Entrepreneurship in Engineering Education

“Closing the Gap”

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Entrepreneurship...
Today much confusion exists about the proper definition of entrepreneurship...

Peter Drucker
The Discipline of Innovation
HBR, 1998
Today much confusion exists about the proper definition of entrepreneurship...

Peter Drucker
The Discipline of Innovation
HBR, 1998

Books on www.amazon.com
75,000 - Leadership
25,000 - Entrepreneurship
What all the successful entrepreneurs I have met have in common is not a certain kind of personality but a commitment to the systematic practice of innovation.

Peter Drucker, HBR, 1998
I. Foundations of Entrepreneurship
II. Technology Entrepreneurship Today
III. Innovation
IV. A Curriculum Example
Foundations of Entrepreneurship
The words *entreprendre, entreprise, and entrepreneur* used in the sense of designing and undertaking some project

Jacques Savary des Brûlons (1723, *Dictionnaire du Commerce*)


Entrepreneurship used in the modern enterprise context with the distinguishing feature being reliance on “unfixed wages”

Richard Cantillon (1755, *Essai sur la nature du commerce en general*)

[On the origins of classical economics: distribution and value from William Petty to Adam Smith, Psychology Press, 1996, p. 82]
History – 19th Century

Entrepreneurs as “Captains of Industry”
Francis Amasa Walker
20th Century - Schumpeter

“...the entrepreneur and his function are not difficult to conceptualize: the defining characteristic is simply the doing of new things or the doing of things that are already being done in a new way (innovation).”

“Those who provide the capital can be called **capitalists**, those who determine the purpose, the spirit, and the place of the enterprise in the market and the national economy can be called **entrepreneurs**, and those who keep the organization functioning can be styled **managers**. . . . It is not correct to define the entrepreneur, as has been done, as the man who makes the decisions within the enterprise. In fact, **all three make decisions**.”

Successful business startups are founded by talented individuals using ideas they had during their prior employment. As Schumpeter [and Drucker] wrote, entrepreneurial ventures seem to be more about ideas and talent and less about individual characteristics and preferences.

From Schumpeterian E-ship: (Bhidé [2000], Kaplan et al. [2005], Klepper and Thompson [2009]).
Technology Entrepreneurship
Today
Terminal Degree

Figure 1:
Terminal Degree Completed by U.S.-Born Tech Founders

- Bachelor's: 44%
- Master's: 30%
- PhD: 10%
- MD: 4%
- JD: 4%
- High School Diploma or Lower: 6%
- Associate's Degree, Certification, Some College: 2%
Field of Terminal University Degree

Figure 2: Fields of Terminal Degrees Completed by U.S.-Born Tech Founders

- Business, Accounting, Finance: 33%
- Engineering: 28%
- Mathematics*: 2%
- Computer Science, Information Technology*: 9%
- Applied Sciences*: 8%
- Law: 4%
- Arts and Humanities, Social Sciences: 3%
- Economics: 2%

*STEM Fields: 47%
Figure 3:
U.S.-Born Tech Founders’ Age at Time of Company Founding

<table>
<thead>
<tr>
<th>Founder Age</th>
<th>Percentage of All Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 24</td>
<td>5%</td>
</tr>
<tr>
<td>25 - 34</td>
<td>26%</td>
</tr>
<tr>
<td>35 - 44</td>
<td>45%</td>
</tr>
<tr>
<td>45 - 54</td>
<td>18%</td>
</tr>
<tr>
<td>55+</td>
<td>6%</td>
</tr>
</tbody>
</table>
Figure 4: Time Lag Between Completion of Terminal Education and Company Founding

- Master’s (MBA Only): 13 years
- Master’s (All): 15 years
- Bachelor’s: 17 years
- PhD: 21 years
Figure 5: Time Lag Between Completion of Terminal Degree and Company Founding by Field of Study

<table>
<thead>
<tr>
<th>Highest Degree</th>
<th>Years Between Highest Degree and Startup Founding</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS, IT</td>
<td>14 years</td>
</tr>
<tr>
<td>Business</td>
<td>15 years</td>
</tr>
<tr>
<td>All STEM Fields</td>
<td>18 years</td>
</tr>
<tr>
<td>Engineering</td>
<td>18 years</td>
</tr>
<tr>
<td>Applied Sciences</td>
<td>20 years</td>
</tr>
</tbody>
</table>
Terminal degree either BS $\rightarrow$ MS/MBA
Degree(s) in Business $\rightarrow$ Engineering
Between 35 $\rightarrow$ 44 years old
Lag time of 13 $\rightarrow$ 17 years between degree and startup
(18 years for engineering)
Opinion

Entrepreneurs look at the world through eyes different than most – they see creative opportunities in the world where others see irritations. They capture value through this creative thought. For many it may take entering the workforce to see these opportunities.

While it may take time to see opportunities, there is no time constraint on developing the necessary vision skills nor on practicing creative thought and innovative synthesis.
Conventional wisdom is the greatest barrier to innovation.

Robert Pittman, Founder MTV
Innovation

Capturing value from creativity
The Creative Power of Spaces

MIT – Building 20
The Creative Power of Spaces

Steve Jobs – Pixar Headquarters
If an innovation does not aim at leadership from the beginning, then it is unlikely to be innovative enough.

BHAG
Because innovation is both conceptual and perceptual, would-be innovators must also go out and look, ask and listen.

Empathic Processes
To be effective, an innovation has to be **simple**, and it has to be **focused**.
Disruptive Innovation

Incumbents nearly always win

Sustaining Innovations

Disruptive Innovations

Entrants nearly always win

Pace of Technical Progress

Measure of Performance

Time
Above all, innovation is work rather than genius. It requires knowledge. It often requires ingenuity. And it requires focus.

Genius is 1% inspiration and 99% perspiration.

Thomas Edison
Entrepreneurship

A Curriculum Example
Penn State
Engineering Leadership Development Program
Educational Approaches

University educational effects are assessed longitudinally only out to 5 years

Recall, >10 year lag time between completion of terminal degree and enterprise founding

1995 - 2006

What can we provide students with that will last beyond 5 years?
Accounting skills? Business planning?
Recall

**Entrepreneurs** look at the world through eyes different than most – they see creative opportunities where others see irritations. They capture value through this creative thought.

There is no age constraint on developing this vision nor on practicing creativity and innovation... *and perhaps it lasts longer than 5 years?*

**Le Sens Visionaire**
Imagination
Help students see the world differently

Creativity
Provide the right environment and allow them the opportunity to fail productively

Perspiration and Innovation
Provide them the opportunity to experience entrepreneurship
Mullah Nasrudin
Overview of 1995 Program
Core Courses (12 credits)

- ENGR 408 (2 credits)  
  Leadership Principles

- ENGR 409 (3 credits)  
  Leadership in Organizations

- ENGR 407 (3 credits)  
  Technology Based Entrepreneurship

- ENGR 493 (1 credit)  
  Leadership Practicum

Leadership Capstone (3 credits)
Science Technology and Society

Total number of credits to complete the Minor = 18
Overview of 2012 Program
Core Courses (12 credits)

ENGR 407 (3 credits)
Technology Based Entrepreneurship

ENGR 408 (2 credits)
Leadership Principles

ENGR 409 (3 credits)
Leadership in Organizations

ENGR 493 (1 credit)
Leadership Practicum*

Global Option *
Global Engineering Teams Seminar (1 credit)
Global Project (2 credits)
International Travel - Hungary (0.5 credit)

or

ENGR 407 (3 credits)
Technology Based Entrepreneurship

Leadership Capstone (3 credits)
Science Technology and Public Policy

Global Option *
Global Engineering Teams Seminar (1 credit)
Leadership, Innovation and Global Resource Challenges – Morocco (2 credits)

* Global options
Seeds of Entrepreneurship

ENGR407 (3 credits)
Technology Based Entrepreneurship

Global Option *
Global Engineering Teams Seminar (1 credit)
Global Project (2 credits)
International Travel - Hungary (0.5 credit)
ENGR 407

Technology-Based Entrepreneurship

Chef Creations

Innovation

JunkYard Wars

Seeing Potential

Crash N Burn

Experiencing Entrepreneurship

Product/Business Plan Competition

Competing in the Real World

Innovation & You
International Entrepreneurship
ILEAD
International Project Management
Virtual Team Dynamics
Collaborative Multi-Cultural-Disciplinary Projects

Simple and focused value addition (Drucker, Christensen)
Ruins to Riches
Fibers from PET Bottles
Haiti

http://web.me.com/iar104/The_Brief/About_Us.html

- How to collect plastic and/or incentivize Haitians to collect?
- How to sort, clean, crush into plastic chips (for fabric)?
Mushrooms for Gaza – Food Security

“Futr (mushrooms) for the Future”

- Develop a scientific strategy and financial business plan for a mushroom laboratory
- Develop a scientific strategy and financial business plan for women at-home-cultivators
- Develop a marketable product which suits the needs of the people in Gaza
Project Kalaab, Pakistan
Rose oil Cooperative Business Plan

• Create a business plan for a unique rural Pakistani agricultural cooperative - extraction of high value essential oil producing crops (e.g. rose oil, jasmine).
  – 5000 kg of roses = 1 kg (~1.2 liters) rose oil = $4500
    conventional = $9000 organic/biologique

• Mid-February - mid-March define a unique value proposition and create effective graphics package to be displayed at the University of Agriculture, Faisalabad’s Golden Jubilee.

• By end-of-semester add depth to business plan.
“making engineering schools exciting, creative, adventurous, rigorous, demanding, and empowering milieus is more important than specifying curricular details”

Questions?