning Outcomes Rubrics developed. This framework has been developed by Ohio Northern University (ONU), and principally, Dr. Rob Kleine. The tool is based on a similar method used by ONU to assess the impact of assurance of learning objectives across the university. The KEEN Learning Outcomes Rubrics assess outcomes across four levels as presented below.

Four Levels of KEEN Rubrics Learning Outcomes Measures

Does Not Meet Expectations	Developing	Meets Expectations	Proficient

The KEEN Rubrics provide a complementary measurement framework to the KEEN – TTI Performance DNA. They will also be used to demonstrate how the seven KEEN learning outcomes can be used to support the ABET a-k learning objectives. Outcome artifacts such as examples of student work, competitions and events can be included.

KEEN will utilize a comprehensive learning outcomes based assessment and measurement methodology. Based on the seven KEEN learning outcomes a comprehensive empirical methodology, the TTI Performance DNA, will help align students and programs with the needs of industry, and measure results. The KEEN rubrics provide a qualitative framework that can capture the essence of student and program outputs with the potential to use KEEN initiatives to support ABET requirements. The DISC universal language allows KEEN to assess student behavioral styles. This will address retention, learning styles and student development. In addition to these assessment methods, most KEEN schools also utilize their own tools. The learning that will come from the KEEN assessment methods will emerge into a model that can be shared with other engineering programs and thus positioning KEEN schools as models for others to emulate.

KEEN Methods and Kern Family Foundation Grantee Assessment

The KEEN Assessment Project is also a platform that can be integrated into the Grantee Assessment Worksheet Success Measures. The following table provides some examples of how the KEEN – TTI Performance DNA Assessment Project can be used for each of the five desired outcomes.

Grantee Assessment Worksheet and KEEN Performance DNA Project

OUTCOMES	Measure Grant Success – Results Indicators
Alliances	- Number of faculty administering TTI Performance DNA - Number of alumni participating in the EME benchmarking project - Number of schools collaborating on assessment research projects
Base of Support	- Number of assessment workshops held on campus - Number of research papers on assessment published - Number of conference presentations on assessment
Individual Impact	- Number of students taking TTI Performance DNA over 4 years - Application of seven KEEN learning outcomes assessment model - Student retention based on DISC universal language
Organizational Capacity	- Performance DNA assessment required for freshman in first 2 weeks - Developing assessment based e-learning modules for network - Leveraging assessment to revise and improve curriculum & programs
Policies	- Using DNA assessment as on-boarding tool for all incoming students - Making DNA assessment a mandatory requirement for all students - Requiring career placement to use assessment to place graduates

Although in the early stage of the KEEN – TTI Assessment Project we are well on our way to developing a series of new comprehensive educational assessment tools. The KEEN Network is actively participating and supporting this important undertaking. With clearly defined learning outcomes, a proven industry partner in TTI, KEEN is focused on reforming undergraduate engineering education and creating a new class of entrepreneurial engineers.

Bibliographic Information

[1] "Open Letter from Dean Julio M. Ottino," the Robert R. McCormick School of Engineering and Applied Science at Northwestern University, accessed January 10, 2011, http://www.mccormick.northwestern.edu/about/.

[2] Benade, S & Heunis, C, 2005, "Management development : more right brain skills required", Management Today, vol. 21, no. 6, pp. 54-58. http://www.management-today.co.za/contact.php?PHPSESSID=9031853998a9051094d36805f4b7e1b3.

[3] "The Engineer of 2020: Visions of Engineering in the New Century" National Academy of Engineering, 2004.
[4] D. Tabat, "Is American Industry Ready for Entrepreneurially Minded Engineers?" last modified March 11, 2011, http://www.keennetwork.com/wp-content/uploads/2010/10/Is-American-Industry-Ready-for-Entrepreneurially-Minded-Engineers.doc
[5] Timothy Kriewall and Kristen Mekemson, "Instilling the Entrepreneurial Mindset into Engineering Undergraduates," *The Journal of Engineering Entrepreneurship*, 1 (2010) :7
[6] Ibid, 8.
[7] Tabat, 1.
[8] D. Pistrui, R. Kleine, D. Carpenter, P. Singh, "Assessing the Entrepreneurial Mindset in Undergraduate Engineering Education: New Methods and Emerging Practices in the Kern Entrepreneurship Education Network," NCIIA 15th Annual Open Conference, Washington, D.C., March 2011.
[9] Kriewall and Mekemson, p. 8.
[10] Kriewall and Mekemson, pp. 8-11
[11] "KEEN-TTI Assessment Primer – Fall 2010," http://www.ttikeen.com/files/keen-tti-assessment-primer-fall-2010-v1.0-6.pdf, last accessed March 11, 2011.
[12] "TTI TriMetrix Personal Skills Hierarchy", http://www.ttiatlanta.com/profiles/TriMetrix_Personal_Talent.pdf, pp. 3-6, last accessed March 11, 2011.
[13] "Call for Papers – Assessment Methodologies," *The Journal of Engineering Entrepreneurship*, 3 (2011).
[14] W.M. Marston, *The Emotions of Normal People* [Columbia: Routledge, 1928].
[15] Ibid.
[16] Ibid.