

# **EXPLORING HOW ENGINEERING ENTREPRENEURSHIP COMPETENCIES ALIGN WITH ABET CRITERION 3A-K**

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# CONTEXT

Interest among educators and policymakers in graduating more engineers with entrepreneurship skills and mindset

## Driving forces:

- Expansion of engineers' roles and responsibilities within work organizations
- Fewer professional opportunities in large companies
- Increased global competition for jobs
- Recognition of value of understanding end-users, working in multidisciplinary teams, communication skills, and business skills

**engineering**  
**ENTREPRENEURSHIP**  
preparing students for  
**LEADERSHIP**

Engineering Innovation &  
Entrepreneurship

Mech 498/898  
1 credit hour  
Tuesdays 8am-9:15am



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# ENTREPRENEURSHIP EDUCATION

**Among fastest growing subjects with formal programs  
quadrupling from 1975-2006 (Brooks et al, 2007)**

**Delivery within engineering programs is increasing**

**However, studies show not yet widespread or institutionalized**

In three programs with entrepreneurship programs accessible to engineers, less than 1/3 of students surveyed felt that entrepreneurship was being addressed within their engineering programs or by engineering faculty (Duval-Couetil, Reed-Rhoads, Haghghi, IJEE, 2012)

# **BARRIERS TO DELIVERY**



**Some faculty members do not have experience in entrepreneurship and do not really understand it** (Zappe et al. 2013)

**Overcrowded engineering curriculum**

**Entrepreneurship low on the priority list of learning objectives**

**Belief that faculty peers and administrators are unsupportive of entrepreneurial learning**

# ROLE OF ABET

**Viewed by faculty as driving the outcomes of core engineering curriculum**

**More recently standards have emphasized a wider range of skills pertinent to engineers**

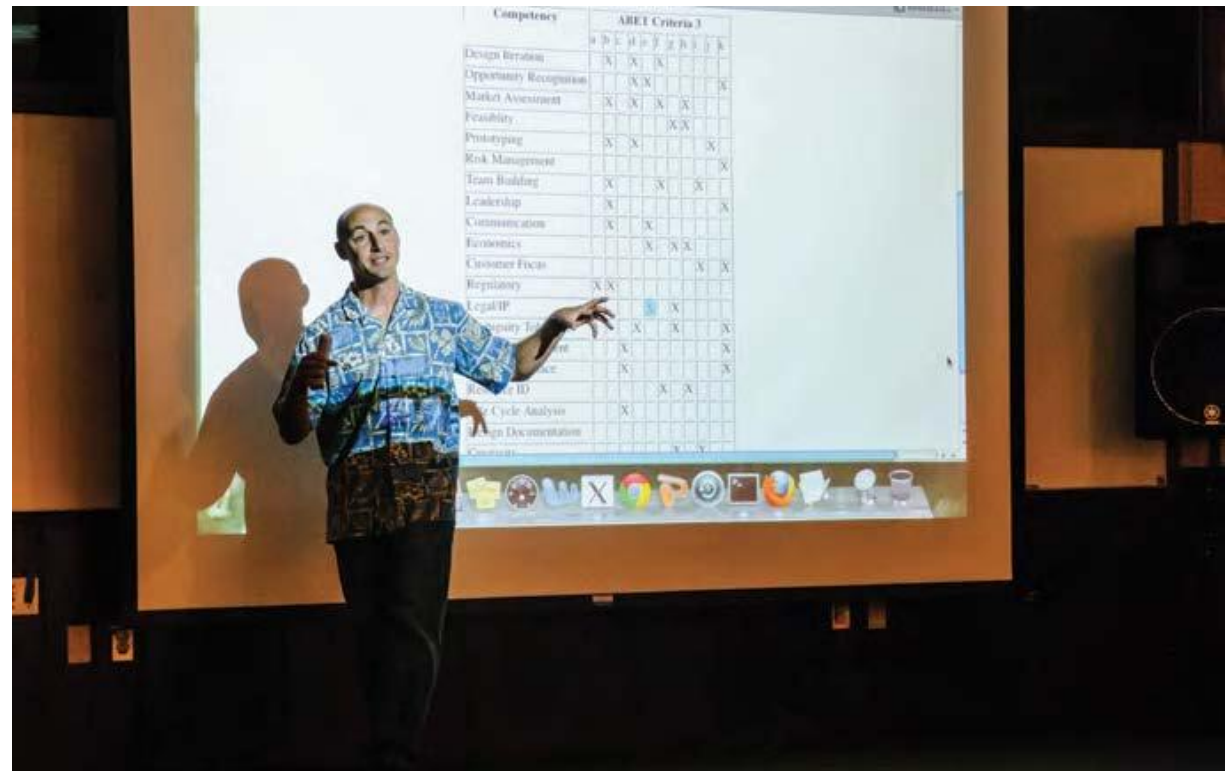
**Some align with entrepreneurship skills and mindset**

- Communicating the manner in which entrepreneurship education meet ABET criteria could catalyze the adoption of more entrepreneurship-related objectives
- Eventually driving faculty to embed more related curriculum and activities into foundational or required courses

# HISTORY OF WORK

**Small group  
formed at  
Stanford  
Epicenter Retreat  
in 2012**

**Submitted small  
grant for  
exploratory work**



# **PURPOSE OF THE PILOT WORK**

**Examined the entrepreneurship education literature to develop and expand the competencies**

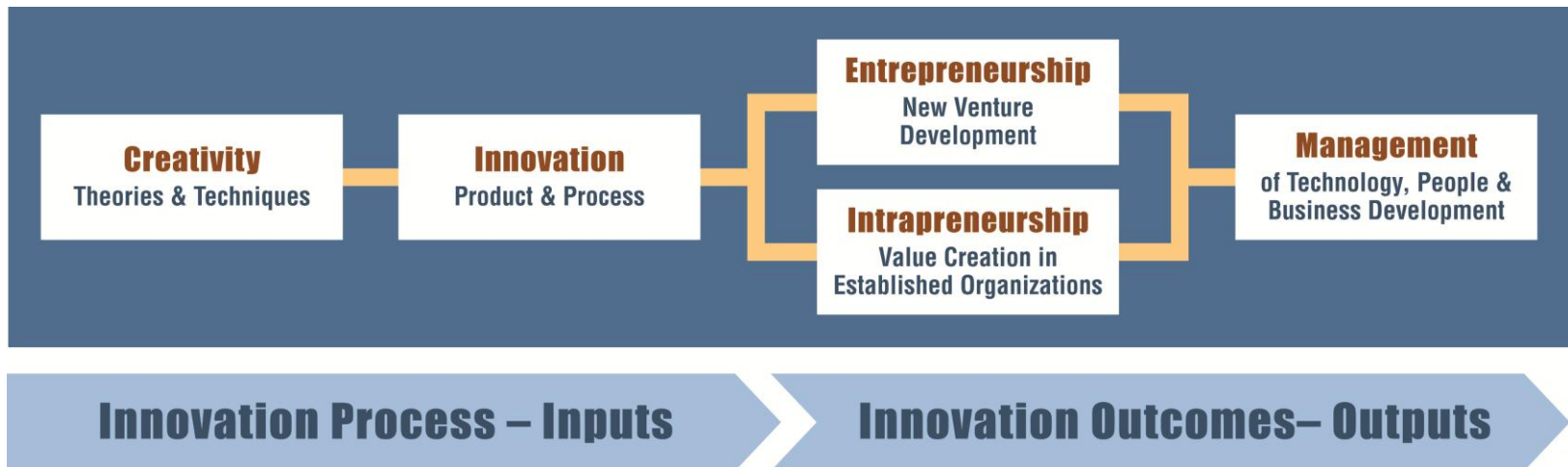
**Identify and validate entrepreneurship-related outcomes that are pertinent to engineers**

**Map these to ABET Criterion a-k**

# FOUR CONTENT AREAS

Via multiple iterations, outcomes were refined and organized into four content areas:

- (1) creativity
- (2) innovation
- (3) entrepreneurship and intrapreneurship
- (4) management and leadership competencies





# 1. CREATIVITY - THEORIES AND TECHNIQUES

## Design iteration

- Employ frequent iteration to improve a design
- Understand that failure is learning
- Extract learning from design iteration failures and successes

## Opportunity recognition -- Environment

- Understand how changes in science industry and economic forces create opportunities
- Evaluate current and future trends and their impact on new venture opportunities
- Compare/contrast the different opportunities and how they create value

## Opportunity recognition -- Customer focus

- Identify methods used to capture customer needs
- Detect latent or explicit unmet needs among customers
- Formulate needs into engineering problem statements

## Creativity

- Use ideation techniques to generate ideas and opportunities
- Understand the environments, practices, and processes that foster creativity

# 2. INNOVATION - PRODUCT AND PROCESS DEVELOPMENT

## Prototyping

- Develop specifications for usability and functionality testing
- Identify resources and techniques for prototype development
- Produce working, testable prototypes of the product/service

## Feasibility analysis

- Evaluate the feasibility of moving from prototype to commercial product
- Perform market research to quantify market demand
- Conduct financial analysis of opportunity by developing budgets and pro-forma financial statements
- Relate industry and regulatory laws and standards to a design concept

## Intellectual property

- Perform a comprehensive patent search for a design concept
- Justify the appropriate legal protection for a design concept
- Generate documentation necessary to file for a provisional patent

## Resource acquisition/identification

- Identify potential partners for sourcing, manufacturing, and production
- Assess human capital needs
- Identify physical capital needs

## Life cycle

- Analyze current product life cycles to anticipate future needs
- Demonstrate consideration of product life cycle in design decisions
- Demonstrate awareness of sustainability issues

# 3. ENTREPRENEURSHIP AND INTRAPRENEURSHIP

## Legal

- Select most appropriate legal entity for new business venture
- Understand the use of non-disclosure agreements
- Understand the process and costs associated with IP protection

## Marketing

- Identify sources of, and methods to obtain, primary and secondary market research
- Perform competitive analysis to develop a value proposition
- Use market segmentation to develop a marketing plan and budget

## Funding/finance

- Determine financial requirements for a new venture at various stages of development
- Understand the process and requirements for obtaining funding from different sources
- Identify the pros and cons of various funding sources
- Understand business valuation

# 4. MANAGEMENT AND LEADERSHIP

## Leadership

- Develop and clearly communicate a vision for the venture/organization
- Translate vision into goals and metrics
- Delegate tasks and organize work groups effectively

## Communication

- Convey accurate and appropriate information tailored to stakeholder needs
- Create and give persuasive presentations and reports on status
- Collect and synthesize information from multiple sources

## Project management

- Select and use appropriate project management tools and methods
- Give team members clear assignments and feedback
- Create a process for measure and reporting on progress and performance

## Negotiation

- Understand and express the positions of various stakeholders
- Apply of the principles, strategies, and tactics of effective negotiation
- Identify and negotiate solutions that are satisfactory to all stakeholders (win-win)

## Team building

- Identify talents and styles of individuals within a team
- Assemble work teams that make best use of members' skills and knowledge
- Implement guidelines for managing and evaluating team performance

# CONCLUSION

**Means to advocate for the integration of more entrepreneurship education in engineering**

## **Next steps:**

- Validate categories and outcomes
- Explore the emphases being placed on particular categories and learning outcomes by educators
- Create a resource for faculty interested in embedding more entrepreneurship-related curriculum and activities into foundational or required courses

# ABET CRITERION A-K

a	an ability to apply knowledge of mathematics, science, and engineering
b	an ability to design and conduct experiments, as well as to analyze and interpret data
c	an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
d	an ability to function on multidisciplinary teams
e	an ability to identify, formulate, and solve engineering problems
f	an understanding of professional and ethical responsibility
g	an ability to communicate effectively
h	the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
i	a recognition of the need for, and an ability to engage in life-long learning
j	a knowledge of contemporary issues
k	an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.(hard)