

EPICENTER research summit

AUGUST 4-5, 2014 • STANFORD UNIVERSITY

Condensed Session Notes

Table of Contents:

- Page 2 - Session A: Research on Students' Entrepreneurial Development and Pathways
- Page 5 - Session B: Cooking Up New Research Ideas: With Students, About Students
- Page 8 - Session C: Research on Entrepreneurship Programming and Unprogramming
- Page 13 - Session D: Research on Curricular Approaches
- Page 18 - Session F: Keynote Panel: Forest-Level Reflections on the Research Landscape

Session A: Research on Students' Entrepreneurial Development and Pathways

Session chairs:

Anne Colby, Stanford University

Bill Damon, Stanford University

Panelists:

Dan Ferguson, Purdue University

Kathryn Jablokow, Pennsylvania State University

Heather Malin, Stanford University

Tenelle Porter, Stanford University

Gisele Ragusa, University of Southern California

Sarah Zappe, Pennsylvania State University

(Bill Damon) Risk-taking and entrepreneurship

- What is it about young people who enter into this objectively risky undertaking without worrying?
- Few people with entrepreneurial interests perceive that what they are doing is risk taking
- Characteristics in common among entrepreneurs: curiosity, variation in curiosity, many different pathways, individuality of learning, freedom to explore
- Interaction between perspective, interests, talents of individual, and nature of context - back and forth between perception of world and then reevaluating; educators need to appreciate interaction when trying to cultivate entrepreneurial intent and interests

(Anne Colby, Bill Damon, Heather Malin, Tenelle Porter) Study on entrepreneurial intention among 18-26 year olds

- 4 questions: causes of intention, what happens to intention, what differs between acted on and not, impact of entrepreneurship training
- 3 contextual factors expose students to entrepreneurship: parents, major, college culture
- Entrepreneurial intention develops, then implementation
- They gain clarity about interests and goals and how entrepreneurship fit in

(Gisele Ragusa) Creativity and propensity for innovation in engineering:

- The Engineering Creativity & Propensity for Innovation Index
- Creativity and innovation not synonymous but related; must measure impact of programs; non-generic constructs; results defying many pre-held traditions
- ECPII constructs: engineering initiative, inquisitiveness, individuality; disciplined imagination and design thinking; flexibility; fluency
- Non-traditional students are natural problem solvers because they are always in adverse situations, very high in flexibility and fluency
- Creativity, originally thought as static, is not in any way

(Dan Ferguson and Kathryn Jablokow) Engineering innovativeness

- Research question - measuring engineering innovativeness based on individual's attributes and skills, characterizing different pathways
- Years 1-5 of research activity, developing instrument

- Characteristics of an engineering innovator: many combinations of characteristics make someone an engineering innovator, there is not one profile; some look learned, some look innate

(Sarah Zappe) Integrative and interactive models of student and entrepreneurship development

- What are the characteristics of advanced entrepreneurial students?
- Advanced students weren't higher in engineering self-efficacy, but they were higher in creative self-efficacy, locomotion, and assessment scores
- What are the beliefs and perceptions of instructors who teach entrepreneurship?
- People who teach entrepreneurship believe skills can be learned
- Do faculty believe the entrepreneurial mindset is developed or innate?
- How do faculty members teach entrepreneurship?
- "There is always an interplay between the psychological characteristics of the person and of a specific environment; the one cannot be defined without [reference] to another"
- University programs and courses provides just one force in student development

Questions and comments:

- *Q: What makes people want to become entrepreneurs?*
- The trajectory you take towards becoming/not becoming entrepreneur relates to individual factors. Doesn't look like individual factors, contextual factors are the same.
- *Q: Does the dominance of white males in the field impact differences seen between innate and learned characteristics?*
- This pool is not dominated by white males. Many surprises about what we thought would have an impact, for example, things that play a role: service learning, type of internship, some gender differences, college generational status, different life experiences. Have primary interests and characteristics of engineers been studied? Popular stereotype.
- *Q: How do characteristics of professors teaching classes influence their students?*
- Faculty are very important to individuals for providing connections and interactions with people working in the field.
- *Q: Why did you choose that model (developmental)?*
- There may be others more appropriate for entrepreneurship, I haven't seen any, but is a good starting point. I like it because it's complex but very comprehensive.
- *Q: Students face barriers when trying to launch companies as undergraduates; tradeoffs and dichotomy between attending classes and this career. Have you thought about how to rectify this dichotomy?*
- Universities have a responsibility to help address this with students. Students need time to be able to go back and forth. We're pleased about the maker space and community based labs where people can work. I don't see them in opposition and hope there are ways barriers can be destroyed. Barriers characterized differently for different kinds of students. Barriers as potential opportunities.
- We shouldn't measure entrepreneurship as a phenomenon by whether people start a business or not. It's how people approach problems. Every engineering graduate could be more entrepreneurial. Using "entrepreneurial" as an adjective, spirit of how you approach things, entrepreneurship should be reserved for actually doing something (not necessarily starting a business).
- To some students, school seems like a distractor. Students are getting things from school whether they believe it or not.

- Someone told our students to drop out of school, that innovation doesn't necessarily happen in classrooms. But it's the environment created by teachers and schools that is so valuable to entrepreneurship.
- In order to get traction amongst engineering faculty who want buy in for courses, we need to show it as mindset for solving problems.
- There is opportunity in the university environment and beyond. Many people met their future colleagues at their universities. We need to give people opportunity. What does that opportunity mean, to change barriers into additional opportunities?
- We require a diversity of answers inclusive and comfortable and appealing to engineering faculty. Use the focus on the mindset when trying to talk to faculty about why we are doing this.
- *Q: How do you identify the mindset?*
- Collect data from engineers who have a solid track record of being innovative. What has led them throughout their careers that allow them to solve problems in their world? Do engineers solve problems in a unique way? Are they better at it than other people? If we can agree on definition and approach, this can answer all kinds of questions
- In our interviews, one thing educators saw in students was good judgment in seeing if a startup was a good approach to problem. Learning to make judgments.
- *Q: How do you think about entrepreneurship's relationship to innovation?*
- We wanted to get at faculty beliefs of entrepreneurship and hold back our own personal views. Mixed bag between those who want to be an entrepreneur and have no ideas, and those who have ideas, want to be, but have no idea how to make it happen.
- Difference between entrepreneurship and innovation is that of scale and engagement with the world. An innovative way doesn't require other resources, while an entrepreneur is interactive with the world. This is less off putting from a marketing standpoint to faculty. What's relevant to students is the interaction with customers, what innovations have the potential to scale and change things, to solve problems in new way.
- I disagree, innovative products and solutions meet needs. We need to recognize there is overlap and that I don't think we want to pull them apart. We should be cognizant about keeping things together.
- Scaling does help the definition, and you might think that innovation was precursor. The word is out on that, but it should be there if you want to be an entrepreneur. We need to be cautious about definitions, and be dynamic and include environment, interplay.
- *Q: What are the intrinsic and extrinsic motivations about students' survey, the sense of purpose, and how is that related to entrepreneurial mindset?*
- In the early stage of analyzing interviews, a lot of people pursuing ventures or considering it think about themselves as entrepreneurs in terms of lifestyle, career, and personal identity goals. People are more motivated by seeing how their interests, goals, and strengths interact as way of contributing.
- Why should any student become an entrepreneur? There are so many established companies and no real need, but if you look at that issue from a future point, then you might see that resolving problems is not enough. As the world becomes more complex, problems do too. It is no longer enough just to solve problems, we must create a culture of anticipatory problem solving. From that point of view the pressure on students to become more innovative and become entrepreneurs will grow.
- Good companies that survive promote entrepreneurial behavior within their company, whether you create an inside or outside environment.

Session B: Cooking Up New Research Ideas: With Students, About Students

Session organizers:

Leticia Britos Cavagnaro, Epicenter, Stanford University

Katie Dzugan, Epicenter, VentureWell

Humera Fasihuddin, Epicenter, VentureWell

Hristina Milojevic, University Innovation Fellow, Union College

Breanne Przestrzelski, University Innovation Fellow, Clemson University

Gurlovleen Rathore, University Innovation Fellow, Texas A&M University

Ben Riddle, University Innovation Fellow, Furman University

Elliot Roth, University Innovation Fellow, Virginia Commonwealth University

Valerie Sherry, University Innovation Fellow, University of Maryland

Gregory Wilson, University Innovation Fellow, University of Georgia

Humera Fasihuddin and Leticia Britos Cavagnaro:

- Today's graduates are not meeting the needs of the workplace. Recent Gallup poll: 96% of provosts think students are prepared a good job educating students, but the workforce says 11%.
- Students need purpose and meaning in their paths they pursue in careers. Are schools meeting this need? Changing fast enough?
- Students as catalytic drivers of change in higher education.
- The goal of the University Innovation Fellows program is to reach peers, work with faculty to change the higher ed system, and start national movement within higher ed.
- Candidate Fellows undergo training to develop landscape canvas/strategic plan: What are the white spaces in the landscape? What can I do to make a change?
- Annual Meetup at Stanford and Silicon Valley, immersed in culture: 63 schools, 88 fellows in March 2014
- Currently 110 active Fellows from 74 schools
- Biggest influence is one another, many collaborate on projects. Support is crucial especially in schools not focused on entrepreneurship
- Fellows have created:
 - 553 activities
 - 22 new creative type spaces
 - 65 new campus resources

Thread 1 intro: Fellows Elliott and Hristina

- Students who are movers, shakers and go-getters
- Hypothetical situation: Students who pursue innovative companies and industry, and students who only study because of heavy strictly academic course load have different outcomes.
- How does introducing entrepreneurship early on impact students?
- We hope to make academia aware that more innovation/creativity and less sole focus on the curriculum and syllabus helps interaction with peers and fosters potential professional relationships in future.
- Creative community thread research question: How might universities create environments that stimulate an entrepreneurial mindset?

- Thread 1 B will focus on environment

Thread 2 intro: Fellows Ben and Gurloleen

- What role do students lay as agents of change on college campuses? What makes us effective as a method of change?
- A lot of barriers to change within faculty and administration at schools. Visualize barriers ese as a web that we need to connect and we are in the middle.
- Requires three things: Mindset, skills, and motivations
 - Awareness of what's going on
 - Ability to connect across functions university
 - How bad you want to make the change? Be a systems thinker. What you do as a person impacts everyone around you. Don't be a "loose cannon."
- Contextual factors: Relationships (with sponsor, alumni, etc), spaces and resources (regional allies, collaborators, etc)

Breakout results

- Thread 1 - Early Action: Elliott and Bre
 - What are the barriers that prevent students from pursuing entrepreneurship?
 - classes credit requirements
 - not a major
 - Why can't we use courses to spur projects that encourage entrepreneurship?
- Thread 1 - Environment: Hristina and Valerie
 - Physical space
 - "Interaction" may be more appropriate
 - what is impact of maker spaces?
 - what is impact of maker spaces on informal programs?
 - Mentorship
 - What is impact of peer mentoring?
 - What has the most relevant value? What influences students that most?
- Thread 2 - Personal characteristics: Katie and Greg
 - What are key differences between Fellows and other students?
 - Cultivate these? Measure these qualities?
 - What are technical skills that relate to this?
 - How can faculty support fellows and other students and not create more barriers? What is the engineering department's role?
 - Giving credit to entrepreneurship endeavors? Does that increase student interest?
 - Cultivation mostly relationships with peers or mentor based?
- Thread 2 - Personal characteristics: Ben and Gurloleen
 - Who is a successful fellow and what makes them that way?
 - How do you continue the legacy of the work you are doing?
 - What leads a faculty member to work together with a fellow?
 - Needing to understand how this mindset leads to change on campuses

Questions and comments:

- *Q: Have any of these tools that we have been using been sent out to faculty?*
- *Q: What effect does Design for America movement have?*

- Educating for political understanding similar to innovating thinking
- Equalizer opportunity at all schools for design thinking
- *Q: Are there plans for lots of schools?*
- *Q: Identifying students that want to be change agents. Resistance from other students? Is exposure to entrepreneurship something for all undergraduates or only those that pursue it?*
- All students should be exposed to it. Mindset should be pervasive in education
- *Q: How do we connect with potential student groups that exist or start a new one?*
- In one school, the entrepreneurship society died, then Fellows created a student group space for all types of people.
- Find a fast moving student and get involved.

Session C: Research on Entrepreneurship Programming and Unprogramming

Session chair:

Mary Besterfield-Sacre, University of Pittsburgh

Panelists:

Ruth Graham, RH Graham Consulting Limited

Doug Melton, Kern Family Foundation

Helmut Schoenenberger, Technical University Munich

(Mary Besterfield-Sacre) Research on Entrepreneurship Programming & Unprogramming

- Think about a journey, how an entrepreneur might think of themselves - “I embrace my childlike wonder”
- Relevant elements:
 - Everything related to students (curriculum, maker spaces, competitions, incubators, living learning communities, coaching and mentoring, IP support)
 - Customers and networks
 - Pathways to “show me the money” people - for example, VCs
 - Leadership
 - Policy
 - Culture and environment - wraps around everything
- We already know what is around our own campuses. How it could be done differently?
- Based on our panelists, we can start breaking these pieces apart, adding things, finding strengths and weaknesses, and looking at different types of campuses
- Our motivating questions:
 - What drives entrepreneurship programming? - Green
 - What roles have students played in advancing capabilities in and commitments to entrepreneurship in universities, with what implications for programs? - Blue
 - What assessments are most effective in evaluating program impact? - Yellow
 - “Going rogue,” or “other” - Red

(Helmut Schoenenberger) Entrepreneurial Journey

- Created TUM Entrepreneurship Center, the biggest entrepreneurship center in Europe
- To change the ecosystem, you have to talk to the students in the next generation
- What assessments are most effective in evaluating program impact?
- TUM tries to build an ecosystem in which people interested in entrepreneurship are able to get engaged, can choose electives. Thousands of people attending courses, alumni network 15,000 members.
- If you want to have a great entrepreneurship education, connect the curriculum to real projects - hook students up with startups in all kinds of ways - for example, “venturepreneurships,” real projects, and prototypes.
- What drives entrepreneurship programming?
- It’s very hard to teach students new technologies. Engineering courses don’t really fit with these technologies.
- How can we better involve our engineering faculty to enable students to use new technology?
- What is entrepreneurship? Entrepreneurship is about starting scalable startups.

- It's something we have to do as educators: help our students to experience this process of opportunity recognition, the "spaghetti" process, prototyping, designing, testing, lean launchpad things, and in particular, failing.
- 75% of projects fail: we have to teach students to cope with failure
- How do we scale these startups and manage them?
- How can you build an ecosystem within the university to help supply the necessary functions you need?
- How can we build a place that is dedicated to entrepreneurship?
- In Munich: we're building a place (Unternehmertum) for education, incubation, prototyping facility, networking area, research, and community.

(Doug Melton) Student-Centric Entrepreneurial Mindset

- Focus: entrepreneurial mindset development in undergraduate students
- Create transformative educational experiences and connect to passions, which leads us to a student-centric view of entrepreneurship
- Redefining engineering education for everyone is a critical step.
- Entrepreneurial mindset is the engine of value creation, pulls the creation of the business.
- An example of why mindset is important: It's great if your doctor has the skills to perform surgery. But if your doctor also has a mindset to care for the human condition, it's even better. Your doctor will be motivated to learn more skills
- KEEN Framework for Engineering Education - focused on the idea that mindset is a separate concept from skills
- 3 elements in an entrepreneurial mindset:
 - Curiosity: constant curiosity about the world, insatiable
 - Connections: habitually collect info from many sources, realize that a mindset is how you approach something.
 - Creating value: typically economic side, where business creation matters
- An entrepreneurial mindset can be applied to any situation. Most students will probably go work for a company. Within the company, they can still create value.
 - There is a certain risk with this. Some managers might not be receptive.
- The KEEN program pushes for a broader approach that comes before even defining the problem. Start with an opportunity, define the problem, complete typical design and system engineering, communicate, scale, and then you have a business.
- KEEN is currently a program in 20 schools. Started in 2005, it's at 40 institutions, has 400 active faculty, and has influenced 15,000 engineering students
- Audience-aware assessments reduce pain and inflammation. How do you assess this program?

(Ruth Graham) Entrepreneurship Programming and Unprogramming

- Conducts research studies focused on educational change in engineering education. How do universities design and implement change? How do you change universities?
- Works with individual universities to help support design and implementation of changes
- What are the drivers for establishing programs of engineering entrepreneurship education (EEE)? Also, why develop these programs?
- Four categories:
 - Discrete EEE courses driven by individual faculty members

- University-driven commitments to the entrepreneurship and innovation (E&I) agenda
- Government-led strategic investment in technology-driven entrepreneurship education
- Student-driven entrepreneurship movement
- What role have students played in advancing capabilities in and commitments to entrepreneurship in universities?
- Two models in universities: Top-down approach (tight intellectual property IP control) and bottom-up approach (loose IP control)
- What has allowed this movement to flourish? Dissatisfaction with the system, people who lead it are well-connected to the regional entrepreneurship community, bring mentors in to the activities
- Often, this activity happens in parallel and doesn't affect core functions of the university
- What assessment tools are most effective in evaluating program impact? Evaluating student learning in I&E, evaluating EEE program impact
- What performance metrics should you use to measure performance or impact of a university-based ecosystem?
- Input indicators (institutional approach), process indicators (entrepreneurial culture and innovation capacity within the university), and output indicators (ecosystem impact. What is coming out of the university?)

(Mary Besterfield-Sacre) Summary

- Drivers of entrepreneurship programming: universities, government, new agenda at an institution, entrepreneurship experience from individual faculty, students, research
- Unprogramming aspect: rethink how we develop programs, in light of the student-led movements
- Need to look at all students, not just the upper 95th percentile. The innovators of tomorrow who will go through this process might be just an average student.
- Assessment of entrepreneurship programs - still seems to be a big unknown, still a struggle

Questions and comments:

- *Q: What have you learned that you were assuming, but then realize it didn't work?*
- Measuring mindset is more complicated than expected.
- In thinking about giving the right assessment for the right audience, we need to ask: what are we trying to do with the assessment? In one case, finding good return on investment (ROI). Can students assimilate info better than before? Can students think about creating value? Can they identify opportunities?
- *Q: Many metrics are more qualitative than quantitative. GPA is one of most quantitative measures. How does GPA act as a predictor of the entrepreneurial mindset of the student?*
- Some studies were done to show that high SAT scores actually negatively reflect on entrepreneurial behaviors. High GPA students are risk-averse.
- From experience, failure is important piece. People who haven't experienced failure aren't as well equipped as others.
- SAT scores are not a good predictor of success. We can't make parallels.

- There is some data that students participating in entrepreneurship programs had a slightly higher GPA than students who didn't. From experience, students who succeed are highly motivated, stay in school, finish their degrees, are organized, well-read, and keep up on what's going on.
- From experience, those students who are buried in books, looking for yes/no answers need to hone their ability to ask questions, execute, etc.
- We can teach people a mindset. This way, the time spent thinking about things on your own is better.
- *Q: As students clue into passions from the outside world, shifting their focus, even while in higher education, how do we create space for the student to forge ahead and prototype? What might this "looped" university look like? A 4-year degree program might be counterproductive.*
- Can't measure smarts by just GPA. "Street smarts" more important. No assessment instrument to judge entrepreneurship smarts.
- *Q: Faculty members are concerned about learning outcomes. Universities can find evidence that improves our position in the marketplace of students and funders. Who is our audience when we do research? Is it other researchers? Or are we trying to affect change?*
- Some research projects are getting industry input. Our most important finding is that companies say want this entrepreneurial mindset but don't believe that the universities can do it.
- What is the evidence that can come out of universities that becomes evidence that they (industry) should endorse?
- Looking at systemic change and previous programs that were successful, the key is in getting active support from the department head, who sets the promotions for faculty. Find someone who says that this is a strategic priority. Higher chance of success.
- To create a program, you need to make all of these constituents simultaneously. We don't have the assessment tools to cover everything that everyone wants. As an institution participating in this, what are the critical things that are important to your community? What are the priorities for your community? How do you fill those gaps?
- Linkage between abilities to think, process information, and outcomes needs to be closer. Need a base of information to do in-depth, long-term studies to prove that it works.
- We have multiple audiences with conflicting goals. In creating programming, we have to think from multiple goals and audiences.
- *Q: What is the mechanism for disseminating information? How are we getting this information to faculty and leaders to develop this roadmap?*
- Incredibly important. Epicenter has a national agenda, and it'd be great if it had an international agenda. We have to focus on engineering fundamentals. Epicenter has a pivotal role in making this change, making it more legitimate.
- *Q: It's hard to create instrument to measure impact. Has anyone thought of scales? Or creating a standard to look at? How do we see the improvement of students throughout the year? Is there a way to measure each student?*
- From experience, problem is not measuring success, but organizing and scaling it.
- Ranking system doesn't help universities, environments, or entrepreneurs.
- Need to look at outcome-based results. When we're building mindset in a program, we have a collective network that has developed rubrics.

- *Q: We think of programming, and we think about starting at ground zero. What are the basic elements we need to starting a viable entrepreneurship program?*
- Get students in contact with entrepreneurs. There needs to be a starting point - a basic understanding of what entrepreneurship is.
- Freedom for students to build their own relationships with industry partners and the community outside of university is a huge driver.
- When we start a new grant, we need 1) faculty development, for faculty to get outside their office, department and see value in the program, and 2) student excitement - in particular, extracurriculars to get students excited.
- Basic concept for an entrepreneurship program: have young people team up, work together, become innovators for themselves, and then become citizens of a society that allows them to create self-efficacy. Just teaching them entrepreneurial behavior doesn't work.
- Music and arts are a good platform or instrument to cover differences in individuals.
- As a baseline, you need to know who your students are. Knowing students, introducing them to mentors and alumni, and creating networks are all important. In addition, we need faculty development and programs outside of the classroom.
- *Q: Universities are organized around departments. Right now, these are non-parallel tracks, but it's better to integrate them. What are others' thoughts on examples where these programs are tied to capstone projects or other things students are engaged with?*
- Programs tied to engineering are more likely to be successful (example: as opposed to being tied to a business school) and have higher engagement. Faculty are taking this stuff seriously. Blending entrepreneurship with engineering curriculum is important. We risk people seeing it as two different pursuits, where people will have to face a choice of being an engineer or an entrepreneur.
- Biggest challenge is connecting different engineering disciplines. For example, 3D printing and robotics involves mechanical engineering, electrical engineering, design, and all sorts of different people. We want cutting edge tech to be a part of everything. We want technology to not just be the concept of the course, but also be an organizing principle.

Session D: Research on Curricular Approaches

Session chair:

Nathalie Duval-Couetil, Purdue University

Panelists:

Erin MacDonald, Stanford University

Sabrina Niederle, Technical University Munich

Mark Schar, Epicenter, Stanford University

Angela Shartrand, Epicenter, VentureWell

(Nathalie Duval-Couetil) Research on Curricular Approaches

- We started multidisciplinary entrepreneurship program for undergrads, and probably have 1500 students now. Novel at the time being because it was outside of business school.
- Now have existential questions. At the time, we didn't ask much of ourselves, just developed curriculum, assessment, and went forward. It's interesting to see more questioning and how much richer the field is.
- What are we teaching? Ideation, creativity, prototyping, understanding product development, networks, leadership, intellectual property, technological commercialization, mindset (well/ill defined), lean launchpad focus on customer, basic business literacy notions
- Different colleges are touching on different aspects and emphasizing different things. What should we be doing? Is there just one answer? What outcomes are we looking for?
- Interviews with young engineering entrepreneurship alumni. How is this manifested in their career? Most are working in large companies.
- Main themes:
 - Communication/business literacy
 - Weeing the "big picture" beyond narrow engineering tasks
 - Working with others outside the discipline of engineering
 - Helping graduates obtain jobs
 - Entrepreneurial mindset or way of thinking
- Approaches:
 - Lecture - not very effective in entrepreneurship education
 - Experiential
 - Case studies
 - Embedded models, add-on, or hybrid programs working with other departments
- Who is teaching them? How do we know they work? Practicing entrepreneurs, professors, business from any discipline
- Role of extracurriculars, environment and ecosystem. Effect of participation in perceived self efficacy
- For which populations?
 - One size fits all vs. tailor to different department students
 - Do we have different needs at different institutions?
 - Needs of students working full time vs full time students
 - Context, environment students are in

- Comparisons across students - should we be teaching students with an existing idea for development differently than students who are just beginning interest?
- What works in teaching entrepreneurship, and how do we know it works?
- Are different approaches necessary for different student populations?
- What are the top priorities or concepts in teaching entrepreneurship to engineering (or all) students?

(Erin MacDonald) Teaching Creativity

- Research: interdisciplinary design, customer perspectives, incorporate psych
- CIRAS and innovation engineering: how do we know it works?
- Different type of curriculum: teaching people in workplace, very condensed
- Adopted system innovation engineering
- CIRAS and NIST decided would be good curriculum
- 3 categories of skills taught, relevant to questions: create, communicate, commercialize
- How do you show that your program that's hard to assess is worth spending money on?
- Creativity and entrepreneurship are important concepts that must be taught
- Trust yourself, learn from "failure," tolerate risk.
- Risk may be there, but just not processing in the same way. Teach this - bring in role models, see other people who took risks and did well, perception of risks may be different
- Example: Students pitch a toy, get feedback from class, allowed to redo project and resubmit, harsh judgment in first round then get a lot better. Ability to switch idea/pivot at any point in project, won't take off points, don't ask to catch up to other teams, no punishment for not getting as far
- Trusting yourself: Meyers-Briggs, learning key characteristics for creativity - everyone can find something that resonates for them
- Students grade their own work, have a portfolio of "creative essence" at beginning, then add to it at the end of the course, allows students to see how they've grown creatively
- Entrepreneurs need to deal with deadlines, creativity need time to explore
- Pose challenge to students: get them to eliminate assumptions about what the answer needs to be
- Entrepreneurs need to know risks down the road
- Creativity makes people a little uncomfortable to push beyond normal thinking.
- Entrepreneurs need to be able to pitch real products and make them palatable

(Mark Schar) Embedded Model

- Entrepreneurial curriculum - the challenge
- Comes from work at NSF, identify ¾ engineering graduates going right into work environment
- About half of all undergraduate engineers return for an MBA, second largest major that returns for MBA
- Engineers in the workplace need to learn something more than they gained from undergrad degree
- Engineering education is overstuffed, full of what people expect engineers to know
- Some view entrepreneurship as a nutritional supplement, like cod liver oil, or something extra that's fun and frivolous like a donut. Our thinking is that entrepreneurship is more

like calcium fortified orange juice: great for you and also tasty! You don't taste calcium: sneak nutrition into orange juice

- Embedded model - right in middle of standard engineering curriculum
- Scenario based learning eSBL
- Case studies: stories about real world, constructed to teach something
- Madison longboard - starting business to go after particular niche.
- Is it working?
- Four-way way chart: eager learners, concerning students, business receptive, engineering receptive
- Student perspective: highest level of satisfaction is hands-on lab, lowest is case study. Some students disliked it. Not for everyone.
- eSBL faculty perspective
 - Difficult to add to class, let alone curriculum
 - Topics are a stretch, don't have training, need to figure out
 - TAs are fantastic resource
 - Adds complexity to what goes on in labs
- 3 priorities moving forward
 - Understand language of business
 - Wrestle with ambiguity
 - Growing self-efficacy

(Angela Shartrand) Lean LaunchPad Approach

- Growing number of people who are doing LLP in engineering context
- I-Corps--teams that take part in 7-week course to learn LLP
- Core elements: product or tech idea, customer discovery, find product-market fit, develop replicable and scalable business model
- Key characteristics: highly experiential, business model canvas as framework, customer interviews, hypothesis testing, rapid cycle of learning and action even when you don't have data you want or need, pivots indicate progress and learning
- Business model canvas framework
- Ingredients for LLP success:
 - Need an idea, doesn't necessarily have to be something student is actively working on
 - Highly motivated students to devote necessary time
 - Willingness to let go of assumptions
 - Mentors are extremely necessary to guide
- Challenges to implementation noted by engineering instructors:
 - Reluctance to enroll in training given time commitment
 - Discomfort contacting/interviewing customers
 - Lack confidence, knowledge of key business concepts
 - Focus on "building stuff" rather than on understanding what customer really wants, not great fit for all students
 - Not all students enthusiastic
 - Finding mentors and customers in rural area
- Benefits to engineering students are learning what the demand is and what customers really want, interdisciplinary study

- Other benefits are communication practice, explaining hypotheses, broader understanding of context, broadening professional network
- Some LLP metrics are completed interviews, validated or invalidated hypotheses, pivots in business model canvas
- LLP is growing rapidly, growing community, not much research done, really interesting possibilities about impact
- Discussion/implications for engineering education:
 - How do people adapt and adopt LLP to engineering context?
 - Can you actually measure shift in technology, customer orientation?
 - Impact on recruitment and retention of engineers?
 - Professional skills, career outcomes?
 - Not just on economic outcomes, people products

Questions and Comments:

- *Q: Is this really about entrepreneurship, or more a new type of management curriculum that makes them more effective in the work place?*
- While it's important to have key characteristics, it's okay to have differences across curriculum. Some standardization is good but don't over-define it. Variation is a healthy thing and sets individual programs apart from one another
- *Q: What is the interplay of teaching skill development vs. mindset in general?*
- Integrated. We can teach skills that students can use to change their mindset.
- More about pedagogy than course content. How much of a change in core content can be recorded versus a change in pedagogy?
- *Q: Differences with cultures from other countries that may have different values?*
- With I-Corps, unwritten curriculum with lots of challenges and subtleties in communication, language, background, and influence on how they respond to curriculum.
- There are biases of who entrepreneurship is for and what it means that we need to be more conscious about
- *Q: How important are language skills? Relates to accessibility of concepts associated with entrepreneurship*
- Great research question! We haven't encountered any language problems. Foreign students are very interested in learning about culture here.
- Just as important to native English language speakers communicate with foreign students. Personal experience, grading projects, we make sure the team knows they will be graded on their inclusion of foreign speakers.
- Each discipline has its own special set of jargon, big problem. We must teach an entirely new set of language, and communication is underutilized and under-taught.
- There are also different ways to describe same thing. We're just not necessarily talking to each other and acknowledging these similarities.
- *Q: There seem to be huge challenges to reach PhD, postdocs students while it's easy to reach bachelors and masters students. What is the experience with I-Corps?*
- Most of I-Corps is grad/postdoc entrepreneurial lead on team, a PI professor, and they act as the entrepreneurship mentor. NSF grant to team, and grad students self select
- We need to go back to individualized paths because outcomes are so variable. You can't just standardize, and it's a problem when it comes to entrepreneurship. We need to step away from paradigm assessment and content to assessment and ways of thinking.

- Value in delivering skills and knowledge that you might not think you want but are actually useful. You need to take courses you may not want to take!
- Humanizing statics, $f=ma$ is very un-human to some students who need more empathy
- *Q: For post-lab employment, government labs have more graduates. Is this just entrepreneurial mindset?*
- Could be outside statistical significance. People trade in and out, people may be interested in nonprof and govt, but interests change.
- *Q: Program priorities: we like to celebrate every time a person becomes an entrepreneur, successful, etc. How do I make this a priority? Beneficial outcome. Is an outcome where someone doesn't want to be an entrepreneur valid?*
- With pre/post, big reduction in people saying they want to pursue it and now understand what's involved. Valid outcome, studying longitudinal effectiveness, what questions we need to study and understand. Students exposed in intro engineering, or graduate from LLP experience, how it then plays out. This will enrich and inform what we do next, providing contextual relevance, motivating students to be more excited
- *Q: How does this play out in a different areas than Stanford?*
- For some people, they wouldn't never be a founder, may just do it later.
- For a company smart enough to hire and keep a student, company thinks they're awesome; this is not a failure. They're generating economic and social value in a program, not just measuring startups.
- Entrepreneurs need to be comfortable with failure but we're all worried if our program is a failure.

Session F: Keynote Panel: Forest-Level Reflections on the Research Landscape

Moderator:

Phil Weilerstein, Epicenter, VentureWell

Panelists:

Susan Brennan, Bloom Energy

Tom Byers, Epicenter, Stanford University

Karl Vesper, University of Washington

(Phil Weilerstein) Introduction

- Looking back and looking forward - reflecting on the evolution of the field, teaching of entrepreneurship, where growth and opportunities exist, and reflect on the needs of the field
- Karl, one of the founders of the field of entrepreneurship. Created Babson Research Conference, has received many recognitions as a pioneer of entrepreneurship, engineering, and technology. History of the field has shown that teaching comes from an engineering background
- Tom, background in startups and investing, many successful students. Roundtable for engineering/entrepreneurship. Curricular/pedagogical view going forward
- Susan, perspective of industry, from engineering career, manufacturing. Engineer on the Nissan Leaf. Passionate about environment, participation of young women in engineering

(Karl Vesper) Possibilities for the Entrepreneurship Field

- Started college in 1950, everything was engineering. Got into entrepreneurship later, career in entrepreneurship with University of Washington
- 7 possibilities for the field:
- On research: tradition is to do things in statistical form to know that things you're talking about are representative. In the future, instead of looking at a range of data, analyzing the scatter or the dispersion, we can put data into a supercomputer and have "individualized learning." Individuals can instead look for someone in "my situation" as opposed to looking only at the average.
- On being an entrepreneur: companies are typically started by one person who plays many roles. A role that should be considered more is someone who helps a technical person do a venture.
- On technology: most entrepreneurship research describes what happens, categorizes it, and returns something that isn't a tool you can use. Technology guides your mind to help you think in a way that you could not do typically by yourself. Seeing that with entrepreneurship, particularly with opportunity recognition. Will help you do certain things instead of just describing something.
- More learning can occur in venture plan competitions.
- More teaching intelligence will come from big data. As computers become more powerful, information will accumulate over time and we'll be able to more "what if" analysis. Requires expertise that may not be represented in this group yet.

- Easier and a safer way for students to experience entrepreneurship: acquire an existing firm. When an individual acquires a business, it typically performs better, whether the new owner understands the business or not.
- Entrepreneurship has strong journals with selection rates comparable to other journals. There are no deniers of it now. But how are we going to do research to help entrepreneurs?

Tom Byers

- Why does entrepreneurship have to be a graduate-only level? Why don't we look at all levels? Amazing how entrepreneurship has blown out of business schools. Compatible with engineering school curriculums
- The Engineer of 2020: visions for the future
- Wish list: work on assessment tools, don't just look at worrying if your school has the next Google
- At Stanford, for a long time, 16% of the students or less were choosing engineering. In the last few years, it's over 40%. What's happened? It's been led by an increase in women — worthy of investigation.
- Institutional buy-in necessary for this movement to continue . The way universities are structured now is research. Excellent opportunity to make these ideas stick.
- We're going to define impact a different way than just a long CV full of references.

Susan Brennan

- Spent 25 years in the automotive industry, 5 years in research. At the University of Illinois at Urbana-Champaign (UIUC), took the science track - specifically, microbiology. No business classes were allowed.
- Make sure that students are technology savvy and also business savvy. Resource allocation: do you have deep technological disciplines, but also understand the business reality? We have limited resources, limited capital, and teams.
- Speed also necessary. Students have to take data, filter it quickly and move on.
- Students need communication skills, need to be able to communicate at all levels in an organization. In a hands-on business, there are cultural challenges of having generations coming together. Millennials don't really know how to talk to someone - can't just send an email.
- Technology will fix itself. Getting people to make the technology scalable is the difficulty.
- People today are more global. Access to the world is so different. When you are global, look, learn, listen wherever you are. Learn how others think, learn what drives them, and think about how you can bring that to the U.S.
- When teaching the next generation of entrepreneurs: it's imperative for the U.S. to keep the edge. The one edge we have is that we're innovators. We're risk-takers. I see other countries not only copying what we're doing, but how we're doing it.

Questions and Comments:

- *Q: What global abilities does industry look in a new graduate?*
- Students should understand culture, see norms, and ask how those norms are changing
- *Q: How can we implement lessons about company acquisition at universities?*
- Simple to acquire a business, it's just not talked about very often. Students don't have any money, but they can do leveraged buyouts. Don't buy a failure! It's the dream to take

a failure and fix it better than the owner, but that's a pipe dream. Buy a business that's succeeding, something really small, and maybe you sell it again.

- *Q: What does an entrepreneur in a large business look like?*
- Entrepreneurs, for a large auto company, are people who build cars better. They ask, why are we doing it this way? If the engineers go to the floor, to the people who build cars, thereby pairing a worker with someone with engineering or design principles, new innovations come out every day. On the kind of companies that you want to work for: if I can get two years out of you, great; if I can convince you to be an entrepreneur within a big company, that's even better.
- Q: Deep worry about industry getting panicked about where innovation will go. What do are the growing new sectors that can inform us?
- Trends are changing but young people's ability to do things is growing. I worry more about people my age sitting back and relaxing. We need to be opening ourselves to learning and listening. Can't lose the American idea of "you work hard, then you go somewhere." We need to listen to the next generation and nurture them.
- Q: Interested in the future of clean energy. What role does sustainability play in entrepreneurial education? What role does "green" play in competitiveness?