Invention and Discovery in Science: ND’s Role in Entrepreneurship
drug discovery platform (systems biology)

“Drug Screening Platform Based on the Contractility of Tissue Engineered Muscle”

US 2006/0105357 “Tissue Sensor and Uses Thereof”

“Monolithic Microspectrometer Using Tunable FLCs”

US 2007/0123762 “Non-Invasive Spectroscopy of Mammalian Tissues”

**spin-out**

**myOmics**

non-invasive hemoglobin (HgB) device

**Corum Medical**

Miniature Spectrometer
growing importance of science

“....the biggest concern is that our competitive advantage, our success in the global markets, our economic growth, and our standard of living all depend on maintaining a leading position in science, technology and innovation. As that lead shrinks, we risk losing the advantages on which our economy depends.”

Rising Above the Gathering Storm

National Academy of Science
National Academy of Engineering
Institute of Medicine
…the ‘gap’ – opportunity for scientist entrepreneur

Universities

Innovation Centers/Labs

Product Development

Marketplace

Innovation Gap

Universities

Innovation Centers/Labs

Product Development

Marketplace

high technology start up companies
....all types of research

consideration for use

research inspired by:

no

yes

quest for fundamental understanding

pure basic research

(bohr)

pure-applied research

(e.g. bird watching)

use-inspired basic research

(pasteur)

no

yes

Curiosity particular things

(e.g. bird watching)

(D.E. Stokes)

Pasteur’s Quadrant: Basic Science & Technological Innovation (Brookings Press, Washington DC, 1997), D.E. Stokes
The Baye-Dole Act is a US law passed in 1980 which grant US universities and colleges the right and even the obligation to patent inventions made by government-sponsored research. This was a dramatic shift from prior public policy where American universities were not able to patent inventions made by public sponsorship.
entrepreneurship opportunities in science

- Science Business Degree
- Science Entrepreneurship Course
- Novel Masters Program (Sci/Eng)
- Faculty Inventions
- Innovation Park
- ND Role in Economic Development
Notre Dame Science
Collegiate Sequence
### University Requirements

<table>
<thead>
<tr>
<th>Category</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language (int/level proficiency)</td>
<td>6 (*)</td>
</tr>
<tr>
<td>Theology</td>
<td>6 (*)</td>
</tr>
<tr>
<td>Philosophy</td>
<td>6 (*)</td>
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<td>Composition</td>
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<tr>
<td>History</td>
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<tr>
<td>Social Science</td>
<td>3 (*)</td>
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<td>Lit/Fine Arts</td>
<td>3 (*)</td>
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<tr>
<td>Free Electives</td>
<td>12</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>36</strong></td>
</tr>
</tbody>
</table>

### College of Science

- Biological Science: 8 credits
- Chemistry: 8 credits
- Organic Chemistry/Geology: 8 credits
- Mathematics: 8 credits
- Physics: 8 credits
- Statistics: 3-4 credits
- Science electives: 20-21 credits

**TOTAL** 64 credits

### College of Business

- Business Courses: 15 credits

**TOTAL** 15 credits

**TOTAL** 79 credits
“Biggest problem in business (science) is people don’t know how to talk to other people in the language they understand.”

Charles Holliday, CEO DuPont

deep domain knowledge in core science discipline

across disciplines
across functions
across cultures

“Equals”
more experienced
more adaptive
more collaborative
more creative
solutions to big problems
...career options for science business?
New Course Experience
...why take this course experience

Look around the room, be perceptive, and list objects are green.

Mentally list green objects

Your Notre Dame Education

“The real voyage of discovery consists not in seeking new landscapes, but having new eyes”

Quote by Marcel Proust

Keep eyes closed

Identify objects that are blue.

Now close your eyes

Look at world problems and opportunities with new eyes (science-rich knowledge).
...post graduate career options

Utilize science degree to:

• Graduate School
• Work at a big company
  (IBM, Philips, Novartis, Lilly, 3M, Cisco, Microsoft, Apple, General Electric, Pfizer, etc.);
• Utilize quantitative skills in other areas/industries
  (law, business, finance, medicine, etc.);
• Create my own high technology business
  (Entrepreneur);

What do you do if the big companies are not hiring?
...what is an entrepreneur

A person who undertakes the creation of an enterprise or business with a chance of profit (or success). Entrepreneurs distinguish themselves through their ability to accumulate and manage knowledge, as well as their ability to mobilize resources to achieve a specified business or social goal.

“pursuit of opportunity”
Knowledge acquired by careful observation - by deduction of laws which govern changes – and by testing these deductions by controlled experimentation.

(1) Empirical Evidence (empiricism)
-- observation, measurement & data

(2) Logical Reasoning (rationalism)
-- process, objective thinking

(3) Skeptical Attitude (skepticism)
-- self questioning, undogmatic

(4) Communication (results)
-- disseminate findings, confidence

(5) Interdisciplinary/partnerships
-- teamwork, stepping outside box
can a scientist be an entrepreneur?

Scientist entrepreneurs have an inherent advantage over other entrepreneurs:

(1) Closer to the “future” than others;

(2) Proximity to the cutting edge – opportunity to start businesses based on science that are truly breakthrough in nature;

(3) Strong quantitative skills & work ethic, understand complexity.
...the process

- Organizational capabilities
- Outside world
- Distribution channels
- Law
- events
- politics
- economics

“Win Statement”
“Gate Document”
Business Plan
Decision–Commit
Resources?
Move to NPD

University
Hospitals
Life
Compelling
Market Need

‘spokes’ define controllable areas
THE 3 C’S OF INNOVATION

- Competency
- Culture
- Courage

Invited Guests

CEO’s
Consultants
Business Development
Entrepreneurs
Coaches
Scientists
...intellectual property rights (IPR)

Intellectual Property
...intellectual property exercise
...projects – medical simulation

- Suspend disbelief (biggest problem)
- Skin ailments (basically non-existent)
- Missing many important symptoms/ailments/conditions
……project – solar cells, nano-materials

“….World energy demand will double by 2050. New initiatives to harvest solar light are needed to meet our future demand of clean energy”

The Problem: How to harvest visible and near infrared (solar) light with greater efficiency?

Nanomaterials exhibit size and shape dependent electronic and optical properties, tunability & efficiency

Impact—
Efficient/economically viable solar energy devices to tap renewable energy

Professor Prashant Kamat, Department of Chemistry and Biochemistry
...additional training for scientists/engineers
...why new master’s program

“.... our success in the global markets, our economic growth, and our standard of living all depend on maintaining a leading position in science, technology and innovation.”
NAS, NAE, IoM

ND Inventions

Masters Degree

Years of Formal Education

...ESTEEM (Science, Business, Engineering)

ND Basic Research Embryonic Science
Embryonic Ideas ‘Fuzzy’ Front End Idea Generation

Innovation Park at Notre Dame
Proof of Concept Prototypes

Start-Ups Technology Transfer Entrepreneurship

Commercialization societal benefit economic development South Bend Indiana

Value Creation

USPTO publications, patents,

Nature PNAS Physical Review Letters

ACS Publications High quality, High impact Journal of the American Mathematical Society

Innovation
Faculty Inventions
"The discovery of something absolutely new is the objective of research, and though apparently not very important for the time being, each new truth may become useful in the future." --Rev. Julius A. Nieuwland
Design of novel antibacterial agents

Anti-TB agents designed and synthesized to interfere with iron uptake systems required for TB to grow during an infection
PiggyBac, a jumping gene, or transposon, has the ability to jump from one place on a chromosome to another.

Carry genes from one location to another

Recognize unique DNA sequences, inserting themselves, and the included gene, very accurately

Professor Mac Fraser, Biological Sciences

- Immunity to parasites and viruses
- Improve the quality of silk, new super-fibers
- Induce the caterpillars to produce silk containing pharmaceuticals
- Controlling disease-carrying insects and crop pests
A process for preparing unassumned esters useful as intermediates for HDAC inhibitors, by reacting an alcohol or lactone having the following formula I:

\[
R_1 \text{O} \text{C} \text{O} \text{C} \text{O} \text{N} \text{H} \text{C} \text{H} \text{C} \text{H}_3
\]

wherein \( R_1 \) is an aromatic group or a combined aliphatic and aromatic group; \( N \) is \(-\text{O} \text{C} \text{O} \text{C} \text{O} \text{N} \text{H} \text{C} \text{H} \text{C} \text{H}_3 \); an aliphatic linking group, an aromatic linking group, or a combined aliphatic and aromatic linking group; \( R_2 \) and \( R_3 \) are each independently hydrogen, a hydroxy group, an alkoxy group, an amine group, an alkyl group, an aliphatic group, an aromatic group, or a combined aliphatic and aromatic group; \( R_4 \) and \( R_5 \) are each independently hydrogen, a hydroxy group, an alkoxy group, an amine group, an alkyl group, an aliphatic group, an aromatic group, or a combined aliphatic and aromatic group; \( R_6 \) is hydrogen, an aliphatic group, an aromatic group, or a combined aliphatic and aromatic group; \( m \) is 0 or 1; \( n \) is 0 or 1; and \( p \) is 0 or 1.

Applications to many diseases (rare)
prostate cancer vaccine

6 patent applications on cancer vaccines and vaccine adjuvants

Dr. Mark Suckow, Director Freimann Life Sciences Center
piggyBac – jumping gene

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...cancer prognosis with gene expression

“Notre Dame’s collaborative environment strongly supports the interdisciplinary teams needed in today’s biomedical research.”

**Problem:** Identify patterns of gene expression that determine which patients can safely forego chemotherapy

**Solution:** Breast cancer patients whose tumors negatively express three genes have good prognosis

**Impact—**
A large group of breast cancer patients can avoid the toxic side effects of chemotherapy with negligible increased risk of relapse

Professor Steven Buechler, Mathematics
...the problem – sun related skin problems

- 61% of adults use sunscreen
- High incident of sun related skin cancer (1.1 M/year USA)
- Current lotions may not be that effective

(Ref: NCI, WHO)

... the solution – active sunscreen

Visible δλ stimulates DNA repair mechanisms

Put it back!
...summer internships

Technology Readiness Gate

Laboratory Invention

Further Breakthroughs & Discovery Needed
Science NOT Ready

Really Risky

Do you technology due diligence early

Call experts, folks who have published or patented in the field of interest.

Gate

Ready for Development
- Optimization
- Scale Up
- Ready for Prototype
- Necessary Tech Available

Probably too Early to spin out

Probably
due diligence early
...speed dating (professional)
economic development
Interface with South Bend
...shopping, restaurants
...hotels
...condominiums
...caught in the middle

Silicon Valley, Cambridge, Austin, Research Triangle, RT 128

the Midwest ?????

5 hour drive, ~50 Universities
...a favorite quote

“The main point that I could make in communication in this area would be to point out that the difference between the great and good societies and the regressing, deteriorating societies is largely in terms of the entrepreneurial opportunity and the number of such people in the society. I think everyone would agree that the most value 100 people to bring into a deteriorating society (discussing Peru) would not be 100 chemists, or politicians, or professors, or engineers, but rather 100 entrepreneurs.”

Abraham Harold Maslow (April 1, 1908 – June 8, 1970) was an American psychologist.