Barriers to Transitioning University Technology for Regional Economic Development:

Institutional Goals, Organizational Structure, and Resources

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NSF Partnerships for Innovation

Barriers to Leveraging Research Universities for Innovation in Legacy Industrial Regions

- Cost of university research
- Poor communication and information exchange
- Difficulty in accessing university facilities
- Long lead-times for university research projects
- Inadequate incentives for faculty and students to work with industry
- Low regional workforce education levels
- Lack of diversity in the regional workforce
1940-1975: The Golden Age

- **World War II**
  - Federal science funding grows from $74 million to $1.6 billion
  - Utilization of non-government contractors, especially universities
  - Emphasis on financial accountability and scientific independence

- **Science: The Endless Frontier, 1945**
- Fragmented system controlled by elite institutions
- Bipartisan support for science
- Strong public support for public science
  - 25% of public supports considers itself scientifically literate and supports government science funding

- **Linear model of technological innovation and “spin-off”**
  - Aerospace
  - Computer science and engineering
  - Nuclear energy

Basic Research → Applied Research → Technology Development → Commercialization
1970s: Economic and Political Challenges

- Loss of market share in key industries long dominated by the U.S.
  - Automobiles, steel, machine tools, electronics
- Unfavorable balance of trade
- 1973 Arab oil embargo
- Declines in U.S. GDP growth and manufacturing productivity growth
- Zeitgeist of Japanese invincibility
- Weaknesses of linear model of technology innovation
- Public suspicion and skepticism on science
  - Nuclear power
  - Biotechnology
- Science becomes “just another pressure group”
1980s
Policy Initiatives, But No Strategy

- Stevenson-Wydler Technological Innovation Act of 1980
- Small Business Innovation Act of 1982
- National Cooperative Research Act of 1984
- NSF ERC program, 1985
- Federal Technology Transfer Act of 1986
- Department of Defense Sematech, 1987
- Omnibus Trade and Competitiveness Act of 1988
- Defense Industrial and Technology Base Initiatives of 1991-92
- Intense state-level policy activism
  - Pennsylvania Ben Franklin Partnership
  - Michigan Strategic Fund
  - New Jersey Commission on Science and Technology
  - New York State Science and Technology Foundation
  - Ohio Thomas Edison Program
1990s: Controversy at the National Level

- Clinton Administration embraces cooperative technology policy
  - NIST Advanced Technology Program (ATP)
  - ARPA Technology Reinvestment Project (TRP)
  - DOE CRADAs
- 1995 mid-term elections
  - New Republican Congress attacks ATP
    - Industrial policy
    - Corporate welfare
  - Defense industry opposition to TRP
  - ARPA reverts to DARPA
  - ATP eliminated in 2007
- State investment continues to expand without regard to political party
Current Decade

- Research universities are called to support regional technology based economic development
- Declining industry sponsored academic research
  - Emphasis on global corporations
  - Academic independence
  - Model agreements and master agreements
- University patenting and licensing
  - Licensing to existing industry
  - Spin-out firms
  - Biotechnology and pharmaceuticals
- STEM “skills crisis”
  - Rising Above the Gathering Storm
- Innovation and entrepreneurship
  - Kauffman Campuses
  - Engineering design and innovation (May 29-30 NSF Workshop)
    - Northwestern Segal Design Institute
    - Stanford Design School
    - Michigan Design Science Program
Economic Development Benefits of Research Intensive Universities

- Investments in university research result in higher levels of local industrial research and innovation (Jaffe, 1989)
- Firms located near centers of advanced research benefit from collaborative basic research (Salter and Martin, 2001)
- Faculty members engaged in industry sponsored research accommodate industry interests without loss of independence (Slaughter, 2004)
Predictors of Successful University Spin-Out Companies

- Commercialization of the invention depends on tacit knowledge and requires direct effort by the inventor (Lowe, 2004; Shane, 2002)
- Engineering faculty and students are of the highest quality (Chukuma and Jensen, 2005)
- Universities are willing to accept lower royalty returns, and equity in lieu of fees (DiGregorio and Shane, 2002)
University Patenting and Licensing

- The average Association of University Technology Managers (AUTM) member institution employs 10 full time technology transfer specialists.
- Of 13 licensed technologies highlighted in the 2006 AUTM member survey summary, 11 are for biomedical products.
- Of the $1.8 billion of licensing income received by 181 reporting AUTM members in 2006, 60% was received by 10 institutions.
- The average AUTM member institution launched 3.4 spin-out companies in 2006 based on licensed technologies.
### Top Ten Institutions, 2006 Licensing Revenue

<table>
<thead>
<tr>
<th>Institution</th>
<th>2006 Revenue</th>
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<tbody>
<tr>
<td>Massachusetts General Hospital</td>
<td>$318,600,000</td>
</tr>
<tr>
<td>University of California System</td>
<td>$193,500,000</td>
</tr>
<tr>
<td>New York University</td>
<td>$157,400,000</td>
</tr>
<tr>
<td>Beckman Research Institute</td>
<td>$98,700,000</td>
</tr>
<tr>
<td>Stanford University</td>
<td>$61,300,000</td>
</tr>
<tr>
<td>Wake Forest University</td>
<td>$60,100,000</td>
</tr>
<tr>
<td>University of Minnesota</td>
<td>$56,200,000</td>
</tr>
<tr>
<td>Wistar Institute</td>
<td>$47,100,000</td>
</tr>
<tr>
<td>MIT</td>
<td>$43,500,000</td>
</tr>
<tr>
<td>University of Florida</td>
<td>$42,900,000</td>
</tr>
</tbody>
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Average 2006 revenue = $10,360,000 for 181 responding institutions

Source: 2006 AUTM Survey
## Top Ten Institutions, 2006 Start-Ups

<table>
<thead>
<tr>
<th>Institution</th>
<th>Start-Ups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fox Chase Cancer Center</td>
<td>55</td>
</tr>
<tr>
<td>University of California System</td>
<td>39</td>
</tr>
<tr>
<td>MIT</td>
<td>23</td>
</tr>
<tr>
<td>University of Utah</td>
<td>17</td>
</tr>
<tr>
<td>Purdue Research Foundation</td>
<td>14</td>
</tr>
<tr>
<td>California Institute of Technology</td>
<td>12</td>
</tr>
<tr>
<td>Carnegie Mellon University</td>
<td>12</td>
</tr>
<tr>
<td>SUNY Research Foundation</td>
<td>12</td>
</tr>
<tr>
<td>University of Colorado</td>
<td>10</td>
</tr>
<tr>
<td>University of Florida</td>
<td>10</td>
</tr>
<tr>
<td>University of Washington</td>
<td>10</td>
</tr>
</tbody>
</table>

Average 2006 start ups = 3.4 for 181 responding institutions

Source: 2006 AUTM Survey
Kauffman Campuses
Providing undergraduate and graduate students and faculty access to entrepreneurship education and resources

Inaugural Campuses:
- Launched in 2003
- $5 million to each

- Florida International
- Howard University
- University of Illinois
- University of North Carolina
- University of Rochester
- University of Texas El Paso
- Wake Forest University
- Washington University in St. Louis

Kauffman Campuses II:
- Launched in 2006
- $20 million total

- Arizona State University
- Georgetown University
- Syracuse University
- University of Wisconsin
- University of Maryland Baltimore
- Northeast Ohio Consortium
  - Burton D. Morgan Foundation
  - Baldwin-Wallace College
  - College of Wooster
  - Hiram College
  - Lake Erie College
  - Oberlin College
Another Model: Morrill Act of 1862... to teach “agriculture and mechanic arts.”

- **Research**
  - Basic research in areas of importance to industry
  - Applied research to address problems and develop opportunities
  - Generic technology development applicable across industries

- **Education**
  - Undergraduate and graduate education programs
  - Workforce development programs for industry
  - Conferences and training programs for service providers

- **Extension**
  - Assessing and organizing efforts to address industry needs
  - Connecting University faculty and students to industry
  - Leadership and coordination at regional and county levels
Morrill Act of 1862: Implementation and Impacts

Agricultural Arts

- More than $50 billion of continuous state and federal funding since 1887
- Reliance on state universities
- Integrated agricultural research, training, and extension services
- Unparalleled productivity gains and global dominance of U.S. agriculture
- Fulfillment of 1862 Morrill Act vision

Mechanical Arts

- No state or federal funding before 1980; only modest investments since then
- Reliance on private economic development “intermediaries”
- Fragmented research, training, and extension services
- Half the manufacturing jobs in PA lost since 1970, from 1.5 million to 670,000 jobs
- Vision of 1862 Morrill Act not fulfilled
Policy Agenda Setting

Problem stream

Policy stream

Political stream

Window of opportunity for policy making
Some Issues and Opportunities for the Coming Decade

- The impacts of Bayh-Dole should be assessed
- Issues of institutional engagement in regional technology based economic development
  - Roles of research intensive universities
    - Significant research expenditures are a precondition
  - Roles of research intensive schools of engineering
    - Engineering design and innovation programs
    - Engineering extension programs
    - Industry-academic research partnerships
    - Politics of engagement
- Emerging opportunities for public policy making
  - Role of existing federal programs and agencies
  - Role of states and state-federal relations
  - Role of professional and technical societies