Synthesis of the Research on Teaching and Learning in Engineering since the implementation of ABET Engineering Criteria 2000

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Part 1: Consensus on direction of research

In 1996, as the accrediting body for engineering, ABET laid out areas of knowledge and skill development by which colleges and departments would be judged beginning in 2001. (Shuman et. al., 2005) The list consists of:

Hard science skills:

A. knowledge of engineering
B. science and math principles and processes
C. the ability to do research and problem solving
D. engineering design
E. using the latest tools and processes

Process skills

F. teamwork
G. communication
H. ethics and professionalism

Awareness skills

I. appreciation for the impact of engineering on society locally and globally
J. a commitment to lifelong learning
K. a knowledge of contemporary issues

These goals have been the touchstones of much of what has been written about the state of engineering education and the focus of engineering education research since then.
The engineering education community wasted no time in launching several initiatives to develop their educational research skills and programs. Although there was research on engineering education prior to 2000, it tended to be single studies about attempts to employ new teaching strategies to a course or program or research that was focused on curricular issues, such as the retention of women and minorities in the field.

The refocusing of the field caused by the ABET criteria resulted in a rapid increase in the amount of attention being paid to identifying research-grounded, evidence-based learning experiences that can be used by engineering faculty to improve the undergraduate programming at most colleges. One discovery was that there was a need for support for engineering faculty in the area of educational research, the processes of which are quite different from standard engineering research. (Borrego, 2007) This recognition led to the establishment of research centers, workshops and institutes for engineering faculty and collaborators, and a renewed emphasis in the journals of the field on high quality research.

As good engineers should, the field also began to try to clarify the problem by taking stock of what was known up to that point. Given that there had to be a period of ramping up efforts following the 2001 implementation of the new criteria, a series of reports and summaries that described the state of the field began to appear around 2005 with additional summaries in 2009-2010. These careful analyses of the literature provide a solid foundation for the focus of this report. Therefore, the results in this report will rest on those foundational pieces,
along with research on key topics since 2000, as displayed in the table that accompanies each segment.

Key summaries:


Part 2: ABET Learning Outcomes

In this section of the paper we will review the ABET learning outcomes that were listed above and the research that has grown up around each one. Not all the outcomes have received equal weight in the research so this report focuses on those with the best and most extensive research. Observations about the literature and recommendations for future considerations are included.

ABET Outcomes A & B (detailed in Chart 1)

A. Knowledge and conceptual understanding of engineering

B. Science and math principles and processes

Because both of these outcomes involve an understanding of the foundational knowledge of engineering and its related sciences, the research on each follows the same pattern of inquiry and findings. Therefore they are presented together in the interest of space.

Observation 1: There is a need for the identification of key concepts and their interrelationships in each subfield of engineering and related disciplines in order to create valid instruments to measure progress and target these concepts for special attention in both research and instruction.

An important step in creating a rigorous research program is the need for agreement on key outcomes and reliable and valid measures of those outcomes. This recognition has resulted in the identification of concept inventories as an important focus of development. Fashioning their efforts on the work in Physics of Hestenes, et al (1992) in developing the Force Concept Inventory, researchers in the various subdisciplines of engineering with the encouragement of the
Foundation Coalition began to develop and refine an array of concept inventories and use them as data sources in research on student understanding. (Evans, Gray, Krause, Martin, et al. 2003). This commonality of measurement instruments has helped to promote comparative research.

Recommendation

An important outcome of the research on engineering learning should be the development and validation of concept inventories in all typical subfields.

A second focus of research on the knowledge component of the ABET guidelines has been the exploration of concept mapping as a valuable research tool as well as having instructional uses. This procedure allows the researcher or instructor to evaluate the understanding of students of the inter-relatedness of the main concepts around a topic. Concept maps have been used to track changes in the way students understand an area either in cross-sectional or longitudinally in addition to comparing expert versus novice conceptual understanding. One caveat to their use has been the finding that experts do not always agree on the "correct" structure of a concept map for a given area, making it difficult to set criteria for evaluation. Heywood (2005) provides an extensive discussion of the use of concept maps in both research and instruction. Besterfield-Sacre, Gershak, Lyons, et. al. (2004) have provided guidelines for researchers seeking to evaluate student understanding through more holistic procedures for scoring concept maps.
A third measurement strategy that is gaining popularity as qualitative research has begun to be accepted as an appropriate research method is the use of think alouds during active learning or student reflective recalls stimulated by reviewing problem solutions or transcripts during interviews. These procedures have proven to be useful especially in research on misconceptions because they give the researcher or instructor access to student thought processes.

Turns, Atman, Adams and Barker (2005) made the interesting point that different phenomena require different measurements. For example, they suggest the following conclusions about measurements:

- Concept maps measure knowledge integration.
- Verbal protocols are focused on procedural knowledge.
- Ethnography recognizes the role of the context and the tools available.
- Surveys and interviews are adaptable to almost any knowledge.

Therefore, engineering education research is starting to use a wider range of measurements and paradigms to address the phenomena they seek to study, but it is unreasonable to expect them to become experts in all the methods used in the learning sciences. The most progress seems to come with collaboration across disciplinary lines.

**Recommendation**

*Faculty in Engineering are being well-served by collaboration with other fields that use multiple measurement strategies as well as programs that have helped them learn to use these strategies. Such*
collaborations should be encouraged through funding or institutional policies that support cross-disciplinary research.

Observation 2: In terms of research on the development of knowledge, researchers have been able to demonstrate changes in conceptual understanding across educational levels, but perhaps not as profound or deep as one would expect.

Although most researchers such as Muryanto (2006) and Segalas, Ferer-Balas, & Mulder (2008) have been able to characterize changes that take place as students move from freshmen to seniors in engineering as an increase in complexity, others such as Case & Fraser (1999) and Montfort, Brown and Pollock (2009) found that seniors often held the same basic level concepts as freshmen. Taraban, Anderson, DeFinis, et. al. (2007) shed some light on this quandary when they found that students were more likely to engage in cognitive change when they were required to be more interactive with the content. A similar movement was observed by Stevens, O'Connor, Garrison, et. al. (2008) who studied students both in cross-sectional and longitudinally and found the following changes in the curriculum brought increases in the complexity of disciplinary knowledge. For example, the changes in the curriculum they highlighted were:

1. shifts from "right answer" to open ended problems
2. shifts from individual as unit to teams as unit
3. shifts from prefabricated data to generating one's own data
4. shifts from ideal problem situations to real world constraints
5. shifts to having to provide additional resources on own initiative
6. changes in the role of the teacher

In almost all of the above, the requirement is for the students to become the agents of change rather than passively waiting for an instructor to tell them what to do. What research exists in this area has shown that the greatest change comes from active student engagement with difficult concepts.

**Recommendation**

*Research on strategies for instruction that cause students to become engaged and metacognitive about their learning would be valuable in this area. This work is well underway as will be seen later in this report.*

**Observation 3: Every area in engineering has difficult concepts that create barriers to learning and therefore should be the focus of research.**

As is the case with other sciences, engineering research finds that there are two types of knowledge that appear to be key obstacles to the development of conceptual understanding of the field.

The first obstacle to understanding is the existence of **threshold concepts** that serve as gatekeepers to more sophisticated conceptions of a field (Baillie, Goodhew and Skryabina, 2006; Meyer & Land, 2005). These concepts are difficult for most students, often abstract, and not recognized by students as keys to new ways of thinking about the discipline. For engineering students the
difficulty also can manifest itself as dependence on ritualistic algorithmic problem solving rather than true understanding, sometimes resulting in the inability of the student to even recognize the problem. An important step forward in the research would be to identify these threshold concepts.

**Recommendation**

> Identifying and helping students to cross over the threshold concepts in each area should be a strong focus of research. This work would be a natural extension of the work on concept inventories and concept mapping.

A second kind of difficulty students have with some concepts is the existence of **misconceptions** that appear logical on the surface but have underlying inaccuracies in conceptual understanding. Because they are often based on personal experiences, it is hard for students to recognize them as misconceptions. Prince, Vigeant and Nottis (2010) offer a good example of how misconceptions might be identified and the damage they do to student achievement. However, other than saying that traditional instruction doesn't appear to dispel misconceptions, the researchers are not able to make many recommendations. They refer us to the science education literature for models of conceptual change. Streveler, Litzinger, Miller and Steif (2008) discuss the idea that misconceptions are so hard to change because they tend to be unobservable but based on emergent processes that are wrongly interpreted. They reference the work of Chi (2005) whose theory on the epistemic sources of
difficulty in knowing can serve as a conceptual framework for research in this area. The most success in overcoming these misconceptions in the science education literature comes from directly confronting learners' incorrect predictions about phenomena about which they have misconceptions. Research on strategies for dispelling misconceptions in engineering should be pursued.

Recommendation

*Science education has much to offer engineering in the area of overcoming misconceptions that impede learning. Collaboration with specialists in this area or other behavioral sciences that deal with conceptual change would be a reasonable path to take.*

Preferred instructional method: Active learning strategies that involve dealing with the structural relationships within the disciplinary concepts, using concept mapping, diagramming, model eliciting activities and so on.

Key summaries:


ABET Outcomes C & D (detailed in charts 2 & 3)

C. the ability to do problem solving and research

D. the development of engineering design process skills

The two areas of instruction that occupy the bulk of the research in engineering education are problem solving and engineering design. This is because engineers first and foremost think of themselves as problem solvers who are in the business of designing solutions to the practical problems that plague the spaces and objects and processes of our lives. These two are also considered key to the field because they represent the way engineers solve problems. The strategies they involve will remain viable even as the world and its problems change around them. They also seem to cut across the sub-disciplines of engineering, being as relevant in chemical engineering as they are in electrical engineering. In a field as fast-paced as engineering, students must be able to envision new ideas and solutions regardless of the context in which they work. Therefore, in addition to skills, these areas represent attitudes toward the complexity of the world, the feeling that there are solutions to every problem and engineers can figure them out. A third characteristic of these two learning outcomes is that they must be able to transfer to the real world of engineering; they cannot remain hypothetical. Of all the STEM disciplines, engineering is the most accountable to industry and society and therefore finds it greatest instructional successes when learning takes place in authentic settings with authentic problems.
Observation 1: Although there are several models of problem solving in the literature, there is a great deal of similarity among them. However, students often are seen to be reluctant to adhere to the discipline of the problem solving models and have to be convinced to follow the recommended steps while still being able to be flexible in their thinking.

Here is a situation in which the pragmatic attitude of those who go into engineering might get in the way of the careful and thorough processes that need to be followed to solve what are very ill-structured problems faced by engineers in the real world. A great many of the articles in this area are descriptions of these various models and demonstrations of how they can improve student solutions. They frequently report difficulty in getting students to go through all the steps. For example an important step in almost all the models is the translation of the verbal problem description first into a graphic representation and then into a mathematical representation, known as "representational transformation" (McCracken & Newstetter, 2001). Students have been found to frequently go straight to a mathematical formula without creating the visual representation of the problem. This usually results in failure or misapplication of a formula leading to a dead-end. Subsequent research has shown that building in metacognitive reflection steps and self-explanation prompts can improve student problem solving.

Recommendation

Additional research on reflective practice and self-explanation habits in students might help point the way to instructional interventions that break
Observation 2: The best results come from the use of active learner processing of problem solutions. However, examples such as case analyses, model-eliciting activities, worked out problem examples, and heuristics may be needed to scaffold students as they gain more experience and confidence.

As will be seen in the next section of the paper, active learning and specifically active problem solving can be unquestionably confirmed as the best learning situation for learning the skills of both problem analysis and engineering design. It is also the most widely demonstrated key to deep conceptual understanding. There are many ways in which to engage learners actively in learning. The four listed in this observation are the ones that have good evidence to support their use, but they are by no means the only ones available.

Observation 3: Skills that have been taught in the classroom alone have difficulty transferring to work settings. The best instructional methods for problem solving involve authentic, complex problems that reflect the characteristics of workplace problems.

The ability to transfer learning from the classroom to the workplace is a significant goal in engineering education, and yet it seems to remain a difficult task. Most programs now incorporate authentic problem solving and project
design as much as possible, most notably in capstone courses for senior level students and increasingly in "cornerstone courses" at the freshman level and up so that the processes of problem solving and design become embedded throughout the curriculum. Rather than attempting to separate problem solving and design as general skills, many programs have accepted the probable situation that these skills are situated in nature and are best learned in real contexts allowing for the skill level of the student. An example is the service learning courses that are becoming more popular. These courses serve the dual purpose of satisfying another set of ABET learning outcomes dealing with social awareness, ethics and professionalism, and communication and teamwork skills.

**Recommendation**

The support of programs that place students at all levels in real problem solving and design settings, either authentic or simulated should be expanded.

**Observation 4:** The increased use of theories and research practices from other disciplines such as the learning sciences has allowed researchers to discover the thought processes of engineers with varying levels of expertise as a way of identifying key skills involved in problem solving.

Because the activities involved in these two aspects of engineering are internal in nature, the most progress in understanding them has come from making those behaviors observable. Strategies from the learning sciences and psychology, such as think aloud protocols during learning and stimulated recall
for retrospective analysis, discourse analysis of interviews, and protocol analysis of written problem solutions have resulted in a much greater understanding of student internal processes. The research program at the University of Washington (Adams, Kilgore & McKenna, 2008, for example) has been very successful using these strategies for understanding how students change in their thinking across their program. The VaNTH project situated initially at Vanderbilt but with a distributed network of researchers has demonstrated the effectiveness of engineering adopting the research paradigms of learning science as well (Cordray, Harris & Klein, 2009).

Recommendation

*Continued collaboration with other disciplines should become a favored strategy for larger programmatic research in order to make more systematic progress in uncovering the underlying psychological mechanisms that drive learning problem solving and design.*

Preferred instructional methods:

- For problem solving, problem-based learning, challenge-based learning and other inductive methods along with reflection and self-analysis of process.
- For design, project-based learning working in teams on authentic problems that reflect the type of workplace problems students will face in the future.
• Cognitive apprenticeships, design studios and other incubator formats in earlier courses, but real apprenticeships and service learning type programs for capstone courses. The latter also bolsters the disciplines connections with industry and keeps the content cutting edge.

Key summaries


Litzinger, T., Van Meter, P., Kapli, N., Zappe, S. & Toto, R., 2010 Translating education research into practice within an engineering education center: Two examples


ABET Outcomes F, G, & H

Process skills

F. teamwork

G. communication

H. ethics and professionalism

This set of skills were sometimes referred to as the "soft skills" for engineering because they deal less with engineering products than with the interactions that go on around the production of products. They are not unique to engineers, but they do have special qualities and characteristics that are tailored to the workplace of engineers. Therefore those in business and industry who employ engineers consider these skills to be possibly more important than the content knowledge that students acquire during their time in the university.

Observation 1: Despite their importance to the workplace, these skills had not received as much attention by the field until they were made explicit by the ABET standards.

The careful analysis of these skills by the field itself lags behind the problem solving and process skills in terms of evidence-based educational practice, so much of the work done in these areas tends to be proof of concept or arguments for their importance. Where engineering faculty have expertise in problem solving and design, their knowledge about these skills tends to be more tacit that explicit. They can work on teams, write and present their own work, and behave in an ethical and professional manner, but articulating how they do these things is new. It is very common for experts to have difficulty
deconstructing their tacit knowledge and explaining why they do what they do the way they do it. Fortunately, in the case of communication skills, the field has benefited from collaboration with others who are experts in communication, so that aspect of this set of skills is a little further along than research on teamwork or teaching ethics and professionalism.

**Recommendation**

*Just as the areas of problem solving and design have benefitted from collaboration with other disciplines skilled in the study of behavior, attempts at finding other professional fields whose expertise is in communication of all sorts, including teamwork skills and professional behavior, as well as ethics should be encouraged.*

**Observation 2: Teamwork - Students working in teams can learn teamwork skills, but care must be given to team formation, training and assessment.**

What is interesting about the literature on teamwork thus far is that there is a lot of work going on around developing measures to assess how teams are functioning. This is prompted by the observation that peer evaluation during teamwork enhances performance. It is also prompted by the need to understand team discourse in order to design effective training while setting up teams and interventions when teams go bad. Just as reflecting on one’s own learning helps individuals become better learning, it has been suggested that this process of reflecting on one’s own team role and the progress of the teamwork itself would be helpful in improving the team process.
Recommendation

Once instruments and procedures for monitoring team work strategies have been validated, discourse analysis should be used to deconstruct team activities to explain team growth and success, followed by the development of simple team building activities that fit the engineering context.

Observation 3: Because practicing engineers have identified the many ways in which they communicate on the job, attention should be given not just to written communication, but also oral (informal and formal) communication, and graphic communication skills in context rather than as a separate course.

The development of this category of skills is a very time-consuming process because it requires individual feedback to each student along with multiple opportunities to practice them. While project-based courses and capstone courses seem to have incorporated at least several opportunities for written and oral communication, only recently with the advent of computer media has much attention been given to graphic communication. However, the consensus of those who work in this area is that these skills should be embedded in the entire curriculum in order for the students to reach an acceptable level by the time they graduate.
Recommendation

In order to convince faculty to embed these skills throughout the curriculum, advantage should be taken of technology that affords both a venue for communication and some tools that simplify its assessment. Rubrics for assessment have been developed for written and oral communication, but are needed for graphic communication. Support of engineering faculty efforts from others skilled in these areas should be sought.

Observation 4: While there are some studies on the development of ethics and professional behavior, what is needed is the development of a "concept inventory" for this area. The use of authentic cases and experiences has already begun to be integrated into the curriculum, but there isn't agreement on what format this should take.

As can be seen from the Chart 6 breakdown of recent literature in this area, research on it remains at a descriptive or philosophical stage of development. This is consistent with other professions such as medicine and law. The need to provide ethical training as part of the students' undergraduate or graduate training is only beginning to be felt. As noted earlier faculty unquestionably have expertise in these areas, but likely at a tacit level. The expertise guides their conduct, but it is so automatic that only when pressed, does the expert take the time to reflect on what values and attitudes are shaping his or her responses to situations requiring ethical or professional judgment.
These also remain difficult for students since they usually involve situations that involve ill-structured problems and abstractions that are not easily concretized. Nevertheless, the ABET criteria have encouraged faculties to begin incorporating these kinds of experiences in the curriculum. Three strategies have been found: 1. a course on ethics and professional behavior; 2. brief allusions to them in other contexts like orientations or special events; and 3. the embedding of ethical and professional discussions in all problem- or project-based coursework. This last option would be the most in line with what is known about conceptual change and the principles of moral development.

Recommendation

*Faculties should adopt the embedded approach to all the skills described in this section so that they become part of the typical practice of engineering rather than being a separate skill seen as apart from engineering.*

Preferred instructional method: Collaborative or cooperative group work around authentic problems that include elements of each. Case studies, team projects, service learning, have all been used to teach these both separately but more appropriately together.
ABET Outcomes I, J & K

Awareness skills

I. an appreciation for the impact of engineering on society locally and globally

J. a commitment to lifelong learning

K. a knowledge of contemporary issues.

Observation 1: Impact of engineering and knowledge of contemporary issues have generally combined with the process skills just described in the cornerstone and/or capstone project-based courses that are increasingly a part of the engineering program.

There is very little research on this particular set of outcomes, probably because the overly full engineering curriculum hasn't yet decided where they fit. However, of the material reviewed for this synthesis, the bulk of the students' exposure to these issues was found in project-based courses, usually at the end of their training in capstone courses, but increasingly in cornerstone courses that are interwoven among the academic content courses. They have the added advantage of increasing motivation and retention, especially of women, and building ties between engineering and communities. A second type of context in which these skills can be learned or polished is the service learning course, a model that is finding favor through the undergraduate curriculum outside engineering as well.
Recommendation

Faculties should adopt the embedded approach to all the skills described in this section so that they become an explicit part of the typical practice of engineering rather than being left to chance.

Preferred instructional method: Case studies, project-based learning, service learning, industrial and/or community collaborative projects

Key summaries


Part 3: Instructional methods recommended

As can be see from the recommendations with each of the outcomes listed above, the predominant instructional methods supported in the literature are the following:

A. **Active learning** - in which the student engages with the content being learned in a way that deepens the understanding of how the content is structured and applied. As seen in the Chart on Active Learning and Engagement, this type of instruction has been reviewed by many researchers in many circumstances and always produces positive results. It is also consistent with constructivism, the dominant theory in psychology of learning today.

B. **Inductive teaching** - in which the students are confronted with a problem or question and encouraged to find the solution with scaffolding by the instructor, but basically on their own. This type of teaching takes several forms including problem-based learning, project-based learning, challenge-based learning, case study learning, guided inquiry, and experiential learning. It, too, has a long history of support from both theory and research. It is probably the best fit to current learning theory.

C. **Collaborative, cooperative or team-based learning** - in which students work as a team to engage in the activities described above under either active learning or inductive teaching. This particular format has the added benefit that students learn from one another, can usually solve more complex problems than an individual student can solve, develops student self-efficacy for problem
solving, and provide motivation through peer support and pressure. Students also learn teamwork and communication skills as an added benefit.

D. Authentic learning - including learning that is situated in an authentic context, such as laboratories, undergraduate research, internships, service learning, and project-based learning in an applied setting. This category of instructional format was not discussed much above because it is a relatively reason addition to the palate of instructional methods from which we chose. Also this is more appropriate called a context for learning rather than an instructional method, so it might be overlooked in the research. However, from research in other fields, we know that this context enhances transfer, depth of understanding of both content and intangibles that are present in the world of work that can't be duplicated in the classroom, including ethics and professionalism, as well as an understanding of the social aspects of engineering.

Key Summaries


Part 4: What is missing from this report

There are several areas of research and theory that have not been included in this report either for reasons of quantity, quality or space. Nevertheless these are important areas that can and do have impact on student learning. They would be included in most programs of educational research. Future syntheses should take them under advisement for inclusion.

Student variables - Perhaps the best example of work being done on the effect of student variables has been and continues to be done by Richard Felder, a name synonymous with learner characteristics. As a very important player in the effects of instruction on learning, it should not have been left out of any discussion of engineering education, but for the priority given to outcomes.

Technology in teaching - This topic is at the same time too broad and too narrow to be included in this review. Too broad because it encompasses not only technological tools of education, such as computer based instruction, computer communication systems, and presentation media, but also technology of the engineering profession and how it is used and evolving. In fact the field changes so rapidly that it has become difficult to find good reviews of the trends outside of technology publications. Nevertheless, as a component of the context of learning, technology should be included in future summaries.
Instructor variables (input and output) - The final missing piece is research on the instructor and how all these forces of change in engineering education impact him or her. And of course, the instructor impacts the effect of instructional practices, either consciously or unconsciously. There is very little current work being done in this area, but like technology and the student, the instructor deserves the attention of research in education as well.

Key resources


Part 5: In conclusion

The impact of the ABET certification criteria has been enormous if only because it made clear the goals for teaching and learning. The field of engineering education is still evolving as a profession, but it has made great strides in the last ten years. Where might it look next for another leap forward? Here are some suggestions gleaned at the meta-level of observation of these studies.

A. Conceptual Frameworks - Research balances on the foundation of theory, both so it can ask the right questions and so it can look in the most fruitful nooks and crannies of a theory for where to go next. There are now very powerful theories of learning and motivation, student development both cognitively and morally, and the interaction of learning with the environment. Becoming familiar enough with these theories to choose those that best fit engineering would be very important to guide future research.

B. Instrumentation - The best way to move forward is to regularize the data that are collected by developing widely used, reliable, valid measures of the outcomes that the field seeks. This has begun in the development of concept inventories, rubrics and other methods learned from collaboration with other fields.

C. Programs rather than single studies - A lot of the research up to this point has been focused on single courses, even a series of implementations of the same course. But in this review, the best data were provided in the context of a larger program of research, such as that at the University of Washington, Penn
State, VaNTH, Smith’s work at Minnesota and now Purdue, and Felder’s work at NC State. The recent establishment of divisions and research centers is the model that will be able to study a phenomenon under constant conditions and systematically. Such programmatic research should be encouraged.

D. **Collaboration with other disciplines** - I have repeated this refrain in several parts of this report, and I will repeat it again here. It is unfair to expect engineering faculty to take the time to become experts in educational research. Becoming an expert takes 10 years, and it can't be done part time. The best solution, and one which was evident in the research that contributed to this summary, was done in collaboration with others who were already experts in educational research. The combination of that expertise with the content expertise of the engineering faculty opened doors for both professions.

E. **Dissemination and building on the work of others** - The Carnegie Foundation's president Lee Shulman has said many times that one of the problems with education is that it doesn't have a solid foundation of previous work on which to build. Therefore, for engineering education to avoid that trap, it needs - and has- exceptional outlets for its work. The sources listed in this review are the prime examples.

F. **And finally, recognition** - Engineering educational research needs to be recognized as a legitimate activity in the discipline that will garner the same rewards as engineering basic research. I believe that is happening, but maybe too slowly for my tastes. Perhaps this paper and the others that have gone before and will come after can contribute to speeding up the process.