Differentiating Ourselves in a Global Market

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Research Alone is Not Enough!

• **Trends:**
  - US global share of new doctorates in science & engineering has slipped from 52% in 1986 to 22% in 2003
  - US share of scientific publications declined from 38% in 1988 to 30% in 2003
  - US leads the world in investments in R&D ($353 billion in 2007), but China leads the world in growth rate of R&D investments and will surpass Japan as #2 this year

• **Number of researchers:**
  - United States (1.3 million)
  - European Union (1.1 million)
  - China (0.93 million)

• **How are our STUDENTS going to be competitive given:**
  - Rising national debt, unbalanced budgets, credit crisis and increased competition in the global economy?
### Overall U.S. Employment

All manufacturing sectors except agricultural chemicals saw layoffs in 2009

<table>
<thead>
<tr>
<th>THOUSANDS</th>
<th>1999</th>
<th>2000</th>
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<th>2002</th>
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<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing</td>
<td>17,322</td>
<td>17,263</td>
<td>16,441</td>
<td>15,259</td>
<td>14,510</td>
<td>14,315</td>
<td>14,226</td>
<td>14,155</td>
<td>13,879</td>
<td>13,406</td>
<td>11,883</td>
</tr>
<tr>
<td>Chemicals</td>
<td>983</td>
<td>980</td>
<td>959</td>
<td>928</td>
<td>906</td>
<td>887</td>
<td>872</td>
<td>866</td>
<td>861</td>
<td>847</td>
<td>803</td>
</tr>
</tbody>
</table>

**Annual Change**

<table>
<thead>
<tr>
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<th>2008-09</th>
<th>1999-09</th>
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<tbody>
<tr>
<td>Manufacturing</td>
<td>-11.4%</td>
<td>-3.4%</td>
</tr>
<tr>
<td>Chemicals</td>
<td>-5.2%</td>
<td>-1.8%</td>
</tr>
</tbody>
</table>
Which sector lost the most jobs in 2010?

- The pharmaceutical sector had the dubious honor of topping all others when it came to U.S. job cuts in 2010.
- Of the roughly 530,000 jobs eliminated in this country last year, nearly 54,000 were at pharmaceutical firms.
- Things were even worse in 2009. Pharmaceutical companies were responsible for about 61,000 of the 1.29 million layoffs announced that year.
- Because of restructuring, the pharmaceutical industry has been bracing itself for years now.
“Research is an expression of faith in the possibility of progress. The drive that leads scholars to study a topic has to include the belief that new things can be discovered, that newer can be better, and that greater depth of understanding is achievable. Research, especially academic research, is a form of optimism about the human condition.”

Henry Rosovsky
Did You Know?

• The top ten in-demand jobs last year in 2010….did NOT exist in 2004…
• We are currently preparing students for jobs that don’t exist yet, to use technologies that haven’t been invented yet…
  → Of our current Freshman, Sophomores and Juniors in College today, one third of them will go into jobs that as of today haven’t been created yet!
• The US Department of Labor estimates that today’s learner will have 10-14 different jobs….by the age of 38…
• One in four workers have been with their current employer for less than a year…

http://www.did-you-knows.com/
“Knowing is not enough; we must apply. Willing is not enough; we must do.”

Goethe
Key Ingredients For Going from Invention to Innovation

- Mentorship
- Recognition that strategy is all about being different
- The most fertile ground for innovation lies between fields
- The best design teams are the most diverse
- Partnerships with domain experts
- Finding the best jumpers…
- A willingness to challenge one’s world view…
- A willingness to fail…
- The ability to seize the fragile and fleeting opportunity…
- The capability of being adaptable…
- Resources!
- And a recognition that the very people who will benefit the most from our technological advances will fight us the most
  → The customer rarely knows what they want!

Vignettes…
Innovation and Diversity

• Great genius takes shape by contact with another great genius
  → but less by assimilation than by friction.

Heinrich Heini
• There is no more fertile ground for innovation than a diversity of experience.

• A successful scientific endeavor is one that attracts a diversity of experience, draws upon the breadth and depth of that experience, and cultivates those differences, acknowledging the creativity they spark.

http://www.chem.unc.edu/people/faculty/desimone/group/diversity.htm
A fundamental insight:

- In problem solving, diversity is powerful stuff.
- It doesn’t always trump ability, but it does so far more often than we’d expect.

Does this logic imply that we should abandon the meritocracy?

- No! Ability matters.
- But—here’s the catch—diversity matters too!
Organic Polymer Chemistry in Unconventional “Media”

- **Novel fluoropolymers & Surfactants**

  
  \[
  \text{F} = \begin{align*}
  \text{CF}_3 \quad \text{CF}_2X
  \end{align*}
  \]

  Polymerizations in Supercritical CO\textsubscript{2}

  - Science 1992, 257, 945
  - Science 1994, 265, 356
  - Langmuir 1995, 11, 4241
  - Science 1996, 274, 2049
  - Nature 1997, 389, 368
  - Macromolecules 1999, 32, 8224
  - J. Am. Chem. Soc. 2001, 123, 7199
  - Langmuir 2004, 20, 1065
  - Macromolecules 2006, 39, 3427
  - Macromolecules 2009, 42, 148

- **Merging Lithography with Therapeutics, Vaccines and More...**

  - Chemistry of Materials 2010, 22, 4069
  - J. Am. Chem. Soc. 2010, 132, 11306
  - Nanoletters 2010, 10, 1113
  - Nature Reviews Drug Discovery 2010, 9, 615
  - Nature Materials 2010, 9, 220
  - Langmuir 2010, 26, 3012
  - Langmuir 2008, 20, 8421
  - Accounts of Chemical Research 2008, 41, 1685

“Solvent Resistant “Liquid Teflon” for Microfluidic Device Fabrication”; JACS 2004, 126, 2322
Adapt emerging techniques from the microelectronics industry to design and synthesize new vaccines and medicines.
Particle Replication in Non-wetting Templates (PRINT®, Platform)

Extremely Uniform, Shape-Specific Particles with a Wide Range of Spatio-Chemical Composition Control

Co-opting Moore’s Law: Vaccines, Medicines and More from a Wafer

- **Medicine**
  - Therapeutics and vaccines
  - Diagnostics
  - Personalized medicine
  - Prevention and nutrition
  - Medical devices

- **Energy**
  - Conversion
  - Storage
  - Transmission

- **Environment and biotechnology**
  - Water purification
  - Diagnostics

- **Advanced technologies**
  - Robotics & Aerospace
  - Complex fluids
PRINT Scale Up: Particle Foundry
Scale-up Vision

PRINT Scale Up: Particle Foundry

cGMP Manufacturing
The PRINT Process
Unique Convergence of Capabilities

**Replication of:**
- Polymers
- Glasses
- Metals
- Other solids

**High-fidelity replication**
- Single nanometer precision
- Complex patterns
- High aspect ratio features

**Variety of Materials**

**Large area, continuous mfg**
- Seamless tiling of small areas
- Low cost, high volume processing

**Precision of Photolithography**

**Scalability of Films Manufacturing**
Team Efforts

Collaborators
Benefits of Scientific Entrepreneurship

- Entrepreneurship for an academic scientist provides:
  - A compass that helps navigate where important problems are;
  - A constant source of feedback/challenge/refinement to one's ideas;
  - A source for additional resources to make a true impact (Langer, Mirkin, Quake, Swagger, McCullough, Bertozzi);
  - Additional bandwidth for collecting relevant literature and scouring the earth for relevant prior art;
  - Improved “grantmanship” as success at entrepreneurship forces one to articulate differences and benefits of your science (the value proposition), which helps land grants;
  - An opportunity for scale-up of nascent concepts that requires millions of dollars, and such scale up can open up new research directions in basic science;
- Dip-pen lithography technology, Quake's microfluidic chip technology, Liquidia molds
- Required outlets necessary to be effective in translational research which is key for universities to be competitive to garner many federal agency grants, like our NCI funded CCNE, the CTSA grant and UCRF.
Lessons Learned

• The business world is a true meritocracy
• #1 Lesson for leadership within a university:
  → At the end of the day, this is an all volunteer organization
• Focus on excellence, most of the other stuff will take care of itself…
• Cash is king!
  → In good times and in bad!
  → Know where your money comes from
    • Don’t get made at your money
    • Good stewardship
    • University?: DC and Raleigh (SOM, LCCC, ESOP effective)
• Strategy is all about being different
  → New monies flow to new and different things
  → Companies, Centers and Institutes
• The most fertile ground for innovation lies between fields…
• The most fundamental tenant of innovation is diversity…
• There’s only two types of negotiations: Collaborative and Competitive…it’s a science
• NOAH Policy
• Think Big!
  → Role of a liberal arts education…
• Believe in yourself and your work…
• Make the most out of the time with your friends and family