International Journal of Engineering Education Vol. 30, No. 1, pp. 72–78, 2014
Printed in Great Britain

0949-149X/91 $3.00+0.00

Capstone Project Problem Statements: Art or Science?*

GENE DIXON
Department of Engineering, East Carolina University, 216 Slay Hall, Greenville, NC 27858-4353 USA. E-mail: dixone@ecu.edu

A review of capstone related literature indicates similar-not identical-approaches to design that include various concepts of what is a problem statement, and problem statement development, evaluation and assessment. There appears to be a variety of approaches for developing the capstone student's ability to craft a quality statement of the project problem. There are few specifics as to what should or should not be included in the problem statement and what is found reflects the preferred design process or programmatic requirements. This paper describes findings from an exploratory study of methods and expectations associated with crafting capstone problem statements. This work is directed at determining what characteristics are valued in a problem statement. The research finds that problem statement characteristics vary with programmatic requirements and preferences in academia and industry. Statistics point to alignment of academia and industry on all but two pre-selected problem statement characteristics, Identified Design Methods ($p = 0.040$) and Evidence of Current Art Research ($p = 0.043$). Industry is found to have the more rigorous point of view for the two characteristics.

Keywords: capstone; problem statement; design

1. Introduction

Engineering capstone design courses are recognized as ". . . a culminating experience" where students apply ". . . knowledge and abilities to practical engineering problems" [1]. The capstone experience permits students to connect theory and practice in an academic process. Developing teamwork skills is also an integral part of capstone.

Design process texts commonly used within the capstone academic process provide test-specific variations of the design process, e.g., stage-gate, systems engineering and systems engineering lifecycle [2]. The variations include references to problem statements, problem definitions, problem scopes, problem formulations and/or problem framing. Savage [3] suggests that the *design method* begins with a careful evaluation of the needs of a customer. Further, he recommends that functional requirements and constraints define what performance is required. The question can be asked as to what part of Savage's method provides a clear, quality statement of the actual problem in a way that leads to a project meeting objectives? While the simple answer is that all of this is required for project success, how much of this design method is a problem statement and how much is engineering specifications? For Adams, et al. [4], it is the *problem definition* that describes what the problem really is, what constraints are to be applied, and what (performance) criteria are to be used. Woods [5] proposes that the define "stage" includes the stated objective, context, constraints, criteria (inputs and outputs) with a focus on classification of given information and not on understanding what really is the problem. Research also indicates that experienced engineers will apply more effort to problem clarification than will inexperienced problem solvers [6, 7].

As the engineering students' capstone experience is marketed and assessed, there seems to have been modest work reported concerning pedagogy related to the development of the capstone student's ability to develop and clarify a (quality) statement of the project problem. Woods [5], recommends that students be taught to focus on the "define stage". Trainor, McCarthy, and Kwinn [8], recommend that students be taught to use stakeholder analysis techniques to compile customer needs, wants and desires as part of the problem definition phase. This broad description of a problem definition contrasts with what others consider to be a need for a succinct problem statement. For example, Rehmann, et al. [9], requires the use of systems thinking in order to view a problem broadly and holistically. Atman, et al., [7] suggests a set of activities that involve identifying criteria, constraints, and requirements; framing problem goals; gathering information; and, stating assumptions about information gathered. The literature does reflect work related to assessment rubrics but these seem to be more focused on formatting than developing related KSAs. Little guidance is available relative to lesson plans for developing design related problem statement KSAs.

2. Presentation

The East Carolina University (ECU) initiated its engineering program in 2004. The engineering curriculum culminates in a two semester capstone design project based learning experience. The ECU engineering program relies heavily on industry

* Accepted 23 July 2013.

sponsored projects for capstone design projects. Faculty conducted assessments have consistently indicated a weakness in the quality of student developed problem statements. Still, sponsor satisfaction with project results exceeds faculty assessment of design quality. This seems consistent with industry's tendency to focus on project success over learning outcomes [10]. The ECU capstone process has begun focusing on improving design quality in order to meet assessment goals. The first step in improving design quality is to focus on project problem statements. Issues of embedded solutions, poorly developed constraints, objectives that are not quantifiable, and weak metrics for determining if design meets the sponsor's requirements were evident. The assessments indicate a need for more focus on developing the project statement. The assessment results are consistent with what others have found [7, 11].

Industry projects are preferred for their ability to introduce students to the time/cost/quality pressures of industry projects [12]. The projects are usually proposed as open-ended statements. Open-ended proposals are believed to increase student motivation and provide an introduction to the reality of engineering [13, 14]. When requesting project proposals from industry, ECU asks for project background, summary objectives/requirements, and design expectations (deliverables). Projects are vetted for selection [15]. Students are assigned to project teams with no student input. The first student team assignment is to begin crafting a problem statement for their project. The problem statement development process [16] is discussed for one class period using examples found in literature. Frequent reference is made to problem statement formulation during subsequent lectures and periodic oral and written design reviews.

In order to compare ECU's processes of teaching capstone problem statement related KSAs to practices found in industry and academia, a survey was used to collect insights from capstone faculty and industry sponsors to determine the key characteristics of a quality problem statement. The survey was developed to gain insights on how to structure both pedagogical materials and assessment rubrics to improve the capstone experiences for senior design students as relates to problem statement or problem definition.

2.1 Methods

A questionnaire was developed and distributed to the capstone community electronically including attendees at recent Capstone Design Conferences (n $\sim$ 300). ECU industry contacts were contacted directly to request participation (n $\sim$ 350). Respondents came from academics (n = 41) and industry (n = 16) and resulted in $\sim$4% participation, conservatively estimated.

The survey was designed to be brief and general. The survey was composed of a Likert scale question containing literature identified characteristics of problem statements in which respondents were asked to assign value on a 4 point scale of doesn't matter (1) to must have (4). The Likert response question asked respondents to rank the value of preselected problem statement characteristics that were adapted from six commonly used design text books. The characteristics selected for ranking were:

- General statement, definition or description, an overview.
- Specific statement, definition; an exact problem statement.
- Constraints/criteria.
- Solution path, objectives, goals.
- Established (customer) need.
- Evidence of prior art research.
- Deliverables.
- Practicality.
- Success metrics.
- Identified design methods.

Space for adding additional preferred alternatives was provided. Qualitative questions addressed problem statement precision. Examples of exemplary problem statements were requested as well as reasons why the problem statements were considered exemplary.

Concerns about the definition of terms used in describing the pre-selected characteristics reflect a lack of standard terminology within the capstone and industry community. It is assumed that the lack of standard terminology reflects the multiple design processes found across design contexts and processes and as described in various design related texts [2, 16–28]. Variations in design processes and terminology can compound challenges students face when trying to understand the terminology and jargon found in a sponsor's project proposal. The language of industry may not be typical of the language used in the classroom or in text book(s) [28].

2.2 Results

General Statistical Data for the preselected problem statement characteristics are shown in Table 1. Means and ANOVA analysis identified significant differences between academics and industry respondents for the problem statement characteristics *Identified Design Methods* ($p = 0.040$) and *Evidence of Current Art Research* ($p = 0.043$). The industry sample indicates a stronger preference for both of these characteristics as components of the problem

Table 1. General Statistics for pre-selected problem statement characteristics

	Role			
	Academic		Industry	
Characteristic	**Mean**	**SD**	**Mean**	**SD**
General Statement	3.44	0.838	3.61	0.979
Specific Statement	3.12	1.100	3.56	0.705
Constraint/Criteria	3.17	0.972	3.24	0.831
Solution/Objectives/Goals	2.39	1.243	2.94	1.197
Customer Need	3.20	0.954	3.29	0.920
Prior Art	1.98	1.060	2.59	0.939
Deliverables	3.29	1.078	3.12	0.993
Practicality	2.54	1.075	2.71	0.849
Success Metrics	2.83	1.138	2.94	1.029
Identified Design Methods	2.00	1.065	2.63	0.806

statement than the academic sample. This is consistent with research finding that experienced engineers are willing to spend more time understanding the problem context than will inexperienced students who seek to get to solutions quickly. For experienced engineers, understanding context includes previous and related problem solutions [7].

The characteristics survey questions included opportunities for respondents to include additional characteristics. Academic respondents suggested problem statement characteristics that included applicable codes and standards; project schedule, required/available resources, stakeholder descriptions, terms/conditions of design submission, definitions of optional scope for extra credit, budget constraints, and a needs statement. Industry respondents suggested adding a characteristic addressing risk. The additional characteristics also points out how problem statement characteristics can vary with context and user.

From the additional characteristics offered, it appears that the academic sample has a stronger need for a set of complete, specific characteristics than exists for the industry sample. This may be indicative of the daily exposure to, or continued experience with, general or vaguely defined issues, constraints and challenges of business in contrast to the need for measurable (assessment) content required by academics. The common practice for classroom exercises seems to focus on in-the-box thinking [12]. The classroom's close-ended problems lend themselves to complete, closed-ended quantitative solutions and may script the academic mind to require *completeness.*

2.3 Qualitative responses related to problem statements characteristics

Respondents were provided space to provide text regarding the characteristics described in the Likert formatted question described above. Comments seemed to largely reflect personal/program specific definitions of terms and perspectives, i.e., what a problem statement is (or definition, scope, formulation and/or framing).

Some text responses addressed problem statements from a general perspective. These responses represented considerable diversity in thinking about what constitutes a problem statement. From the sample data, it seems that problems—their definitions and scopes—may be programmatically defined rather than formulated from a single source guideline, i.e., in a cookie-cutter fashion. Example comments include:

> *As a career design and development specialist for a large international corporation, I always try to establish a professional problem statement. I insist on a project planning exercise with for example a Gantt chart. Regular meetings with the design teams ensure that they recognize the need for adherence to their project plan and take unforeseen problems in stride. I strongly believe that lectures are not design and few academics have the background and experience to appreciate the niceties of professional design.*
>
> *Capstone design would be a better experience if students had to struggle finding a compelling opportunity space and within that a valuable problem to solve, then worry about the simpler parts of solution, design, etc.*
>
> *In my view the 'problem statement' is just one part of the problem definition that also should include a background/context statement, target specifications (preferably quantified), design constraints, and timeline for deliverables. A summary of project learning and functional breakdown may be part of the problem definition but more often would appear under 'concept development activities'.*
>
> *In my view the "problem statement" is a complete and separate element of the process. The problem statement is independent of objectives, constraints, etc. Including those in a "problem statement" only serves to contaminate the problem statement, leading students to think about solutions before truly understanding the problem, and leading, in some cases, to actually addressing the wrong problem by moving ahead too quickly.*

In context, these responses are representative of diversity in thinking about what constitutes a problem statement. This may well parallel intra-industry approaches where problems and projects dealing with design are initiated and developed from various states of generalization. Pedagogically then, this could imply that related assessment processes should be, of necessity, program specific, precluding development of or use of a standard approach for developing related KSAs.

Responses were categorized by whether the respondents were considering the project proposal (received from the sponsor) or the student (re)definition of the design. Proposals were preferred to be vague or general with exceptions only for proprietary interests, e.g., use of a specific PLC manufacturer. The term "open-ended" was frequently used or implied. Sponsor proposals were frequently considered to be problem statements with the inclusion of some or all of schedule, budget, resource, constraints and deliverables identified. Two comments are offered as examples:

> *Must be important to the sponsoring company, should be a "cool" project, best if it requires the use* [of] *new technologies, should leave room for students to innovate.*
>
> *Requirements flowdown from goals, to objectives, to performance requirements, to performance metrics with identified margins is a particularly important part of the process. When done well, this flowdown enables the reverse process of verifying and validating performance—a necessary part of establishing that the goal has been met.*

Industry engineering projects can range from the mundane warehouse lighting redesign to highly specialized product development, with all having value for the project sponsor. When considering problem statements from the perspective of what students should develop, sample data were consistent in stating a preference for starting with vague, open-ended proposals that require students to interact with project sponsors in order to develop a full understanding of the problem and it's characteristics (as listed above). There were exceptions. One capstone coordinator takes input from the sponsors and (re)writes each project problem statement in a way that meets programmatic needs and ensures students get a fast start on their project design. Some focused on addressing separation of the components/characteristics, to wit:

> *You have combined "solution path and goals"... I would separate these. There is the GOAL which is defined in my exemplar problem statement below, but then there is the PATH that my students define as they solve their problem. The PATH is what students figure out, so this is NOT given at the start. Of course, there are constraints: available equipment, available team skills, available money, and time that will define the boundary of their path.*

From the point of view of this respondent, actual problem statements should be a concise general statement and embellished with the characteristics as part of a broader problem definition. It might be inferred that what is intended and what is commonly referred to as a problem statement is nothing more than a design report format requirement that has been confounded by the requirements of a communications plan and not in providing the basis for initiating a design endeavor. This is further illustrated in the next subsection which discusses the questions related to exemplary problem statements.

2.4 Exemplary problem statements

Fourteen respondents provided exemplary problem statements (a partial listing is found in Appendix 1). Two respondents emailed examples, one in the form of a MS PowerPoint® presentation, the other in the form of a sponsor's proposed problem. The provided problem statements varied from simple one line questions to abstracts of $\sim$550 words. The reasons given as to why the problem statements were exemplary included:

- identifies/conveys a (specific) need
- concise and clear
- single sentence that introduces key vocabulary terms
- degree of open-endedness
- contains (all) requirements and deliverables
- includes metrics for success or performance criteria
- does not suggest design approaches, constraints or objectives
- avoids any restrictions to problem solution
- appropriate context and specifications to understand the topic and scope
- focused and well-defined
- Covers everything needed. Outlines expectations without tons of verbiage
- Easy to read, to the point, and worked very well with a spoken presentation

While reasons for designating a problem statement as exemplary seem to be at times contradictory, a deeper reflection seems to indicate that contextually they are complementary. Conflicts may be attributed to programmatic needs and requirements. Complementariness is found in recognizing that each respondent has identified what is working within the context of their academic/industry methods. In that sense, any diversity reflects the needs of the represented constituencies, meaning, there is no one best way. This is exemplified in two comments:

> *It* [problem statement] *is focused and well-defined. It does not mention an approach, constraints, or objectives—these are critical to solving the problem and conducting the senior design project, but their inclusion only leads student*[s] *too quickly to restrict their thinking.*
>
> *A Capstone design problem statement is more than likely a comprehensive report.*

An additional comment came in the form of a confession:

> *While reading through the problem statement from my capstone project experience, I came to realize that I didn't find it to be exemplary. The actual specific project statement was weak. Fortunately, constraints, goals, established customer need, current art research, deliverables, success metrics were all included. However, practicality and identified design methods could have been fleshed out better.*

Perhaps this comment represents an underlying "learning" of capstone. Whether it is in the form of developing a problem statement, patenting a design concept or in learning from failure, reflection is powerful in creating opportunities for life-long learning [5].

2.5 Discussion

When considering both the commonalities and differences found in the study reported here and the literature reviewed, there appears to be a need for a common definition of terms and usage of terms that can be used when communicating about (capstone) problem statements. Still, the variations in program application within academia and industry promote the need for acceptance, or toleration, of differences. Additionally, if those variations are accepted, then it seems reasonable to expect, and accept, differences in problem statements as crafted by students. Nevertheless, the requirements to review and (re)develop problem statements seem to support an iterative approach to the crafting of problem statements despite the obvious inefficiency. It could be said then that, similar to a spiral curriculum [29], problem statement development is iterative in that the problem statement is refined in (each of the design) stages. What is proposed as a result of this study is a progressive evaluation rubric that "improves" with each stage or cycle of the design spiral. The initial rubric might represent a project inception problem statement rubric. The final rubric, used with project completion, would represent a more advanced problem statement rubric. The advanced problem statement could also be used to lead the capstone student to reflect on the need to revisit or iterate the problem statement. Dixon, has proposed some conceptual problem statement rubrics that reflect the use of progressive rubrics across the project life cycle [30].

3. Conclusions

The article has considered the diversity of perspectives surrounding capstone problem statements both from an academic and industry prospective. The study determined that the perspectives of industry and academia are for the most part aligned. The study results also recognized that within academic programs just as in industry, methods for crafting problem statements vary with programmatic need and tradition. There is wide acceptance that problem statement development is inherently inefficient in that iterative development is the norm. Additionally, the study suggests that while common academic texts may direct text-specific methods, transitioning students between classroom and industry jargon may lead to mixed understandings that impact problem statement qualities.

References

1. R. Gerlick, D. Davis, S. Beyerlein, J. McCormack, P. Thompson, O. Harrison and M. Trevisan, Assessment Structure And Methodology For Design Processes And Products In Engineering Capstone Courses, *2008 American Society for Engineering Education Annual Conference Proceedings*, Pittsburgh, 2008.
2. A. R. Carberry, H.-S. Lee and M. W. Ohland, Measuring Engineering Design Self-efficacy, *Journal of Engineering Education*, **99**(1), 2010, pp. 71–79.
3. R. Savage, A Design Methodology for Empowering Project-Based Learning, *2007 American Society for Engineering Education Annual Conference Proceedings*, Honolulu, 2007.
4. R. Adams, P. Punnakanta1, C. J. Atman and C. D. Lewis, Comparing Design Team Self-Reports with Actual Performance: Cross-Validating Assessment Instruments, *2002 American Society for Engineering Education Annual Conference Proceedings*, Montreal, 2002.
5. D. R. Woods, An Evidence-Based Strategy for Problem Solving, *Journal of Engineering Education*, October, **89**(4), 2000, pp. 443–449.
6. E. P. Douglas, M. Loro-Ljungberg, A. T. Malcolm, N. McNeill, D. J. Therriault and C. S. Lee, Moving Beyond Formulas and Fixations: Exploring Approaches to Solving Open-Ended Engineering Problems, *2011 American Society for Engineering Education Annual Conference Proceedings,* Vancouver, 2011.
7. C. J. Atman, R. S. Adams, M. E. Cardella, J. Turns, S. Mosborg and J. Saleem, Engineering Design Processes: A Comparison of Students and Expert Practitioners, *Journal of Engineering Education*, October, **96**(4), 2007, pp. 359–379.
8. T. Trainor, D. McCarthy and M. Kwinn, From Cornerstone to Capstone: Systems Engineering the West Point Way, *2010 American Society for Engineering Education Annual Conference Proceedings*, Louisville, 2010.
9. C. Rehmann, D. T. Rover, M. Laingen, S. K. Mickelson and T. J. Brumm, Introducing Systems Thinking to the Engineer of 2020, *2011 American Society for Engineering Education Annual Conference Proceedings*, Vancouver, 2011.
10. M. Green, T. Hellmuth, R. Gonzalez, S. Ayers and P. Leiffer, Effectively Implementing The Interdisciplinary Senior Design Experience: A Case Study And Conclusions, *2007 American Society of Engineering Education Annual Conference Proceedings*, Honolulu, 2007.
11. D. Jonassen, J. Strobel and C. B. Lee, Everyday Problem Solving in Engineering: Lessons for Engineering Educators, *Journal of Engineering Education*, April, **95**(2), 2006, pp. 139–151.
12. C. Charyton, R. J. Jagacinski, J. A. Merrill, W. Clifton and S. DeDios, Assessing Creativity Specific to Engineering with the Revised Creative Engineering Design Assessment, *Journal of Engineering Education*, **100**(4), 2011, pp. 778–799.
13. R. Bannerot, An Exercise In Problem Definition In An Early Design Course, *2003 American Society for Engineering Education Annual Conference Proceedings*, Nashville, 2003.
14. J. Conrad, D. Hoch, P. Schmidt, N. BouSaba, W. Heybruck and D. Sharer, Assessing Senior Design Project Deliverables, *2009 American Society of Engineering Education Annual Conference & Exposition*, Austin, 2009.
15. P. Kauffman and G. Dixon, Vetting Industry Based Capstone Projects Considering Outcome Assessment Goals, *International Journal of Engineering Education*, **27**(6), 2011, pp. 1231–1237.
16. R. Eggert, *Engineering Design,* High Peak Press, Meridian, 2010.
17. K. T. Ulrich and S. D. Eppinger, *Product Design and Development,* 4th ed. McGraw-Hill, Boston, 2008, pp. 120–124.
18. P. H. King and R. C. Fries, *Design of Biomedical Devices and Systems,* 2nd ed. CRC Press, Boca Raton, 2009.
19. E. Lumsdane, M. Lumsdaine and J. W. Shellnut, *Creative Problem Solving and Engineering Design,* McGraw-Hill College Custom Series, New York, 1999.
20. K. Otto and K. Wood, *Product Design,* Prentice Hall, 2001.

21. M. T. Holtzapple and W. D. Reece, *Concepts in Engineering,* 2nd ed., McGraw Hill Higher Education, Boston, 2008.
22. K. T. Ulrich and S. D. Eppinger, *Product Design and Development,* McGraw-Hill Irwin, New York, 2012.
23. C. L. Dym and P. Little, *Engineering Design,* 3rd ed., John Wiley & Sons, Hoboken, 2009, pp. 24.
24. D. G. Ullman, *The Mechanical Design Process*, 4th ed., McGraw Hill Higher Education, Boston, 2003.
25. G. Pahl, W. Beitz, J. Feldhusen and K. H. Grote, *Engineering Design,* 3rd edn., Springer, Verlag, 2007, pp. 125–128.
26. Niku, Saeed, Benjamin, *Creative Design of Products and Systems,* John Wiley & Sons, Hoboken, 2009, pp. 111–163.
27. B. V. Koen, *Discussion of the Method,* Oxford University Press, New York, 2003.
28. G. E. Dieter and L. C. Schmidt, *Engineering Design,* McGraw Hill, New York, 2013, 127–131, 139–140.
29. K. Takaya, *Jerome Bruner's Theory of Education: From Early Bruner to Later Bruner*, Interchange, 2008, **39**(1), pp. 1–19.
30. G. Dixon, Experiencing Capstone Design Problem Statements, *2012 American Society of Engineering Education Conference and Exposition,* San Antonio, 2012.

Appendix 1 Example problem statements.

The first example is excerpted from a 41 page file. Only Section 1.1, Summary of Design Problem is included. Names and specific identifiers have been redacted.

1.1 Summary of Design Problem

The [redacted] GPS Animal Tracking System ([redacted] ATS) was primarily designed for the purposes of ecological research but is also used to fulfill the needs of other researchers, resource managers, and livestock producers. The [redacted] ATS technological capabilities are currently acceptable and the current package configuration has worked successfully for cattle but researchers would like to use the capabilities of the collar to track smaller animals such as wolves, deer and elk.

The current ATS Collar includes a Laminate Conveyor Belt, Satellite Modem, UHF/VHF transceiver, GPS receiver, Microprocessor Control board (w/ SD card slot), 4 D-Cell Batteries, GPS Antenna, Satellite Modem Antenna and UHF/VHF antenna. The new collar enclosure will only have two D-Cell batteries with the capabilities of adding two additional D-Cell batteries when the weight carrying capabilities of the animal will allow. The primary focus of this project will be to reduce the size of the electronics/battery package(s) paying special attention to the depth and height of the enclosures to ensure the animal's survival will not be compromised while wearing the collar. The co-primary focus is ensuring the electronics, batteries, wires and circuit integrity stay intact and the collar functions normally through all possible weather from the equator to the poles, including submersion up to 1 meter.

The configuration of the electronics, batteries and antennas will be a major part of the project and [redacted] stressed that the only limitation is that the Satellite Modem circuit board and components can not be replaced or modified.

The second example was provided by an industry sponsor. The problem statement was provided in the form of a MS PowerPoint® presentation file created by students.

Overall: Design a separator grate cover that can be easily locked into position on the 2012 model year combine.

- Manually operated.
- Future automation.
- Design cannot obstruct crop flow when open or closed.
- Safe design that keeps user away from moving parts.
- Design cannot conflict with current combine options.

The third example was provided by a capstone coordinator and represents an industry sponsor's proposal for a capstone. The problem statement was provided in the form of a MS PowerPoint® file for presentation. The capstone program requires sponsors to provide slide presentations to the capstone coordinator who in turn gives the presentation to students. Students "bid" on projects based on the presentations and are assigned to teams via the bid process.

Problem

- We would like to add demo capabilities to our radios.
- When we take our radios to a show to present their capabilities many of them are difficult to showcase in a way a casual/new customer who hasn't worked with them before can understand.
- Voice is one particular feature we are always asked to demo but with our current funding and test environment it's not easy to do that outside a lab environment.

- We would like to expose the voice codecs in a windows environment to be able to show a potential customer we have a working radio that is operational in a voice enabled network.

The three examples provided demonstrate the diversity of understanding relative to what is a problem statement. However, all three represent valid problem statements within the programmatic context with which they were presented.

Gene Dixon is a faculty member at East Carolina University in the Department of Engineering and teaches engineering professional practices, engineering economics, project management, entrepreneurship and leader-follower topics to aspiring engineers. Previously he has held positions in industry with Union Carbide, Chicago Bridge & Iron, E.I. DuPont & deNemours, Westinghouse Electric, CBS, Viacom and Washington Group as a welding engineer, project engineer, process safety engineer, project engineer, TQM coach as well as serving as both a production manager and outage manager for multiple DOE nuclear production reactors. He received a Ph.D. in Industrial and Systems Engineering and Engineering Management from The University of Alabama in Huntsville, a Masters of Business Administration from Nova Southeastern University and a Bachelor of Science in Materials Engineering from Auburn University. His dissertation and on-going research explore the leadership process from the follower point of view. He has authored several publications on the follower component of leadership. Dixon was part of the opening panel discussion for the 16th Annual Kravis-de Roulet Leadership conference and has been an invited presenter to the National Society for Professional Engineers, the American Society for Engineering Management, the Society of Women Engineers, the International Leadership Association, and multiple community service organizations. He was the key note speaker at the Luther Rice University Leadership Annual Seminar in 2012 and currently serves as the Secretary for the American Society for Engineering Management.