



Fostering the Entrepreneurial Mindset in the Engineering Classroom

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Introduction

- The global economy is evolving.
- "Organizations are relying less on formal qualifications and years of experience and more on attitude, motivation, learning capacity, and potential for collaboration.[1]"
- Mid-1990s ABET (Accreditation Board for Engineering and Technology) revision of engineering post secondary education.

In response to these changing market needs, the Biomedical Engineering Department piloted a two-semester graduate level course during the 2007-2008 academic year, Graduate Biomedical Engineering Design Team (BiomedE599).

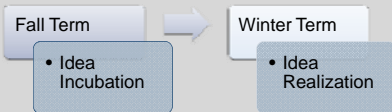
Course Purpose

- Develop adaptive learners through innovative design.
- Provide students with the necessary skill sets for success beyond the University environment.

Context



BiomedE 599 primarily focuses on the first three phases (Ideation, Product Selection, and Development) of the innovation value chain.



Idea Incubation

"I want to work on my own project, but I don't have an idea."

- Students meet with U-M medical community to discuss current clinical challenges.
- Students brainstorm with medical faculty about potential solutions to these clinical challenges.
- Students propose team design projects to be completed during the second semester.

Context

Idea Realization

"So how do we make it work?"

- Students are educated on commercialization aspects of development through a guest lecture series.
- Speakers address commercialization topics including affordable design, ethics, intellectual property, product development, and regulatory consideration.
- Students build prototypes.

Final Deliverable

- Final design and prototype
- Patent Search
- Anticipated regulatory pathway
- Estimated manufacturing costs
- Market analysis

Learning Principles

Learning principles used were designed to:

- Generate a culture that cultivates the highest probability of success for the students.
- Encourage students to take ownership of their projects.



Fundamental Canons:

- Self-assembly promotes comfort amongst the team.
- Self-selection promotes buy-in and motivation.
- Self-awareness promotes more effective communication.

Team Experiences:

- Design Teams: Within the class, students divide into teams to pursue individual design projects.
- Class Team: Entire class instructed to work as a collective, similar to a technology incubator.
 - Students develop concept designs as a collective.
 - Students provide technical feedback to their peers on a weekly basis.

Results

Fall Semester: 18 students enrolled

Winter Semester: 18 students enrolled (2 new, 16 return)

- Students interested in joining the course for the winter terms were instructed to "apply" to the class and were hired by individual team members.

Five project teams were formed by the end of the fall semester:

Team	Project Title (Clinical Mentor)
Morphocor	Minimally-invasive Device to Prevent Heart Failure and Promote Healing (Stephen Bolling, MD)
Moduline	Stabilization of Percutaneous Drivelines to Reduce Infection Rates (Francis Pagani, MD, PhD)
Neurosensor	A Quantitative Characterization of Parkinson's Disease (Parag Patil, MD, PhD)
Fontis Medical	Transdermal Drug Delivery System for Macromolecules (Charles Boyd, MD, MBA)
Centaur Instruments	A Novel Bolt Design for Arthroscopic Tibial Inlay Surgical Technique (Jon Sekiya, MD)

- All teams guaranteed \$500 for prototype development.
- Students not required to participate in any external competitions, but were informed of competition deadlines through the course website.
- Several teams opted to participate in various local and national competitions to generate additional funds during the fall and winter semesters.

Team	Competition/Sponsor	Award
Morphocor	NCIIA BMEIdea Stipend	\$500
Moduline	ZLI Dare to Dream	\$500
Neurosensor	NCIIA BMEIdea Stipend	\$500
Fontis Medical	ZLI Dare to Dream	\$500
	U-M CoE CFE Sponsorship	\$3,000
	CoE CFE Quickpitch Competition	\$1,000
	Ross School of Business Future Tech	Finalists
	Bay Area Innovators Trip	

At the conclusion of the class, several students pursued further prototype development and commercialization through external funds:

Team	Funding	Amount
Moduline	MORE Internship	\$5,000
Fontis Medical	MORE Internship	\$10,500
	NCIIA e-Team	\$16,710
Centaur Instruments	MORE Internship	\$5,000

As of August 2008:

- Total student generated funding = \$43,210
- One provisional patent submitted
- One team incorporated
- Another provisional patent in process

Discussion

- The culture cultivated during the two semester pilot course, resulted in more than a simple academic experiential exercise.
- Students embraced an entrepreneurial mindset as evidenced by their performance outside of the classroom.

"Entrepreneurship is a particular type of mindset, a unique way of looking at the world....At the heart of entrepreneurship lies the desire to achieve, the passion to create, the yearning for freedom, the drive for independence, and the embodiment of entrepreneurial visions and dreams through tireless hard work, calculated risk-taking, continuous innovation, and undying perseverance.[2]"

Conclusion

Results suggest that learning principles that encourage students to take a more active role in their academic development in the context of real world problems help students develop critical entrepreneurial skills[3]:

- Leadership competencies
- Alliance building and networking
- Commitment and persistence
- Creativity, imagination
- Ability to mobilize
- Management ability
- Vision creation
- Flexibility
- Mission/target setting
- Overcoming lack of resources
- Transformational competencies
- Problem definition
- Excellent communication skills
- Problem solving
- Negotiation skills

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Frank Pagani, MD, PhD

BME 599 2007-08 Students

