Where Is the Transformational Leadership in Engineering Education?

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Abstract

Leaders in both industry and academia agree that to meet the needs of the 21st century, more and better engineers are needed. To provide them, schools must change how their engineering students are taught to better prepare them for the new global challenges that they face. This will literally require us to transform our system of educating engineers. To transform engineering education, we need what students of leadership studies recognize as transformational leadership. Yet a review of the current leaders in the field of engineering education reveals that no one seems to address the appropriate theories, skills and behaviors that can be learned from leadership studies. This leaves us with the question: Where is the transformational leadership in engineering education?

Introduction

Engineers transform society on a regular basis. They transform the structures in which we live, play, and work; the transportation used to get from place to place; and the tools used in every part of our lives. In essence, the things engineers design and build change the way we live. Engineering educators shape the skills and thought processes that the next generation of engineers will use to create societal changes.

The National Academy of Engineering (NAE) has published a book entitled *Educating the Engineer of 2020*, which is a compilation of the results of a project administered by the Committee on Engineering Education of the NAE. [1] The goal of the project was to answer the question: "What will or should engineering education be like today or in the near future to prepare the next generation of students for effective engagement in the engineering profession in 2020?" By its nature, the authoring committee is made up of many of the leaders in the field of engineering education. They point out that some huge changes are necessary, including:

1. There needs to be a complete overhaul of the BS/MS degree system in engineering education, such that the BS degree becomes essentially an "Engineer-in-Training" degree and the MS degree becomes mandatory as the required professional degree. Thus, similar to the medical profession, advanced degrees would be required before one would be recognized as being ready for practice in industry.

2. Universities need to accept that education research is equally valid and equally valuable when compared with pure technical research in engineering schools. The emphasis on advanced engineering research at Research One (R1) universities is not benefiting the training of the vast majority of new engineers entering the U.S. workforce.
3. Engineering education programs need to become more interdisciplinary, including exposure to liberal arts, humanities, and social sciences.
4. Universities should supply significant support to the Science, Technology, Engineering, and Math (STEM) education program in the pre-collegiate programs at the K-12 grade levels. This is a significant change in direction since most R1 universities maintain a focus that bypasses the bachelor's degree level and focuses on advanced degrees and advanced research. Most schools provide little support from their engineering faculty to the growth of STEM education in grades K-12.

The report also states that addressing these issues is going to be a challenge, because there are "lurking concerns about the institutional inertia, whether in the form of faculty resistance to change, or the challenges of moving the 'battleship' of the modern research university." [1]

Progressive leadership would seem to be called for in the leadership of engineering educators. Yet, one can attend the major and minor conferences of the American Society of Engineering Education (ASEE) and the Institute for Electrical and Electronics Engineers (IEEE), or the annual Frontiers in Engineering Conference (jointly sanctioned by ASEE/IEEE), or read the journals of engineering education research, and find virtually no mention of the fundamental leadership theories and concepts of today's age, particularly the one that provides the strongest asset to changing the current environment of technical education: transformational leadership. Which raises the question: "Where is the transformational leadership in engineering education?"

The Need for Change in Engineering Education

James Melsa, the past president of ASEE discussed the need for ASEE to take a leadership role in the changes needed for engineering education in a recent guest editorial. [2] Thomas Litzinger, director of the Leonhard Center for the Enhancement of Engineering Education, used the same forum to discuss changes that needed to occur within the field that the center oversees. [3] Charles Vest, president of the NAE has done likewise. [4] The research team of Farr and Brazil recapped the history of engineering education, up to and including the previously referenced NAE report of 2005, discussing the need for leadership training both for the educators and for the students being trained for industry. [5] The team of Jesiek, Newswander, and Borreg discussed extensively the new trend in developing engineering education research. [6] In 2008, the *Journal of Engineering Education* ran a special issue regarding the changes that are currently occurring (or need to

be) in this specialized academic field. Yet, in none of these instances is general leadership theory even mentioned. It appears that the leaders in engineering education are well aware of the need for change and for creative leadership to create that change. However, they do not appear to be drawing on the benefits and knowledge associated with normally accepted leadership theories.

Shirley Ann Jackson, president of Rensselaer Polytechnic Institute traces the history of divergence between engineering and technology and the liberal arts, philosophy, sociology, and psychology fields (often referred to collectively as the "soft sciences" by engineers). [7] Maria Paradisio presents the case that engineering and the social sciences have long been on opposite sides of a "chasm," which has prevented them from benefiting from each other. [8] Although communication and the recognition of inter-societal needs has begun to close that gap, the fact of the matter is, engineers in general still tend to give little respect to the work performed in the humanities and social sciences. This is a probable explanation for why engineering leadership is slow to take hold of the theories of leadership studies, since these studies would be viewed as coming from the "soft," i.e., non-technical, sciences.

Perhaps the biggest change being recommended for engineering educators is a readjustment of the focus that engineering faculty should apply. Currently, tenured engineering faculty tend to focus on technical research projects as their major contribution to the university, frequently teaching as few as one undergraduate class per semester. In fact, in many cases, research faculty may be able to completely buy their way out of teaching commitments using funds coming from industry consulting or research grants. The NAE report states that faculty members need to redirect their efforts toward improving the education of undergraduate students, reducing the focus on performing research. These faculty must play a major role in the changes that need to take place, yet "providing incentives for their support is challenged by the present faculty reward system, which bases decisions for tenure primarily on research." [1] By this, the report is referring to technical research in engineering specializations. The NAE summary, continues to say that many major advances in both business innovation and improvement in lifestyle are the result of engineering research, yet "this has not necessarily translated into excellence in undergraduate education." [1] To make the necessary improvements in the way engineering students are educated, there must be a realignment. The curriculum must align better with the challenges and opportunities of the workplace, and the faculty must align better with the skill sets necessary to deliver that curriculum.

Crawley, Malmqvist, Ostlund and Brodeur state "Part of the change process will require strengthening the competence of faculty in skills and in active experiential learning and student assessment. [9] There is little reason to expect a faculty that has been recruited as a cadre of researchers to be proficient in many of the skills of engineering practice. And there is absolutely no reason to believe that these faculty researchers would be able to teach these skills." Mathieu, Pfund, and Gillian-Daniel address the differences in the way research faculty and teaching faculty look at their instructional preparations. [10] Academic

leaders in higher education must deal with the fact that there are distinctly different types of instructors on their staff, with very different approaches and objectives. Balancing these differences in a manner that creates a homogeneous whole is a significant leadership challenge.

Tenure continues to be awarded, at most engineering universities, primarily for success in technical research. Funding for faculty projects and faculty salaries tends to also be based on success in the technical research arena. At some Research One universities, applicants for new faculty tenure track positions are not even considered if they are not deemed adequately qualified for the task of advancing the school's technical-research agenda. Engineering educators are being told that they need to change, both at the national level and the individual faculty level. They are being told, by the priorities of tenure, that there is a need for them to change, but they are not being incentivized to make those changes occur.

The Need for Leadership Theories

For all of the significant changes that need to occur in engineering education, there appears to be no use of transformational leadership theory in attempting to solicit faculty buy-in to advance the change. Nielsen, Randall, Yanker, and Brennan state, "Transformational leaders may have a profound impact on followers' perceptions of their work characteristics, because they provide personal attention to providing development through individualized consideration, enable new ways of working, encourage novel problem solving, provide coaching, and encourage specific behaviors of subordinates through intellectual stimulation." [11] All of these attributes would seem to mesh well with engineering academia, indicating that transformational leadership could be a strong tool in the hands of leadership. Transformational leaders are generally viewed as "being innovative and less likely to support the current situation, seeking opportunities in the face of risk, and attempting to shape and create." [12] These are descriptors of precisely the kind of leadership that is needed in engineering academia if the transformative changes described earlier are to be achieved.

Mark Sanders, keynote speaker at a recent conference of the International Technology Education Association (ITEA), provided observations and reflections on leadership within engineering and technology education. [13] Consistent with the previous discussion, he made no recognition of transformational leadership, or other leadership theories. From a general position, he proposes that all effective leaders must be motivated by passion. Sanders recognizes that this passion can be for either good or ill, saying, "It may be their quiet passion to improve the human condition…or their loud passion for wealth, power, control, fame, or some even more ignoble purpose." Miller defines both transformational and charismatic leadership traits and discusses the concept of "love" as a motivating factor in transformational leadership. [14] It would be a semantic error, in many instances, to confuse these two authors' use of the words "passion" and "love." However, in this case, they are both talking about the motivating factor for creating transformative leadership. In

fact, both authors give examples of leaders motivated in this way, and the lists share names such as Nelson Mandela and Mother Teresa. Sanders also lists names as examples of the dark side of passionate leadership, such as Stalin and Hitler. While Miller gives no negative examples, those of Sanders would clearly fit her description of a non-transformational (charismatic) leader whose objective is self-elevation and self-fulfillment. The two authors show considerable similarity of thought. Yet, Sanders shows no acknowledgement of leadership theory. So it is not surprising that there is no discussion of how these new leaders of engineering education will inspire their followers to change their direction and follow their leaders on a course to change the way we educate new engineers. There is no conversation regarding the mutual benefit that academia will gain by improving the education process, and society will gain by having a generation of better educated engineers, or what will influence engineering educators to bring about the change.

Syndell points out the role that emotional intelligence plays in transformational leadership. [15] This involves:

> The ability to monitor one's own and others' feelings and emotions that focuses on an array of emotional and social abilities, including the ability to be aware of, understand, and express oneself; the ability to be aware of, understand, and relate to others; the ability to deal with strong emotions; and the ability to adapt to change and solve problems of a social or personal nature.

Those possessing this would clearly fall into the positive side of the slate created by Miller and Sanders, rather than the negative side. Those on the negative side would avoid any feelings whatsoever for those they lead, while those on the positive side would focus on mutual elevation, which is a key transformational-leadership trait. Hopewell et al., explain the role of engineering education leaders thusly:

> Academic leaders are charged with, for the most part, a cadre of scholars and analysts immersed in the pursuit of diverse interests encompassing both research and teaching. However, academic leaders also must represent the interests to the non-academic community to garner support and sustain institutional legitimacy. Thus, academic leaders must move their institutions and communities forward with both tangible and intangible motivators. [16]

Typical of articles emanating from engineering academia, there is no discussion of the leadership types that would be best used in motivating and attaining these goals. However, by comparing the articles, it is obvious that the characteristics needed in engineering academia are those characteristics generally associated in leadership studies as transformational leadership. Transformational leaders change the organizations they lead by educating and involving their followers in the changes needed and the reasons behind those changes, then relying on those followers to institute the changes while supplying the

support and encouragement necessary to ensure that the changes are indeed enacted, thus elevating their followers to a new level so as to advance the entire organization. With no other incentive, and no recognition of transformational leadership behaviors, the current academic leadership has very little chance of actually achieving the needed change. Let us continue to examine how other leadership theories could potentially assist engineering academia in this process.

There is an argument that could be made that transactional, rather than transformational, leadership might be useful in this scenario. Singer and Singer point out that "organic organizations," (i.e., those with non-rigid goals and structures, highly educated members, and need for innovation) frequently function best under transactional leadership. [17] Certainly, engineering academia meets the description for an organic organization. However, the cost-benefit aspect of transactional leadership, in which the leader motivates subordinates by exchanging rewards for behaviors and results, is inconsistent with the university's need for the financial benefits associated with advanced research; therefore, the transactional approach probably has little applicability in our scenario.

One might think that instructional leadership theory would be applicable to those teaching engineering. However, Hallinger points out that this model really "focuses predominantly on the role of a public school principal in coordinating, controlling, supervising, and developing curriculum and instruction in the school." [18] This does not really apply to our discussion, because university deans and chancellors play virtually no role in these aspects, instead leaving it to the faculty to develop virtually everything about not only the individual class instruction, but also what classes make up the required plan of study.

Participative leader behavior, as described by House, is directed at encouraging subordinates by including them in the decision-making process and taking into consideration their opinions. [19] This is not likely to be viable in our scenario, as the current faculty at most engineering schools are strongly biased toward the existing research model and they have a vested interest in maintaining that situation. Thus, their participation in the decision process is likely to leave the ship grounded exactly where it sits rather than floating it on a new course.

There is also no leader-member leadership effect visibly at play in trying to motivate educators to change the current model, because rewards to faculty (both financial and promotional) continue to be mostly handed out for success in technical research. [20] This reward system maintains the status quo rather than instilling a drive for change. There is, therefore, no organizational citizenship effect to prompt the faculty to put in extra effort to enhance their teaching in addition to their primary focus on research. [21] Likewise, schools are not incentivized to educate. Under growing funding cuts from government (local, state, and federal) they are incentivized to sell their research skills to industry, pursue valuable high-tech research grants, or perform research on new products that can be entrepreneurially marketed to their financial benefit.

Path-goal approaches as described by House might well prove useful in this situation, if we assume that leaders will show faculty a path to mutual improvement, define their role in following that path, and give them the training necessary to move forward on that path. [19] But there is currently no apparent use of path-goal leadership to effect change in the system because despite what is said about change, administrators continue to steer faculty on a research path, and tenure and promotion requirements continue to indicated that the path to success is through engineering research.

Equity leadership theory as described by Deluga, indicates that if research faculty and teaching faculty in engineering education were treated equally, with regards to rewards such as tenure, promotion, project financing, and of course, salary, then there would be a much stronger incentive to improve instructional skills and teach more classes. [22] Of course, this would also imply that universities would hire more faculty members for tenured teaching track positions equitably with tenured research track positions, but this does not seem to be the case. So once again, the theories from leadership studies, which might prove beneficial to engineering academia, appear to be getting too little aqttention within engineering academia.

The merits of situational leadership versus contingency leadership as applied to the presented scenario of engineering education deserve some consideration. Situational leadership theory, as described by Graeff, suggests that as situations change and evolve, leaders must be able to be flexible and adapt to the needs of each situation. Since every university is somewhat different from every other, as national leaders work to institute changes across the range of engineering schools, there will be a strong need to be flexible in working with the programs at each school. [23] On the other hand, at any given school, it may be necessary to apply contingency leadership philosophy which says, it may be necessary to put new leadership in charge in order to see changes successfully implemented in order to adjust to the need to totally revamp the way that the school's administration approaches tenure and promotion, and the way that faculty members approach teaching as opposed to research. This would be a case of applying contingency leadership approaches locally and situational approaches globally within engineering education leadership.

Conclusions

It appears that the leaders of engineering education are not familiarizing themselves with relevant theories from the field of leadership studies. This leaves them ill-equipped to institute the changes needed in the engineering education field today. For this reason, it is strongly suggested that leaders in engineering academia spend time examining the extensive work available on leadership styles and behaviors. The skills and approaches generally associated with transformational leadership (by students of leadership) appear to offer the greatest strength as tools for engineering education leadership. If those in leading roles in engineering academia were to learn and apply transformational leadership

approaches, the job of changing the education environment to meet the needs of the future could be much easier.

This study points out a lack of exposure to accepted leadership theory by engineering education leaders, even though it is clear from their writings that the attributes they consider desirable are consistent with leadership studies. This can be taken as an example of engineering leaders not utilizing the work produced by those in what technical personnel frequently refer to as "the soft sciences." This lack of transfer of potentially valuable knowledge and experience appears to be due to a long-standing view by those in the technical fields that somehow the less quantifiable work in these non-technical fields is of lesser value. A more liberal-minded position is required, wherein engineers and engineering educators acknowledge the shortcomings of their own solution approaches and the potential benefit of utilizing the results of research conducted outside the engineering arena. This points toward a strategic weakness in the way engineering education leaders are attempting to provide progressive leadership for the future and indicates a need for more understanding and recognition of general leadership studies by engineering education leaders.

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Biography

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