- Minutes -
Engineering College Council Meeting
October 21, 2016
Ithaca, NY

Members Present: Nadine Aubry, Jim Becker, Najib Canaan, Lance Collins, Robert Cowie, Frank DeCosta, Michael Even, Sarah Fischell, Greg Galvin, Virginia Giddings, Rana Glasgal, Kent Goklen, Andrea Ippolito, Michele Kaliski, Aref Lahham, Jonathan Ludwig, Ivan Lustig, James McCormick, James Ricotta, Susie Riley, Daniel Simpkins, Elissa Sterry, Duane Stiller, John Swanson, Joseph Thanhauser, Molly Tschang, Andrew Verhalen, Lisa Walker, Craig Wheeler, Eric Young

Emeriti Present: Richard Aubrecht, Jay Carter, Robert Shaw

The meeting presentations and materials can be found at:
https://confluence.cornell.edu/display/ECC/2016+Spring+ECC+Meeting

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**Welcome and Introductions**

Greg Galvin, ECC Chair, welcomed the Council to the Fall '16 ECC Meeting. Lance Collins, Dean of Engineering, announced that the focus of the meeting would be "the modern engineering educational experience" in the college. He also welcomed the new members to the Council: Aref Lahham (Cornell M.Eng. '86 CEE), Orion Capital Managers; Molly Tschang (Cornell B.S. '85 ChE), Abella Consulting; and Lisa Walker (B.S. ChE '86), Leadership Capital Advisors.

**Education in the Age of Exponential Technology**

*Charles Fadel, Founder and Chairman of the Center for Curriculum Redesign, via Skype*

Charles Fadel participated in this meeting via Skype. The Center for Curriculum Redesign (CCR) is a non-profit global organization dedicated to improving Education via answering the question: "*What* should students learn for the 21st century?" The CCR brings together international organizations, jurisdictions, academic institutions, corporations, and non-profit organizations including foundations. It focuses on both designing and propagating new curricula.

Fadel discussed the skill sets needed for today's engineers, as well as innovative strategies to create a curriculum that would enhance these necessary skill sets. His presentation, "Education in the Age of Exponential Technology" posed the question: how do we deliver and manage this education? He explained that innovation follows patterns. If you follow patterns, you can create innovation. Fadel also noted that there is incremental and radical innovation. Incremental innovation seeks to improve an existing "state", whereas radical innovation involves inventing a completely new "state". He pointed out that the good news is that computers are unlikely to be capable of radical innovation soon, however, the bad news is that incremental innovation is

estimated to be 95% of the total. He noted that the road ahead is challenging due to numerous factors such as technological disruption, climate change, personal privacy, financial instability, political partisanship, religious intolerance and inequities. He described our new world as: VUCA – Volatile, Uncertain, Complex, and Ambiguous. We're at the mercy of the weakest link (whether it's a pandemic, i.e., the ebola virus, or that one country's financial situation can affect the global financial situation, i.e. Greece's effect. He also posed the question, "20 years from now, what will you need to be successful in that world"? Fadel explained that good communication and leadership skills, creativity, tolerance, collaboration, empathy, and resilience will be necessary. It's not just what you know, but how you use what you know.

Fadel also discussed the power of exponential technologies and the impact of Big Data and Machine Learning.: We're on the road to ExoBrain: by 2025, we'll be able to have the computing accessibility of the human brain. We'll have access to unfathomable computing power. He noted that there are three key areas in which machines beat humans: they can consume huge amounts of data; they can receive thousands of inputs at once, and can create a unified model of knowledge across that scale of information and make judgments from it, and do so with fewer human cognitive biases. However, humans have access to much more diverse date than a machine does: "building intuitions and holistic pictures in our mind and seeing connections that the machine might not even have the possibility of seeing because it doesn't have the right data. Humans also have a powerful role in figuring out the sources of data to give the machine, and projecting their intuition.

Fadel added that artificial intelligence is applied everywhere (speech recognition, video content recognition, computer vision, natural language processing, machine learning, etc.) Robots are learning from each other, and knowledge and experience is being shared worldwide. Computing tasks carried out in the Cloud are creating hyperbolic improvements. We are often limited by our limited imagination. He described the creation of lens that can be used to experience augmented reality. Emotions can also be detected in the body (i.e., anger, fear, disgust, happiness, sadness, etc.). Virtual reality: googles will allow you to experience a virtual reality. Someday, cyber psychologists will be needed. Other advances include 3-D printing; brain enhancers to enhance the brain's capability; synthetic biology, increased connectivity and access to the internet; and nanomaterials: the ability to design materials moving atoms.

Fadel added that biotechnology is booming. Genome "Sequencing costs are dropping faster than Moore's law (i.e. cost per Genome Sequencing dropped from $1.5B to $1k in 15 years, which will be down to 10 cents in another 15 years. He explained that Genome editing is possible by changing genomes. "The Beijing Genomics Institute's Cognitive Genomics Project is currently doing whole-genome sequencing of 1,000 very high-IQ people around the world, hunting for sets of sets of IQ-predicting alleles… Kids produced by any one couple typically differ by 5 to 15 IQ points. So this method of "preimplantation embryo selection" might allow IQ within every Chinese family to increase by 5 to 15 IQ points per generation". Fadel warned that we must consider the unintentional and intentional implications of changing genomes. We'll need to think seriously about the ethics of these changes. This technology will open the area of enhancing human intelligence. Fadel pointed out that other advances include STEM Cell

research. “Miniature ‘human brain’ grown in lab will transform the understanding of neurological disorders. The pea-sized structures reached the same level of development as in a nine-week-old fetus.”

Fadel explained that there’s a combinatorial explosion of possibilities which is accelerating change. He explained that this has created a race between technology and education resulting in social pain, then prosperity, then social pain. He added that we might be headed for “Event Horizon”: What if formal education cannot catch up with technology? Fadel emphasized that in the present and future, adaptability and versatility are key strategies. It’s also the ability to be modern age renaissance people. The goal of education is to create fulfilled individuals and a sustainable humanity.

Fadel pointed out 10 jobs that did not exist 10 years ago, such as: app developer, social media manager, Uber driver, driverless car engineer, cloud computing specialist, big data analyst/data scientist, sustainability manager, YouTube content creators, drone operators, millennial generational expert. He explained that there is a disconnect between youth, employers and educators. He noted that education providers are twice as likely as employers and youth to rate youth as prepared. This accelerating change demands different skills than in the past. The demand for non-routine analytical (e.g., engineers) and non-routine interpersonal skills (e.g., consultants) has increased dramatically over the past 40 years.

The mindset on what is engineering is expanding. In the past it had a narrow definition of: specifications → design→ prototype. Now it has expanded to: people → problem → concept →specifications → design → prototype → product → market. Students are begging for relevance with respect to their education. According to Albert Einstein “you cannot solve a problem from the same consciousness that created it. You must learn to see the world anew”. It is important that education become much more relevant than it is today. He stressed the need to embed in education the cross-cutting themes of global, information, environmental and digital literacy, as well as systems and design thinking. He added we also need to learn the 4 “C” skills of: creativity, critical thinking, communication and collaboration. In addition, we also need to build character through: mindfulness, curiosity, courage, resilience, ethics and leadership. Fadel described the matrix of the 21st Century Learner, which involves a “Metacognition Growth Mindset”. Four-Dimensional Education: He explained that Meta-Learning involves “How we reflect and adapt”. It’s Knowledge, “What we know and understand”. Skills, “How we use what we know”, and Character, “How we behave and engage in the world”. “Educators worldwide (need) to rapidly operationalize these dimensions”. Fadel noted that we need to remove deep re-examination of every single discipline’s branches, topics, items, etc. He added that we need change management because every system has a certain amount of inertia and he’s concerned that we’re not moving fast enough. He stressed that the planet needs leaders who can move decisively.

Fadel concluded by explaining that the benefits of meta-learning include increased human potential, societal wellbeing and collective prosperity. “Let’s shape education for the future we want”.

Comments regarding Charles Fadel's presentation

*How can this type of education be implemented?*

Fadel: We need to rethink which competencies are best suited for each specialty. The competency table in his presentation describes what competencies are needed for each specialty. These analyses can be done with faculty and determine competencies needed for each field.

*Education in the arts gets less funding and support. What is the role of the arts and humanity education in engineering?*

Fadel: He had poor arts education. However, he feels that engineering and the arts have similar processes, which open your mind to new possibilities. The arts cover most of the competencies we are looking for in engineering. Logical reasoning is too narrow and, currently, it's the only competency valued. Out of the box innovation arises from creativity.

*Comment: Being well-rounded is very important. It is valuable to hire people with dual degrees (i.e., engineering/history). However, some majors are so difficult that students don't have time for electives.*

Fadel: The faculty need to have a conversation about this. We should reward faculty for making these changes, however, he's not sure of the answer. Lance added that at the graduate level there is more flexibility than at the undergraduate level. He believes there's band width to move in the direction that Fadel describes.

Fadel: Every system has about 25% leg room. You need a roadmap (like a visible matrix) to have people pay attention to this.

*It's about framework, so that the organization uses the same vocabulary for change. How about mixing up the professors (music professors, near engineering professors). Real estate might help enhance this change.*

*Accreditation is a barrier to creativity. How do we break that barrier?*
Fadel: College entrance requirements are full of biases. ABET has biases about everything you're doing. It's controlled by a small number of people. How about getting together with other institutions to confront this issue.

*A lot of what we teach are engineers will be useless in the future. The jobs of the future will require many facets: business, art, architecture. We need to dramatically change our curriculum.*

Fadel indicated that it is a good idea to integrate co-op education with a rigorous curriculum. Extracurricular activities and electives are important, however, it is still a struggle to give credit to students who do this. He added that there are other models that are emerging such as the NAE Grand Challenges program. He also stressed the importance of interdisciplinarity as an approach to education.

**Breakout Sessions**

Breakout groups met and addressed the following question: *What did you hear that could be applied to Cornell Engineering?*

Feedback from Breakout Group led by Molly Tschang:

3 Overarching themes:

- Leading change
- Managing complexity
- Embracing experimentation

We saw Cornell engineering as being an "M" vs. a "T" type college, and as playing a role in helping students gain both perspective and relevance.

Opportunities going forward -- we saw tremendous richness already within the College, but we didn't necessarily have a full view and shared reality, which is important.

A. Create baseline inventory of just what all is offered (think - "current state") - including who is taking advantage of what so we have demographics
B. Be explicit in above as to the competencies and qualities that courses/experiences are intending to offer ("desired outcomes") - meta-learning, art of disruption (create perspective shift, challenge the norm), innovation, beginner's mind, see the forest through the trees, making the impossible possible, etc.
C. Understand impediments to students taking advantage of above, e.g., incentives or structure related to both students and faculty. This includes current mindsets, and potential culture evolution needed

From A and C, clarify the gaps, which helps guide steps to make the most of existing offerings that students are deriving greatest/desired benefits. Can tap into alums/ECC to unpack ways to close the gaps.

We noted a distinction of working technically across engineering or university vs. broader interdisciplinary interaction/learning that support 'real-world' relevance - i.e., students are more functional in the world (not just do the job - but if moved to China for a few months, can adapt to new environment). We encourage 'walking the walk' of experimentation and perhaps model x-disciplinary learning by having a history prof co-teach w/ a civil engineering prof.

Emphasis on expanding and gaining broader reach of co-op programs. For some of us it was an option for "just a few" it seemed - can this reach many more, as we found it extremely powerful experience.

Lastly, we noted our conversation centered on incremental approaches and ignored anything 'radical.' We're not necessarily advocating for radical, but seemed important to think truly out of the box.

Molly added that she echoed Craig Wheeler on the need for clarity of Vision (e.g., best engineers are equipped to succeed in complex, changing world - and define 'best' and 'success'). She indicated that in her own experience this is galvanizing for an organization and essential to gaining alignment of all stakeholders.

Feedback from Breakout Group led by Andrea Ippolito:

**Summary recommendations**

1. Help advocate and influence policies and factors external to Cornell:
   During discussions, it came out that many professors feel pressured to keep up with their peers and feel compared to their peers at external institutions. Therefore, it would be hard for them to deploy some of the strategies described during the presentation because they would feel the need to keep up the status quo. Therefore, Cornell should advocate to standards groups, such as ABET etc., to ensure professors have the latitude to deploy some of the novel strategies discussed.

2. New approaches with curriculum:
   With professors (as told by the professor in our group!), they have started taking the "less is more" approach. Instead of trying to fit in every bit of content, they are trying to allow for more time for discussions and creativity. More should be done to encourage the "less is more" approach. In addition, more experiential options should be built into the curriculum, such as co-ops, internships, apprenticeship, student project teams, and extracurricular opportunities + leadership roles (Society of Women Engineers, etc.). Also, how can we systematically encourage more opportunities for team-based classes that mimic real-world project teams. Olin College graduates are among the top communicators and team players in their professional roles (as one of our teammates said "we could not hire Olin College graduates fast enough").

3. Create a culture of taking risks and "learning to learn":
   As part of the College of Engineering culture, encourage students to take risks and not fear failure. In addition, focusing on creating opportunities for students to "learn how to learn" to learn how to problem solve and be resilient.

4. Creating more feedback loops throughout the school year:
   By creating more feedback loops with administrators, professors, and students,

professors can respond to students' need in a more iterative manner throughout courses. In addition, curricula should be reviewed on an annual rhythm to infuse more modern disciplines (design thinking, etc.) and modern unmet needs (artificial intelligence, climate change, etc.).

Feedback from Breakout Group led by Mike Thompson:

- Courage to start a company.
- EXPAND what is the curriculum.
- Depth in liberal electives.
- Need some depth.
- Faculty that tell students they are solely here for research. And some that are all about teaching and are aware of implications.
- Pace of technology change is so much faster than timescales of academia.
- Introspection about what we are really doing.
- Conscience articulation of what are some of the business qualities.
- Cost / performance tradeoffs
- Systems analysis / business analysis / taught by accident
- Personal and team collaboration teams / currently taught but not an objective of the class
- Need to completely rethink how we teach
    - Change out of lecture format ...
    - Still in buildings. Still with teachers. Still in classrooms.
    - Everything is the same today as it was in 1964.
    - World is moving fast, need to think about new ways to do education.
    - New school - free tuition - peer taught.
    - Need to change perspective.
- Need to increase the ability to reflect on societal impact and meaning of work
    - Marriage of people and technology. Well-rounded engineer. Understand philosophical impact.
- Add to curriculum in every course.
- How to build true interdisciplinarity. Especially in broader aspects.
- Increase / prepare students are Arts / Liberal / Humanities
- COOP particularly valuable
    - Numbers decreasing due to other opportunities
- Project teams in some ways equivalent
- Need to change expectations -- back to a 5 year engineering program as at Northeastern
- MIT ethics need. Ethics in everything
- Rapid especially in bio and bio-medical materials
- Racker lecture - ethical and policy issues.
- Break culture. Day in / day out / we are the engineers. L&A&H are second class. Need to change that "just an arts major" fallacy
- Need to open up more options for students to reflect broader needs through electives.

- Force re-evaluation of the required curriculum ... just because done for 50 years is it necessary.

Feedback from Breakout Group led by Najib Canaan:

- We don't have enough data to see if we have the right approach.
- Cornell is already good at preparing students to be problem solvers.
- Cornell has changed over the years and is more collaborative. We're creating resilient students.
- How do we pick the students to enhance our goals?
- How do we guide our students and let them know all that there is for them to do?
- How do we get them out of their comfort zone?
- How do we teach them the "why" for what they do?
- Should consider asking students to meet with an advisor from outside of engineering.
- Use Cornell Tech as a lab. What can we learn from it?
- Faculty also have to change. Although they're already changing, slowly but surely.
- Allow the students to force the faculty to change, bottom up approach.
- The metrics for success need to be established.

**Division of Professional Practice**
*Michael Thompson, Associate Dean for Undergraduate Programs and Associate Professor, Materials Science and Engineering*

Michael Thompson gave an overview of the Division of Engineering Practice. He explained that ABET, which is the organization that accredits several Cornell Engineering programs, evaluates the following eleven student outcomes:

a) Fundamental knowledge
b) Conduct experiments
c) Design systems
d) Multidisciplinary teamwork
e) Solve engineering problems
f) Understanding of professional ethics
g) Communicate effectively
h) Broad education to understand impact of engineering in society
i) Desire for life-long learning
j) Knowledge of contemporary issues
k) Use of modern engineering tools

Thompson pointed out that Cornell is already at the forefront of many of these requirements, such as through experiential learning, which strives to create, lead, disrupt and invent. He also outlined numerous experiential programs which promote learning by doing, including the: Co-op program, business minor with the Dyson School, the entrepreneurial minor, project teams (Swanson endowment), eLab/PopShop and eHub Expansion, Kessler Fellows, Engineering

Leadership Program, and the Product Design and Manufacturing Institute. Thompson indicated the college has one of the largest project team programs in the country, with over 23 teams in 2016-17 and over 1,000 student participants. He added that this multidisciplinary collaboration spans 14 engineering majors and 7 undergraduate colleges and schools, and asked the council for advice on how the college can better support these teams and integrate this experience into the curriculum.

Thompson also discussed the College of Engineering Division of Engineering Practice Wheel which represents engineering in action through: Project Teams (design, implementation, leadership, team management); McCormick Teaching Excellence Institute (pedagogy and assessment); Bovay History and Ethics Program (individual and society responsibility, unique engineering role as stewards); Leadership Program (vision, team management, communication, project management, group dynamics); Engineering Communications Program (written, oral, visual, range of formats from technical papers and presentations to elevator pitches); Kinzelberg Entrepreneurship Program and Kessler Fellows Program (innovation enterprise, networking, self-awareness); and Engineering Learning Initiatives (research involvement, collaborative learning). He added that this wheel shows combining existing programs to leverage synergies in professional development that will span broad aspects of the professional engineer's life.

Thompson also pointed out that students need to be involved in a wide range of interests in the areas of: industry and technology; academia and research; entrepreneurship; consulting and business; with the center of these areas being technical and professional expertise. He indicated that these skills are often difficult to train, however, there are programs in the College to assist students with these skills, such as the Engineering Communications program, led by Richard Evans, Robert N. Noyce Director of Communications. Thompson explained that the objective of this program is to enable undergraduate engineering students to develop strategies for learning how to act effectively and efficiently as communicators. He noted that the Bovay Program for Ethics in Engineering, led by Professor Ronald Kline, Sue G. and Harry E. Bovay Jr. Professor in the History and Ethics of Professional Engineering, has a similar goal to embed these concepts into the curriculum. The objective of this program is to be a catalyst for consideration of social and ethical issues in the College. He added that the Project Teams Program, led by Rebecca MacDonald, Swanson Director of the Engineering Student Projects, coordinates and manages the team and team projects, as well as develops training programs to support team dynamics (leadership and team building, conflict management, corporate relations). Another program that supports our students is the Engineering Leadership Program, led by its Director, Erica Dawson. The purpose of this program is to develop and support programs to foster leadership and team management skills and integrate these into the curriculum.

In addition, Thompson discussed opportunities for Cornell engineering students to be involved in entrepreneurial activities through Entrepreneurship@cornell.edu, the Kessler Fellows, the new entrepreneurial minor, and the Dyson business minor. He pointed out that the college also has an Engineering Learning Initiatives Program led by Lisa Schneider-Bentley, Director, and

Anne Poduska, Associate Director. The purpose of this program is to enhance the learning environment in the College by providing students with opportunities to engage in collaborative learning, undergraduate research and peer research. It also provides Academic Excellence Works, engineering graduate TA development, engineering undergraduate TA training and engineering math workshops.

Thompson explained that the McCormick Teaching Institute, led by Kathy Dimiduk, Director, is involved in the assessment and improvement of the engineering curriculum. This is done through various activities including: individual consultations, classroom observation, new faculty assistance, teaching research assistance, teaching tips and resources, workshops and seminars, as well as books and articles on college teaching. Dimiduk encourages new teaching styles, such as the movement to flipped course models. Thompson concluded by stating that it is critical to implement these changes with this new paradigm.

**Massive Open Online Courses (MOOC) and Simulations: Creating a New Paradigm in Engineering Education by Combining Two Disruptive Technologies**
*Rajesh Bhaskaran, Swanson Director of Engineering Simulation*

Rajesh Bhaskaran gave an overview of the Swanson Simulation Program at Cornell. This program was established in 2000 in the Department of Mechanical and Aerospace Engineering with a generous endowment from John Swanson. The goals of this program are to facilitate the introduction and routine use of computer simulation in MAE curriculum and to provide support and leadership to the community on simulation in engineering education. Bhaskaran directs the Swanson lab and has helped introduce industry-standard simulation tools into Cornell courses covering fluid mechanics, heat transfer, solid mechanics and numerical analysis. He pointed out that the Swanson Program has had an impact on numerous project teams, including the: Formula SAE Racing, Baja SAE Racing, Violet Satellite, Mars Rover, AIAA Design-Build-Fly, CU Sustainable Design, Cornell Rocketry, Concrete Canoe, Steel Bridge, Agua Clara.

Bhaskaran led the development of simcafe.org, a free online portal for learning and teaching finite-element and CFD simulations. It contains over 50 learning modules, including Finite-element analysis (FEA) and Computational Fluid Dynamics (CFD) using ANSYS. He added that the learning modules have a uniform structure that connects fundamentals to hands-on practice. It has enabled the integration of ANSYS-based simulations into 12 Mechanical and Aerospace engineering courses at Cornell. In June 2016, Bhaskaran launched a massive open online course (MOOC) entitled "A Hands-on Introduction to Engineering Simulations" at edx.org. He noted that this course appeals to a broad audience from high school students interested in engineering to practicing engineers, as well as instructors who are interested in using simulation tools in their courses.

Bhaskaran added that to build the MOOCs he used six ANSYS Case Studies: one Conduction, two Structural Mechanics, two Fluid Dynamics, and one Fluid dynamics and Structural mechanics studies. The big ideas for these studies involved techniques for solving mathematical models. This meant "breaking the rules", since there was nothing else quite like what he was

doing. He gave the example of the blackbox. In order to solve the problem of what's inside the blackbox, one needed to conduct a pre-analysis using a mathematical model, a numerical solution procedure and hand-calculations of expected results and trends, followed by verification and validation. Verification: Did I solve the model right? Validation: Did I solve the right model? He added that online lectures are recorded in a self-service studio. Bhaskaran indicated that he can bring in industry experts and can present his lectures in 4-minute chunks, which matches short-term memory. To date, he has made over 220 videos.

Bhaskaran noted that to sign up for this MOOC course, all you need is an email address. Currently, over 25,000 students from 169 countries have signed up. Over 9,000 are actively engaged with the course and 1,600 have completed it. 1,100 have signed up for a verified certificate, paying $49 each. He added that they come from diverse levels of education and the course materials have received very positive rating (greatly exceeded his expectations).

Bhaskaran concluded by indicating that MOOC demonstrates a new paradigm in engineering education. Students gain practical skills sought be employers, a better understanding of fundamental math and physics, enabled by combining the two disruptive technologies of simulations and MOOCs. This new paradigm disrupts the status quo because it is integrative (it cuts across traditional boundaries); flips the curriculum (beginners are exposed to advanced material); uses learning modes proven to be more effective (hands-on, visual, case-study based, guided exploration in a numerical lab environment; scalable (one person can teach thousands; Global (faculty can run an international classroom sitting in the office); and is customizable (accommodates diverse audiences). His vision is to develop and disseminate the next-generation engineering curriculum that is simulation-based and digitally delivered. This will enable the "democratization of simulation". In the future, he plans to develop a core simulation-based curriculum, increase awareness, provide crowd-source teaching, facilitate the integration of MOOC content into courses, and support interested faculty.

**Group discussion regarding Division of Professional Practice**
Led by: *ECC Chair Greg Galvin and Vice Chair Elissa Sterry*

Mike Thompson asked the Council for their feedback on the best way to start based on the ideas presented at this council meeting

Comments:

- *The big ideas themes stood out. How do we actually build those life skills that students will need in industry?*
- *Begin with the end in mind. Find out what % of UG's have a tendency to end up in industry, entrepreneurship, etc.*

Lance responded that part of our role is to produce leaders whether or not that manifests itself in industry, start-ups, etc. He added that when our students took a survey on entrepreneurship, our numbers were as high as any other university. We are very effective at producing entrepreneurs. However, we need to increase those numbers.

Thompson added that we want leadership to be a 10 and want to nurture the areas in which students are passionate.

Comments:

- *How do we integrate Co-op and project teams into the curriculum?*
- *We never talk about engineers in policy-making roles? We don't mention that as a goal. We want to produce people who are leading. Do students come to Cornell knowing that this is a possible track? Is this something we can nurture?*
- *Students want to make societal impact. We should interweave that into their curriculum.*
- *Freshmen could benefit from a personalized mentoring network to connect them with an external advisor.*
- *Students want mentorship, especially freshmen want to be mentored by senior students or faculty. We should try to make it easier to find that mentorship. What are the measures of success if we want to serve those constituents? Why is our K-12 education so terrible? What are our different outcomes and how do we measure them?*
- *When you consider what it takes to go to any other field, there are many paths blocked off, how do you do overcome that? The rigor of the curriculum is very intense. It can make it difficult to pursue another path.*
- *When we think about the skills we want to include in the curriculum, there's lots of data from enrolled student surveys, alumni surveys. We might be able to make a diagnosis if we look at past surveys (ILR has these surveys). Should create a focus group of employers.*
- *One of the things that make entrepreneurs is failure. How do you teach students how to recover from failure? It's a valuable skill.*
- *We need to create engineers who can succeed in whatever environment they are in.*
- *Failure and innovation. Corporations are looking for finding a new way of doing things, Failure mode – a culture that promotes this is often successful. It's ok to fail.*
- *Small incremental changes will give us what we want. Remember to make changes incrementally instead of reinventing what going well.*
- *Entrepreneurship is at an all-time high. We shouldn't over index important decisions regarding entrepreneurship. Engineering teaches students how to solve problems. We should think about our curriculum in that mindset. We should make it easier for students to do this.*
- *How do we keep doing what we're doing so well with fewer resources? Failure is going to become more and more important. Start introducing more 2 credit courses. Can be pass/fail. We are all life-long learners.*
- *In course feedback, start to ask students what they learned in the classes.*
- *Teach leadership in the 1050 class.*
- *Entrepreneurship should be a means, not an end. Entrepreneurship is a tool.*
- *T-shaped engineers are hard to find. In the end it's about impact. Entrepreneurship is important. Role of empathy is important and should be included in curriculum.*
- *Problem-solving skills, not only technical, but dealing with ambiguities.*