Introduction

Innovation and Productivity Growth

Prosperity

Competitiveness (Productivity)

Innovative Capacity

- The most important sources of prosperity are created not inherited
- Productivity does not depend on what industries a region competes in, but on how it competes
- The prosperity of a region depends on the productivity of all its industries
- Innovation is vital for long-term increases in productivity
Introduction

The California Wine Cluster

- **Grapestock**
- **Fertilizer, Pesticides, Herbicides**
- **Grape Harvesting Equipment**
- **Irrigation Technology**
- **State Government Agencies** (e.g., Select Committee on Wine Production and Economy)
  - **Winemaking Equipment**
  - **Barrels**
  - **Bottles**
  - **Caps and Corks**
  - **Labels**
  - **Public Relations and Advertising**
  - **Specialized Publications** (e.g., Wine Spectator, Trade Journal)

- **Growers / Vineyards**
- **Wine Growers / Vineyards**
- **Wineries / Processing Facilities**
  - **Wineries / Processing Facilities**

- **Educational, Research, and Trade Organizations** (e.g., Wine Institute, UC Davis, Culinary Institutes)
  - **California Agricultural Cluster**
  - **Tourism Cluster**
  - **Food Cluster**

- **Source**: California Wine Institute, Internet Search, California State Legislature. Based on research by MBA 1997 students R. Alexander, R. Arney, N. Black, E. Frost, and A. Shivananda
Clusters of Innovation Initiative Objectives

To enhance innovation in regional economies by:

- Understanding the composition of regional economies
- Understanding how clusters develop
- Understanding how innovation arises
- Developing lessons from regional case studies that inform key decision makers; and,
- Developing a methodology, process, and data infrastructure that can be utilized widely across America
# Unique Data Sources

## Cluster Mapping Project Data
- Consistent performance measures, 1990–1999
  - Employees
  - Wages
  - Establishments
  - Patents
- Systematic data on regional clusters, industries, and patenting
  - Empirically derived cluster linkages
  - Evolution of clusters over time
- Comparative data at multiple levels of geography
  - County
  - MSA
  - Economic area
  - State

## Surveys
- Surveys (1,025)
  - Both paper and electronic
  - Measure numerous aspects of business and regional cluster performance in a consistent matter that allows quantification

## Interviews
- Interviews (264)
  - Access the knowledge and expertise of regional leaders
  - Assess numerous aspects of business environment and cluster development at a qualitative level
  - Provide nuance to other data sources
  - Help identify unique lessons, challenges, and opportunities
Regions and Clusters Studied

**Wichita**
- Plastics
- Aerospace Vehicles and Defense

*Interviews: 74
Surveys: 138*

**Atlanta**
- Financial Services
- Information Technology
- Transportation and Logistics

*Interviews: 43
Surveys: 232*

**San Diego**
- Pharmaceuticals / Biotechnology
- Communications

*Interviews: 49
Surveys: 202*

**Pittsburgh**
- Pharmaceuticals / Biotechnology
- Information Technology
- Production Technology

*Interviews: 51
Surveys: 202*

**Research Triangle**
- Pharmaceuticals / Biotechnology
- Communications
- Shorter Case Studies of Chemicals, Fibers

*Interviews: 47
Surveys: 251*
Introduction

Special thanks to . . .

- Council on Competitiveness
- National Steering Committee
- Regional Advisors
- Institute for Strategy and Competitiveness
- Monitor Group
- ontheFRONTIER
- Survey Respondents and Interviewees

Over 1,300 participants
Agenda

- The Economic Performance of Regions
  - The Composition of Regional Economies
  - The Evolution of Regional Economies
  - The Determinants of Regional Competitiveness and Innovative Capacity
  - Clusters
  - The Development of Clusters
  - Creating and Implementing a Regional Economic Strategy
  - Action Agendas for the Public and Private Sectors
Average Wages and Employment Growth

U.S. Economic Areas

The Economic Performance of Regions

Average Wage, 1999

Annual Percentage Growth Rate of Employment, 1990-1999

U.S. Average
Innovation Performance Across Regions
Patents per Capita, 1998

Note: There are 172 Economic Areas in the United States
Source: Cluster Mapping Project, Harvard Business School

U.S. Average = 19.7
Innovation and Prosperity
Patents per Inhabitant vs. Average Wages, U.S. Economic Areas, 1998

Adj. $R^2 = 0.36$

Source: Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School
**Economic Performance Measures**

### Overall Economy
- **Employment Growth**
  - Rate of employment growth
- **Unemployment**
  - Percentage of persons unemployed
- **Average Wages**
  - Payroll per person
- **Wage Growth**
  - Growth rate of payroll per person
- **Cost of Living**
  - Cost of living index
- **Exports**
  - Value of manufactured and commodity exports per worker

### Innovation Output
- **Patents**
  - Number of patents and patents per worker
- **Establishment Formation**
  - Growth rate of establishments
- **Venture Capital Investments**
  - Value of venture capital invested
- **Initial Public Offerings**
  - Number of initial public offerings
- **Fast Growth Firms**
  - Number of firms on the Inc. 500 list
The Economic Performance of Regions

**Atlanta Overview**

### Economic Performance

**Employment Growth**
- Annual employment growth from 1991–2001 in Atlanta MSA was 3.2% vs 1.9% for the US.

**Unemployment**
- Unemployment rate (2.8% in 2000) was below the US and Georgia for the last decade.

**Average Wages**
- Atlanta average wages in 1999 were $35,380 vs. $32,110 for the US.

**Wage Growth**
- Average wage growth in Atlanta was 4.5% from 1990–1999 vs. 4.0% for the US.

**Cost of Living**
- Atlanta cost of living is 10 to 20% higher than the US average.

**Exports**
- 14.4% annual growth rate of Atlanta exports from 1993–1999 was nearly twice the national average.

### Innovation Output

**Patents**
- Patenting is low (4.7/10,000 employees), versus the national average of 6.3; growth is well above the US metro average.

**Establishment Growth**
- Number of (traded cluster) establishments grew 9.0% annually from 1990 to 1999, 4 times the US average.

**Fast Growth Firms**
- Strong growth in both INC 500 and Gazelle Firms over past 5 years.

**Venture Capital Investments**
- VC investments over $2.6 billion from 1995–2000, but Atlanta’s share of total national VC funding still trails other comparative regions.

**Initial Public Offerings**
- IPOs increasing, but at rate below other high-growth regions.

### Economic Performance Indicators

#### Overview of the Pittsburgh Metro Area

<table>
<thead>
<tr>
<th>Economic Performance</th>
<th>Innovation Output</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Employment</strong></td>
<td><strong>Patents</strong></td>
</tr>
<tr>
<td>• Annual employment growth rate between 1991–2001 in the Pittsburgh MSA 0.3% vs. 1.9% for the U.S.</td>
<td>• 7.0 patents per 10,000 workers in the Pittsburgh MSA in 1999 vs. 6.3 for the U.S.; 1.3% annual growth in the MSA vs. 4.7% in U.S. from 1990–1999</td>
</tr>
<tr>
<td><strong>Unemployment</strong></td>
<td><strong>Fast Growth Firms</strong></td>
</tr>
<tr>
<td>• Unemployment rate in the Pittsburgh MSA of 4.3% in 2001 vs. 4.4% for U.S.</td>
<td>• Pittsburgh had 0.8% of the firms on the Inc 500 between 1991–2000 vs. 0.9% of the U.S. employment</td>
</tr>
<tr>
<td><strong>Population</strong></td>
<td><strong>Venture Capital Investments</strong></td>
</tr>
<tr>
<td>• The population of the Pittsburgh MSA is decreasing at 0.3% annually between 1990–1999 vs. 1.0% growth for the U.S.</td>
<td>• VC investments of $301 per worker in Pittsburgh in 2000 vs. $387 for the U.S.</td>
</tr>
<tr>
<td><strong>Wages</strong></td>
<td><strong>Initial Public Offerings</strong></td>
</tr>
<tr>
<td>• Average wage in the Pittsburgh MSA of $32,365 in 1999, vs. $32,711 for the U.S.; annual growth of wages equaled the U.S. growth rate</td>
<td>• Pittsburgh had 0.4 IPOs per 100,000 workers in the past 10 years, well below benchmarked regions</td>
</tr>
<tr>
<td><strong>Exports</strong></td>
<td><strong>Establishment Growth</strong></td>
</tr>
<tr>
<td>• Exports per worker in the Pittsburgh MSA were $3,416 in 1999 vs. $5,212 for the U.S.</td>
<td>• The number of establishments in Pittsburgh grew 0.5% annually between 1990–1999, vs. 1.4% for the U.S.</td>
</tr>
</tbody>
</table>
## Patents by Organization

### Research Triangle MSA, 1995–1999

<table>
<thead>
<tr>
<th>Organization</th>
<th>Patents Issued from 1995 to 1999</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 International Business Machines Corporation</td>
<td>495</td>
</tr>
<tr>
<td>2 Ericsson, Inc.</td>
<td>325</td>
</tr>
<tr>
<td>3 Becton, Dickinson and Company</td>
<td>128</td>
</tr>
<tr>
<td>4 North Carolina State University</td>
<td>128</td>
</tr>
<tr>
<td>5 Duke University</td>
<td>127</td>
</tr>
<tr>
<td>6 University of North Carolina — Chapel Hill</td>
<td>124</td>
</tr>
<tr>
<td>7 Square D Company</td>
<td>48</td>
</tr>
<tr>
<td>8 Novartis</td>
<td>46</td>
</tr>
<tr>
<td>9 ABB Power T&amp;D Company, Inc.</td>
<td>44</td>
</tr>
<tr>
<td>10 Alcatel Network Systems, Inc.</td>
<td>43</td>
</tr>
<tr>
<td>11 Mitsubishi Semiconductor America, Inc.</td>
<td>41</td>
</tr>
<tr>
<td>12 Lord Corporation</td>
<td>36</td>
</tr>
<tr>
<td>13 Kennametal, Inc.</td>
<td>29</td>
</tr>
<tr>
<td>14 Rhone-Poulenc, Inc.</td>
<td>29</td>
</tr>
<tr>
<td>15 Telefonaktiebolaget LM Ericsson</td>
<td>28</td>
</tr>
<tr>
<td>16 Caterpillar, Inc.</td>
<td>26</td>
</tr>
<tr>
<td>17 Cree Research, Inc.</td>
<td>26</td>
</tr>
<tr>
<td>18 E.I. DuPont De Nemours and Company</td>
<td>26</td>
</tr>
<tr>
<td>19 MCNC</td>
<td>25</td>
</tr>
<tr>
<td>20 Raychem Corporation</td>
<td>24</td>
</tr>
<tr>
<td>21 Reichhold Chemicals, Inc.</td>
<td>24</td>
</tr>
<tr>
<td>22 American Sterilizer Company</td>
<td>21</td>
</tr>
<tr>
<td>23 Siemens Energy and Automation, Inc.</td>
<td>21</td>
</tr>
<tr>
<td>24 Northern Telecom Limited</td>
<td>20</td>
</tr>
<tr>
<td>25 Research Triangle Institute</td>
<td>20</td>
</tr>
</tbody>
</table>

Source: Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School
## Patents by Organization
### Wichita, EA, 1994–1998

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Coleman Company</td>
<td>95</td>
</tr>
<tr>
<td>Symbios Logic Inc.</td>
<td>20</td>
</tr>
<tr>
<td>Hay &amp; Forage Industries</td>
<td>14</td>
</tr>
<tr>
<td>Wescon Products Company</td>
<td>12</td>
</tr>
<tr>
<td>Boeing Company</td>
<td>11</td>
</tr>
<tr>
<td>AT&amp;T Global Information Solutions Company</td>
<td>10</td>
</tr>
<tr>
<td>Koch Engineering Co., Inc.</td>
<td>10</td>
</tr>
<tr>
<td><strong>St. Francis Research Institute</strong></td>
<td><strong>6</strong></td>
</tr>
<tr>
<td>Vulcan Materials Company</td>
<td>6</td>
</tr>
<tr>
<td>Cessna Aircraft Company</td>
<td>5</td>
</tr>
<tr>
<td>NCR Corporation</td>
<td>5</td>
</tr>
<tr>
<td>Tweco Products, Inc.</td>
<td>4</td>
</tr>
<tr>
<td><strong>Via Christi Research, Inc.</strong></td>
<td><strong>4</strong></td>
</tr>
<tr>
<td>Case Corporation</td>
<td>3</td>
</tr>
<tr>
<td>Pizza Hut</td>
<td>3</td>
</tr>
<tr>
<td>Beech Aircraft Corporation</td>
<td>2</td>
</tr>
<tr>
<td>Koch Industries, Inc.</td>
<td>2</td>
</tr>
<tr>
<td>Metal Fab Inc.</td>
<td>2</td>
</tr>
<tr>
<td>Uniflow Conveyor, Inc.</td>
<td>2</td>
</tr>
<tr>
<td>Turbochef, Inc.</td>
<td>2</td>
</tr>
<tr>
<td>Balco / Metalines, Inc.</td>
<td>2</td>
</tr>
<tr>
<td>Legg Company, Incorporated</td>
<td>2</td>
</tr>
<tr>
<td>The Bradbury Company, Inc.</td>
<td>2</td>
</tr>
<tr>
<td><strong>The Women’s Research Institute</strong></td>
<td><strong>2</strong></td>
</tr>
<tr>
<td>Great Plains Manufacturing Incorporated</td>
<td>2</td>
</tr>
</tbody>
</table>

Source: Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School

Regional Foundations of U.S. Competitiveness
### Patents by Universities

<table>
<thead>
<tr>
<th>Rank</th>
<th>University</th>
<th>Total Patents, 1995–1999</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>University of California</td>
<td>1,585</td>
</tr>
<tr>
<td>2</td>
<td>Massachusetts Institute of Technology</td>
<td>605</td>
</tr>
<tr>
<td>3</td>
<td>University of Texas</td>
<td>444</td>
</tr>
<tr>
<td>4</td>
<td>Wisconsin University</td>
<td>339</td>
</tr>
<tr>
<td>5</td>
<td>Stanford University</td>
<td>335</td>
</tr>
<tr>
<td>6</td>
<td>California Institute of Technology</td>
<td>299</td>
</tr>
<tr>
<td>7</td>
<td>Johns Hopkins University</td>
<td>275</td>
</tr>
<tr>
<td>8</td>
<td>Cornell University</td>
<td>266</td>
</tr>
<tr>
<td>9</td>
<td>University of Pennsylvania</td>
<td>253</td>
</tr>
<tr>
<td>10</td>
<td>State University of New York</td>
<td>217</td>
</tr>
<tr>
<td>11</td>
<td>University of Michigan</td>
<td>209</td>
</tr>
<tr>
<td>12</td>
<td>Iowa State University</td>
<td>208</td>
</tr>
<tr>
<td>13</td>
<td>Michigan State University</td>
<td>200</td>
</tr>
<tr>
<td>14</td>
<td>Columbia University</td>
<td>196</td>
</tr>
<tr>
<td>15</td>
<td>University of Minnesota</td>
<td>180</td>
</tr>
<tr>
<td>16</td>
<td>University of Washington</td>
<td>173</td>
</tr>
<tr>
<td>17</td>
<td>Harvard University</td>
<td>164</td>
</tr>
<tr>
<td>18</td>
<td>University of North Carolina</td>
<td>154</td>
</tr>
<tr>
<td>19</td>
<td>Washington University</td>
<td>151</td>
</tr>
<tr>
<td>20</td>
<td>Duke University</td>
<td>139</td>
</tr>
<tr>
<td>21</td>
<td>University of British Columbia</td>
<td>137</td>
</tr>
<tr>
<td>22</td>
<td>North Carolina State University</td>
<td>129</td>
</tr>
<tr>
<td>23</td>
<td>University of Nebraska</td>
<td>122</td>
</tr>
<tr>
<td>24</td>
<td>University of Utah</td>
<td>121</td>
</tr>
<tr>
<td>25</td>
<td>Penn State University</td>
<td>116</td>
</tr>
</tbody>
</table>

Source: Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School
Agenda

- The Economic Performance of Regions

- **The Composition of Regional Economies**
  - The Evolution of Regional Economies
  - The Determinants of Regional Competitiveness and Innovative Capacity
  - Clusters
  - The Development of Clusters
  - Creating and Implementing a Regional Economic Strategy
  - Action Agendas for the Public and Private Sectors
### Composition of Regional Economies

#### United States

<table>
<thead>
<tr>
<th></th>
<th>Traded Clusters</th>
<th>Local Clusters</th>
<th>Natural Resource-Driven Industries</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Share of Employment</strong></td>
<td>32.1%</td>
<td>67.1%</td>
<td>0.8%</td>
</tr>
<tr>
<td><strong>Employment Growth, 1993 to 1999</strong></td>
<td>2.5%</td>
<td>2.8%</td>
<td>-0.1%</td>
</tr>
<tr>
<td><strong>Average Wage</strong></td>
<td>$41,678</td>
<td>$26,049</td>
<td>$31,264</td>
</tr>
<tr>
<td><strong>Relative Wage</strong></td>
<td>134.0</td>
<td>83.8</td>
<td>100.5</td>
</tr>
<tr>
<td><strong>Wage Growth</strong></td>
<td>5.0%</td>
<td>3.8%</td>
<td>2.5%</td>
</tr>
<tr>
<td><strong>Relative Productivity</strong></td>
<td>144.1</td>
<td>79.3</td>
<td>139.5</td>
</tr>
<tr>
<td><strong>Patents per 10,000 Employees</strong></td>
<td>20.48</td>
<td>1.38</td>
<td>6.40</td>
</tr>
<tr>
<td><strong>Number of SIC Industries</strong></td>
<td>592</td>
<td>241</td>
<td>46</td>
</tr>
</tbody>
</table>

**Note:** 1999 data, except relative productivity which is 1997 data, and patents data which is 1998 data

**Source:** Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School
Economic Importance of Traded Clusters
Traded vs. Local Wages by Economic Area, 1999

The Composition of Regional Economies

Correlation: 0.82

Average Local Wage, 1999

San Francisco-Oakland-San Jose, CA
New York-No. New Jersey-Long Island
San Diego, CA
Atlanta, GA-AL-NC
Raleigh-Durham-Chapel Hill, NC
Pittsburgh, PA-WV
Las Vegas, NV-AZ-UT
Anchorage, AK
San Antonio, TX-
- NM-AZ-UT
Austin-San Marcos, TX
Reno, NV-CA
Wichita, KS-OK
Hobbs, NM-TX
Beaumont-Port Arthur, TX
Specialization of Regional Economies
Select Geographic Areas

Note: A geographic area can be either a Metropolitan Area (MSA, PMSA, CMSA or NECMA) or Economic Area as defined by the Bureau of the Census and Bureau of Economic Analysis, respectively. Clusters are the three highest ranking clusters in terms of share of national employment.
Source: Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School
Specialization of the Atlanta Economy
Traded Clusters by Relative Size and Growth Rate,
Metro Area, Narrow Cluster Definition

Percentage Share of National Cluster Employment in 1999

Transportation and Logistics
(4.2, 78.1)

Atlanta’s Share = 1.8%

Power Generation
(1.8, 268.5)

Note: (y-axis, x-axis)
Source: Cluster Mapping Project, t Institute for Strategy and Competitiveness, Harvard Business School
Clusters usually referred to as “high tech” make up only 8.0% of traded employment, 2.5% of total U.S. employment.
The Composition of Regional Economies

Atlanta Metro Area

Job Creation by Cluster, 1990–1999, Narrow Cluster Definition

Largest Growth in Traded Clusters

- Business Services: 76,705 Jobs Added
- Financial Services: 37,135 Jobs Added

Net Employment Change = +218,649

Largest Loss in Traded Clusters

Source: Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School
The Composition of Regional Economies

Wichita’s Leading Clusters by Employment
Average Wages MSA, Narrow Cluster Definition, 1998

Average Wages
- Aerospace Vehicles and Defense
- Metal Manufacturing
- Business Services
- Plastics
- Heavy Construction Services
- Oil and Gas
- Education and Knowledge Creation
- Hospitality and Tourism
- Processed Food

Employees
- 73,566

Average Wage of Wichita MSA = $30,050

Source: Cluster Mapping Project at Institute for Strategy and Competitiveness, Harvard Business School
The Composition of Regional Economies

Implications

- **Defining the right region**
  - Regions tend to follow political jurisdictions in defining the economic region
  - A broader geographic definition widens opportunities and brings constituencies together

- **Building a strategy**
  - Successful regions build on their unique assets and strong clusters
  - Strength then spreads to additional clusters over time

- **Clusters of clusters**
  - Focus on a few clusters exposes a regional economy to the booms and busts
  - Regional strategy should encompass a wide range of clusters, and be attentive to clusters that overlap

- **Widen innovative capacity to many clusters**
  - “High-tech” accounts for a small percentage of a regional economy
  - To meaningfully increase overall regional prosperity, innovative capacity must be built in many clusters
Agenda

- The Economic Performance of Regions
- The Composition of Regional Economies

**The Evolution of Regional Economies**

- The Determinants of Regional Competitiveness and Innovative Capacity
- Clusters
- The Development of Clusters
- Creating and Implementing a Regional Economic Strategy
- Action Agendas for the Public and Private Sectors
### Building the Foundation

<table>
<thead>
<tr>
<th>Research Triangle Park Founded</th>
<th>U.S. Environmental Protection Agency opens field office</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950s</td>
<td>1960s</td>
</tr>
</tbody>
</table>

- **1971**: Alcatel establishes presence
- **1971**: IBM establishes manufacturing facility
- **1971**: National Institute of Environmental Health Sciences offered space at Research Triangle Park
- **1971**: Chemstrand establishes a fiber R&D facility
- **1971**: U.S. Forest Service establishes small lab

### New Cluster Development

- **1974**: Troxler Electronics becomes the first locally based tenant at Research Triangle Park
- **1980**: Microelectronics Center of North Carolina founded by the State
- **1982**: Glaxo opens R&D center
- **1983**: Union Carbide opens R&D facility
- **1984**: Sumitomo Electric Lightwave founded

### Innovation Expands

- **1986**: BASF opens R&D center
- **1994**: Rheo-Poulec acquires Union Carbide
- **1996**: Union Carbide opens R&D facility
- **1997**: Biogen builds mfg. facility
- **1997**: Red Hat Software establishes operations

### Timeline of the Regional Economy

<table>
<thead>
<tr>
<th>1950s</th>
<th>1960s</th>
<th>1970s</th>
<th>1980s</th>
<th>1990s</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950s</td>
<td>1960s</td>
<td>1970s</td>
<td>1980s</td>
<td>1990s</td>
</tr>
</tbody>
</table>

- **1950s**: Burroughs Wellcome comes to the Research Triangle
- **1960s**: Benckton Dickson opens office
- **1970s**: Univ. of North Carolina Lineberger Comprehensive Cancer Center founded
- **1980s**: General Electric sets up research and manufacturing facility
- **1990s**: North Carolina Biotechnology Center founded by the State
- **2000s**: Ciba-Geigy establishes Biotechnology Center

- **1950s**: Northern Telecom establishes U.S. subsidiary
- **1960s**: Center for Advanced Computing and Communication established
- **1970s**: Quintiles founded
- **1980s**: North Carolina Biotechnology Center founded by the State

- **1990s**: Ciba-Geigy establishes Biotechnology Center
- **2000s**: Paradigm Genetics founded

### The Evolution of Regional Economies

- **1970s**: Covance opens manufacturing facility
- **1980s**: Redback Networks establishes operations
- **1990s**: Sphinx Pharmaceuticals sold to Eli Lilly

### Regional Foundations of U.S. Competitiveness

- **1970s**: Covance opens manufacturing facility
- **1980s**: Redback Networks establishes operations
- **1990s**: Sphinx Pharmaceuticals sold to Eli Lilly
The Evolution of Regional Economies

Pittsburgh Economic Development Timeline

Innovation in Manufacturing
- Westinghouse invents the airbrake as one of over 360 patents
- Charles Hall discovers inexpensive process for smelting aluminum; basis for Alcoa

Manufacturing Retrenchment
- U.S. mills expand with old, blast furnace technology and fall behind foreign rivals
- Management agrees to steel salaries at 2x the mfg wage
- Carnegie Mellon begins computer curriculum
- Westinghouse buys Unimatics Robotics
- Carnegie Mellon develops Robotics Institute

New Cluster Development
- Carnegie Mellon opens computer school;
  U of Pitt opens Center for Biotech and Bioengineering
- Seagate, Rand research locate in Pittsburgh
- UPMC opens Center for Biomedical Informatics
- VC funding over $500 million in 5 years

Andrew Carnegie opens Edgar Thompson Works; prototypes Bessemer Converter successfully
- U.S. Steel goes public at $1.4 Billion
- Pittsburgh supplies 60% of U.S. steel market
- Fourth steel strikes in 15 years, at 116 days, sends firms to Europe to source steel
- Pittsburgh buys Pittsburgh based Gulf
- University of Pittsburgh’s Dr. Starzl and Dr. Bahnsen perform world’s first double transplant operation
- Pittsburgh Tech Council formed
- USX 6 month strike; 150,000 jobs lost since 1970s.
- Westinghouse begins major downsizing
- Pittsburgh Supercomputing Center established

Steel firms back at tech parity with foreign firms; moving to specialty steel
- Union starts collaborative Negotiation
- Rockwell, Raytheon, Hugh Ball, Lockheed, GE close local facilities
- Carnegie Mellon, U of Pittsburgh professors spin-off firms such as FORE Systems;
  Tissue Informatics, Automated Healthcare Robotics

VC funding over $500 million in 5 years puts Pittsburgh as 8
- Digital Greenhouse begins
- 2000
- 1998
- 1996
- 1994
- 1993
- 1992
- 1990
- 1986
- 1984
- 1982
- 1980
- 1978
- 1976
- 1974
- 1972
- 1970
- 1968
- 1960
- 1958
- 1956
- 1954
- 1952
- 1950
- 1948
- 1946
- 1944
- 1942
- 1940
- 1938
- 1936
- 1934
- 1932
- 1930
- 1928
- 1926
- 1924
- 1922
- 1920
- 1918
- 1916
- 1914
- 1912
- 1910
- 1908
- 1906
- 1904
- 1902
- 1900
- 1898
- 1896
- 1894
- 1892
- 1890
- 1888
- 1886
- 1884
- 1882
- 1880
- 1878
- 1876
- 1874
- 1872
- 1870
- 1868
- 1866
- 1864
- 1862
- 1860
- 1858
- 1856
- 1854
- 1852
- 1850
- 1848
- 1846
- 1844
- 1842
- 1840
- 1838
- 1836
- 1834
- 1832
- 1830
- 1828
- 1826
- 1824
- 1822
- 1820
- 1818
- 1816
- 1814
- 1812
- 1810
- 1808
- 1806
- 1804
- 1802
- 1800
- 1798
- 1796
- 1794
- 1792
- 1790
- 1788
- 1786
- 1784
- 1782
- 1780
The Evolution of Regional Economies

Key Influencing Factors

- Natural Endowments
- Government Actions
- Specialized Assets
- Civic Leadership
- Entrepreneurship
### Institutions for Collaboration

#### Selected Institutions for Collaboration in Pittsburgh

#### Private Sector
- Pittsburgh Regional Alliance
- Cluster Specific Organizations — i.e., SPIRC
- Pittsburgh Technology Council
- Pittsburgh Biomedical Development Corporation
- Industrial Research Center for Manufacturing
- Advanced Manufacturing Network
- Regional Industrial Development Authority

#### Joint Private / Public
- Pittsburgh Digital Greenhouse
- Pittsburgh World Trade Center
- Governor’s Action Team
- Allegheny Conference on Community Development

#### Informal Networks
- Carnegie Mellon University Alumni
- University of Pittsburgh Alumni
- Duquesne University Alumni
- Angel investor community

#### Public Sector
- Small Business Administration
- Center for Economic Development
- Small Business Development Center
- Allegheny Working Together Consortium
- SWPA Regional Development Council
- Innovation Works

Source: Interviews, Organization’s Websites

---

The Evolution of Regional Economies
The Evolution of Regional Economies

- Building strong regional economies takes decades
- Key influencing factors include
  - Natural endowments
  - Government actions
  - Civic leadership
  - Entrepreneurship
  - Specialized assets
- Institutions for collaboration play an important role in building regional economies
- Regional development involves some inheritance and serendipity, but also purposeful action
- Successful regions leverage their unique mix of assets to build specialized clusters
Agenda

- The Economic Performance of Regions
- The Composition of Regional Economies
- The Evolution of Regional Economies
- The Determinants of Regional Competitiveness and Innovative Capacity
  - Clusters
  - The Development of Clusters
  - Creating and Implementing a Regional Economic Strategy
  - Action Agendas for the Public and Private Sectors
The Determinants of Regional Competitiveness and Innovative Capacity

Productivity and the Regional Business Environment

Government

Context for Firm Strategy and Rivalry

- A local context that encourages investment and sustained upgrading
  - e.g., Intellectual property protection
- Open and vigorous competition among locally based rivals

Institutions for Collaboration / Attitudes

Demand Conditions

- A core of sophisticated and demanding local customer(s)
- Unusual local demand in specialized segments that can be served nationally and globally
- Customer needs that anticipate those elsewhere

Factor (Input) Conditions

- High quality, specialized inputs available to firms
  - Human resources
  - Capital resources
  - Physical infrastructure
  - Administrative infrastructure
  - Information infrastructure
  - Scientific and technological infrastructure
  - Natural resources

Related and Supporting Industries

- Availability of capable, locally based suppliers and firms in related fields
- Presence of clusters instead of isolated industries

Regional Foundations of U.S. Competitiveness
Productivity and the Regional Business Environment

Context for Firm Strategy and Rivalry

Factor (Input) Conditions
- National
  - Capital market conditions
- Regional
  - Education system
  - Regional universities
  - Communication infrastructure
- Regional Cluster
  - Cluster-specific research institutions

Demand Conditions
- National
  - Environmental regulation
  - Consumer rights legislation
- Regional
  - State consumer protection laws
- Regional Cluster
  - Sophistication of local customers

Related and Supporting Industries
- National
  - Intellectual property legislation
  - Antitrust policy
- Regional
  - Regional tax policy
- Regional Cluster
  - Number of local competitors

The Determinants of Regional Competitiveness and Innovative Capacity
Advantages
- High levels of university R&D investment
- Numerous specialized university research centers
- Numerous specialized training institutions
- Large pool of scientists, engineers, and technicians
- New airport

Disadvantages
- Declining Corporate R&D
- Traffic congestion in the metro area
- Old physical infrastructure
- Difficulty retaining younger workers
- Challenging environment for entrepreneurship
Advantages
- High levels of university R&D investment
- Numerous specialized university research centers
- Numerous specialized training institutions
- Large pool of scientists, engineers, and technicians
- New airport

Disadvantages
- Declining Corporate R&D
- Traffic congestion in the metro area
- Old physical infrastructure
- Difficulty retaining younger workers
- Challenging environment for entrepreneurship

Advantages
- Emerging technology focused companies
- Manufacturing has stabilized
- 1990s employment in traded clusters increased by 50,000

Disadvantages
- Low levels of collaboration within studied clusters

Advantages
- Aging population provides early picture of future health care needs of U.S.

Disadvantages
- Infrequent contact and learning from local customers
- Local demand not perceived to be an advantage
Pittsburgh’s Competitive Position

**Context for Firm Strategy and Rivalry**

**Institutions for Collaboration**
- **Advantages**
  - Large number of organizations
- **Disadvantages**
  - Organizations under-leveraged; not effective within or across clusters
  - Inconsistent knowledge commercialization from universities

**Related and Supporting Industries**

**Attitudes Toward the Economy**
- **Advantages**
  - Extensive regional analysis — over 25 reports in four years
  - Positive views on the value of competition
- **Disadvantages**
  - Fragmented leadership with varying agendas
  - Attitudes for collaboration are parochial within and across clusters — inhibit cluster building activity

**Government**
- **Advantages**
  - Strong state programs for funding, networking and attracting new business
  - Responsive state and regional government
  - High levels of federal funding for R&D in the region
- **Disadvantages**
  - Fragmented local government
  - Local government focused on needs of established companies

**Factor (Input) Conditions**
- Demand Conditions
  - **Advantages**
  - **Disadvantages**
- **Context for Firm Strategy and Rivalry**
  - **Advantages**
  - **Disadvantages**

Regional Foundations of U.S. Competitiveness
The Determinants of Regional Competitiveness and Innovative Capacity

- A strong physical and information infrastructure is a baseline requirement to establish and sustain a prosperous regional economy.

- A strong K–12 educational system is important for developing local talent and attracting outside talent.

- Universities and specialized research centers are the driving force behind innovation in nearly every region.
Role of Specialized Research Centers
Good vs. Poor Innovation Environments

Specialized Research Centers Are Readily Available

Specialized Research Centers Frequently Transfer Knowledge

Percent of Respondents in Agreement

Source: Clusters of Innovation Initiative Regional Survey
The Determinants of Regional Competitiveness and Innovative Capacity

- A strong physical and information infrastructure is a baseline requirement to establish and sustain a prosperous regional economy.

- A strong K–12 educational system is important for developing local talent and attracting outside talent.

- Universities and specialized research centers are the driving force behind innovation in nearly every region.

- Mechanisms for commercialization are essential if innovation is to translate to economic success.
The Determinants of Regional Competitiveness and Innovative Capacity

Strength of Linkages, Research Triangle Region Commercialization of Technology

Comparative Frequency vs. Other Regions

1st

2nd

Regional Suppliers

3rd

Research Institutes
Community Colleges
Business Incubators
Business Assistance Centers
Universities
Local Customers
Other Local Firms

4th

Venture Capital Firms

5th

Trade Associations

Research Triangle Firms’ Use of These Institutions for Commercialization

- Rare Use — Less than 50% said sometimes or frequently influenced commercialization
- Occasional Use — Between 50%–80% said sometimes or frequently influenced commercialization
- Frequent Use — Greater than 80% said sometimes or frequently influenced commercialization

Note: August 2001, n=116. Source: Clusters of Innovation Initiative Regional Survey

Source: Clusters of Innovation Initiative Regional Survey
The Determinants of Regional Competitiveness and Innovative Capacity

- A strong physical and information infrastructure is a baseline requirement to establish and sustain a prosperous regional economy.
- A strong K–12 educational system is important for developing local talent and attracting outside talent.
- Universities and specialized research centers are the driving force behind innovation in nearly every region.
- Mechanisms for commercialization are essential if innovation is to translate to economic success.

**Specialized talent and training are more important than abundant labor.**
The Determinants of Regional Competitiveness and Innovative Capacity

Role of Specialized Talent and Training

Good vs. Poor Innovation Environments

Your Region Has an Ample Supply of High Quality...

| Source | Clusters of Innovation Initiative Regional Survey |

Percent of Respondents in Agreement

- Advanced Educational Programs
- Qualified Scientists and Engineers
- Skilled Labor
- Cost of Business (e.g., real estate, wages, utilities)

Poor Innovation Environment

Good Innovation Environment
The Determinants of Regional Competitiveness and Innovative Capacity

- A strong physical and information infrastructure is a baseline requirement to establish and sustain a prosperous regional economy

- A strong K–12 educational system is important for developing local talent and attracting outside talent

- Universities and specialized research centers are the driving force behind innovation in nearly every region

- Mechanisms for commercialization are essential if innovation is to translate to economic success

- Specialized talent and training are more important than abundant labor

- Poor coordination among local jurisdictions impedes efforts to improve the business environment
## Coordination Among Local Governments

### Representative Interview Quotes

<table>
<thead>
<tr>
<th>Region</th>
<th>Quote</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atlanta</td>
<td>“The Metro Atlanta local government system is fragmented. There is still a lot of in-fighting. Counties fight against each other rather than working together.”</td>
<td>– Financial Services Executive</td>
</tr>
<tr>
<td>Pittsburgh</td>
<td>“One of the major barriers to Pittsburgh’s economic prosperity is the high number of municipalities — we have 131 in Allegheny County, which were never coordinated.”</td>
<td>– Economic Development CEO</td>
</tr>
<tr>
<td>Research Triangle</td>
<td>“The Research Triangle is comprised of three main regions with three different cultures, and three different styles of government, whereas Charlotte is hierarchical, with a single corporate culture where a few individuals can make things happen.”</td>
<td>– University Leader</td>
</tr>
<tr>
<td>San Diego</td>
<td>“Regional government is weak and ineffective with regard to the planning and implementation of regional development.”</td>
<td>– Biotechnology Executive</td>
</tr>
</tbody>
</table>

Source: Clusters of Innovation Initiative Regional Interviews
The Determinants of Regional Competitiveness and Innovative Capacity

- A strong physical and information infrastructure is a baseline requirement to establish and sustain a prosperous regional economy.
- A strong K–12 educational system is important for developing local talent and attracting outside talent.
- Universities and specialized research centers are the driving force behind innovation in nearly every region.
- Mechanisms for commercialization are essential if innovation is to translate to economic success.
- Specialized talent and training are more important than abundant labor.
- Poor coordination among local jurisdictions impedes efforts to improve the business environment.

- Government can have a significant influence on the business environment, both positively and negatively.
## Government’s Impact on the Determinants of Regional Productivity

### San Diego

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Factor Inputs</strong></td>
<td>(+) High levels of R&amp;D funding (SPAWAR, NIH), both past and present</td>
<td>(+) Founded UCSD (+) Funds San Diego State University, and Community Colleges (+) Increasing funds for engineering school</td>
<td>(+) Zoned Torrey Pines Mesa for research (+) Provided land on favorable terms (e.g., Salk, General Atomics) (-) Energy policies deter building of new capacity (-) Average K-12 education (-) CA Coastal Commission regulations discourage facilities expansion (-) Lack of coordination and leadership prevents maintenance and improvements of infrastructure (e.g., roads, schools, airport)</td>
</tr>
<tr>
<td><strong>Demand Conditions</strong></td>
<td>(+) U.S. Navy is a sophisticated customer of wireless technology</td>
<td>(-) State FDA regulations different from Federal FDA regulations</td>
<td></td>
</tr>
<tr>
<td><strong>Related and Supporting Industries</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Context for Firm Strategy and Rivalry</strong></td>
<td>(+) Defense cuts refocused firms on civilian markets</td>
<td>(-) Inadequate state and local tax incentives to encourage R&amp;D investment</td>
<td></td>
</tr>
</tbody>
</table>
The Determinants of Regional Competitiveness and Innovative Capacity

- A strong physical and information infrastructure is a baseline requirement to establish and sustain a prosperous regional economy.

- A strong K–12 educational system is important for developing local talent and attracting outside talent.

- Universities and specialized research centers are the driving force behind innovation in nearly every region.

- Mechanisms for commercialization are essential if innovation is to translate to economic success.

- Specialized talent and training are more important than abundant labor.

- Poor coordination among local jurisdictions impedes efforts to improve the business environment.

- Government can have a significant influence on the business environment, both positively and negatively.

- Regions face the need for strategic transitions, as success at one strategy creates the need for a new strategy.
San Diego’s Economic Vision
New Directions

<table>
<thead>
<tr>
<th>Elements of Current Development Strategies</th>
<th>Targets of New Development Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Jobs:</strong> Increase employment in selected clusters</td>
<td><strong>Wages:</strong> Increase wages across all clusters</td>
</tr>
<tr>
<td><strong>Research:</strong> Develop strong research capabilities</td>
<td><strong>Entire Value Chain:</strong> Develop strength in all aspects of the business</td>
</tr>
<tr>
<td><strong>Government and Non-Commercial Organizations:</strong> Attract and leverage noncommercial organizations</td>
<td><strong>Companies:</strong> Grow, attract, and support companies</td>
</tr>
<tr>
<td><strong>Growth of “High-Tech” Clusters:</strong> Concentrate efforts and resources on supporting specific clusters</td>
<td><strong>Foster Innovative Capacity across ALL Clusters:</strong> improve the innovation environment in a wide array of San Diego clusters</td>
</tr>
</tbody>
</table>
Agenda

- The Economic Performance of Regions
- The Composition of Regional Economies
- The Evolution of Regional Economies
- The Determinants of Regional Competitiveness and Innovative Capacity

- Clusters
  - The Development of Clusters
  - Creating and Implementing a Regional Economic Strategy
  - Action Agendas for the Public and Private Sectors
Clusters

The Houston Oil and Gas Cluster

Upstream

- Oil and Natural Gas Exploration and Development
- Oil and Natural Gas Completion and Production
- Equipment Suppliers (e.g., Oil Field Chemicals, Drilling Rigs, Drill Tools)
- Specialized Technology Services (e.g., Drilling Consultants, Reservoir Services, Laboratory Analysis)
- Subcontractors (e.g., Surveying, Mud Logging, Maintenance Services)
- Business Services (e.g., MIS Services, Technology Licenses, Risk Management)
- Specialized Institutions (e.g., Academic Institutions, Training Centers, Industry Associations)
- Oilfield Services / Engineering and Contracting Firms

Downstream

- Oil Transportation
- Oil Trading
- Oil Refining
- Oil Distribution
- Gas Gathering
- Gas Processing
- Gas Trading
- Gas Transmission
- Gas Distribution
- Gas Marketing
- Oil Wholesale Marketing
- Oil Retail Marketing
Clusters and Innovation

Clusters Increase Productivity / Efficiency

- Efficient access to specialized inputs, employees, information, institutions, and “public goods” such as training programs and training institutions
- Ease of coordination across firms
- Rapid diffusion of best practices
- Ongoing, visible performance comparisons and strong incentives to improve vs. local rivals

Clusters Stimulate and Enable Innovations

- Better ability to perceive innovation opportunities
- Presence of multiple suppliers and institutions to assist in knowledge creation
- Ease of experimentation given locally available resources

Clusters Facilitate Commercialization

- Opportunities for new companies and new lines of established business are more apparent
- Lower barriers to entry into cluster related businesses because of available skills, supplies, etc.

Competition is fundamentally enhanced by externalities / linkages across firms, industries, and associated institutions
Research Triangle Park encompasses 150 organizations employing approximately 45,000 people within 7,000 acres.

Source: Research Triangle Foundation
Regional Foundations of U.S. Competitiveness
Note: Clusters with borders or identical colors except gray have at least 20% overlap of industries by number in both directions.

Regional Foundations of U.S. Competitiveness
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 San Francisco-Oakland-San Jose, CA</td>
<td>45,400</td>
<td>4.6</td>
<td>$114,474</td>
<td>27.6</td>
<td>10.6</td>
<td>6.3</td>
</tr>
<tr>
<td>2 Boston-Worcester-Lawrence-Lowell-Brockton, MA-NH-RH-VT</td>
<td>41,857</td>
<td>-0.9</td>
<td>$66,121</td>
<td>8.7</td>
<td>5.9</td>
<td>4.8</td>
</tr>
<tr>
<td>3 Chicago-Gary-Kenosha, IL-IN-WI</td>
<td>41,168</td>
<td>-2.3</td>
<td>$32,147</td>
<td>8.5</td>
<td>9.6</td>
<td>1.0</td>
</tr>
<tr>
<td>4 New York-N. New Jersey-Long Island, NY-NJ-CT-PA-MA-VT</td>
<td>38,583</td>
<td>-3.5</td>
<td>$49,901</td>
<td>22.7</td>
<td>10.6</td>
<td>1.8</td>
</tr>
<tr>
<td>5 Los Angeles-Riverside-Orange County, CA-AZ</td>
<td>33,410</td>
<td>0.0</td>
<td>$55,858</td>
<td>12.4</td>
<td>5.8</td>
<td>1.5</td>
</tr>
<tr>
<td>6 Dallas-Forth Worth, TX-AR-OK</td>
<td>30,217</td>
<td>3.8</td>
<td>$57,546</td>
<td>12.9</td>
<td>9.1</td>
<td>2.5</td>
</tr>
<tr>
<td>7 Raleigh-Durham-Chapel Hill, NC</td>
<td>11,616</td>
<td>0.6</td>
<td>$57,255</td>
<td>10.9</td>
<td>18.9</td>
<td>0.9</td>
</tr>
<tr>
<td>8 Washington-Baltimore, DC-MD-VA-WV-PA</td>
<td>10,076</td>
<td>2.2</td>
<td>$59,462</td>
<td>21.4</td>
<td>5.1</td>
<td>4.5</td>
</tr>
<tr>
<td>9 Philadelphia-Wilmington-Atlantic City, PA-NJ-DE-MD</td>
<td>10,048</td>
<td>-1.8</td>
<td>$50,831</td>
<td>10.0</td>
<td>4.8</td>
<td>2.2</td>
</tr>
<tr>
<td>10 Fort Wayne, IN</td>
<td>8,798</td>
<td>0.2</td>
<td>$29,257</td>
<td>1.1</td>
<td>6.9</td>
<td>3.3</td>
</tr>
<tr>
<td>11 Phoenix-Mesa, AZ-NM</td>
<td>8,571</td>
<td>-3.0</td>
<td>$59,564</td>
<td>26.2</td>
<td>16.7</td>
<td>3.7</td>
</tr>
<tr>
<td>12 Atlanta, GA-AL-NC</td>
<td>8,007</td>
<td>-5.3</td>
<td>$45,199</td>
<td>2.2</td>
<td>17.5</td>
<td>4.9</td>
</tr>
<tr>
<td>13 Miami-Fort Lauderdale, FL</td>
<td>7,034</td>
<td>-1.9</td>
<td>$30,072</td>
<td>14.5</td>
<td>5.4</td>
<td>6.8</td>
</tr>
<tr>
<td>14 Rochester, NY-PA</td>
<td>6,897</td>
<td>0.3</td>
<td>$41,809</td>
<td>23.7</td>
<td>5.6</td>
<td>2.3</td>
</tr>
<tr>
<td>15 San Diego, CA</td>
<td>6,660</td>
<td>2.0</td>
<td>$43,243</td>
<td>24.4</td>
<td>7.3</td>
<td>3.8</td>
</tr>
</tbody>
</table>

Source: Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School
Clusters

Competitive Position

Communications Cluster, Research Triangle EA

- Metal Processing: 267
- Specialized Inputs: 1,462
- Electronics and Optical Components: 3,384
- Related Services: 1,989
- Electronic Parts: 810
- Office Machines: 1,762
- Communications Services: 235
- Software and Computer Services: 3,687
- Communications Equipment: 8,391
- Computer Equipment: 18,020
- Research Institutions: MCNC, North Carolina State University, Center for Advanced Computing and Communication: 6,837
- Related Equipment: Analytical Instruments, Measuring Devices: 1,999
- Specialized Services Banking, Accounting, Legal
- Specialized Risk Capital VC Firms, Angel Networks
- Distribution: 3,145

Cluster Organizations
- North Carolina Electronics and Information Technology Association
- Training Institutions
  - Univ. of North Carolina - Chapel Hill, North Carolina State University

Note: Employment numbers are given inside boxes were available
Source: Clusters of Innovation Initiative Regional Survey Data, Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School, and Interviews
## Select Subcluster Cluster Rankings in Wichita

### Share of National Employment, Economic Area, 1998

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Subcluster</th>
<th>National Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace Engines</td>
<td>Aircraft Engines and Engine Parts</td>
<td>16</td>
</tr>
<tr>
<td>Aerospace Vehicles and Defense</td>
<td>Aircraft</td>
<td>4</td>
</tr>
<tr>
<td>Heavy Machinery</td>
<td>Construction Machinery</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Farm Machinery</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Mining Machinery</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Equipment and Parts</td>
<td>24</td>
</tr>
<tr>
<td>Lighting and Electrical</td>
<td>Electric Lamps</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Batteries</td>
<td>8</td>
</tr>
<tr>
<td>Motor Driven Products</td>
<td>Appliances</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>Specialized Pumps</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Motorized Vehicles</td>
<td>29</td>
</tr>
<tr>
<td>Oil and Gas</td>
<td>Oil and Gas Machinery</td>
<td>12</td>
</tr>
<tr>
<td>Prefabricated Enclosures</td>
<td>Mobile Homes</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Trucks and Trailers</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Elevators</td>
<td>14</td>
</tr>
<tr>
<td>Production Technology</td>
<td>Process Equipment and Subsystems</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>Production Machinery</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Transportation Equipment</td>
<td>44</td>
</tr>
<tr>
<td>Textiles</td>
<td>Specialty Components</td>
<td>32</td>
</tr>
</tbody>
</table>

Source: Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School
Cluster-Specific Institutions for Collaboration

Select Survey Results

Valuable Contacts and Information Received by Start-up Companies from Regional Industry or Cluster Councils . . .

Source: Clusters of Innovation Initiative Regional Survey
## Research Triangle Communications Cluster
### Innovation Environment-Summary

<table>
<thead>
<tr>
<th>Element of Diamond</th>
<th>Assets</th>
<th>Challenges</th>
</tr>
</thead>
</table>
| **Basic and Specialized Factor Inputs** | - Relatively large pool of communications related scientists, engineers and technicians  
- Many research divisions of major communications firms (e.g., Cisco Systems, Ericsson) | - Insufficient marketing and managerial talent  
- Lack of coordination among firms on local workforce development  
- Under utilization of non-commercial research facilities |
| **Context for Firm Strategy and Rivalry** | - Sale of Cronos to JDUmphase points to some success in development and marketing efforts by institutions for collaboration | - Sporadic cooperation among firms to jointly develop technology  
- Moderately intense local competition |
| **Related and Supporting Industries** | - Strong regional presence in most communications sub-clusters | - Insufficient frequency of contact with suppliers on innovation |
| **Regional Demand** | - North Carolina Information Highway project demands the latest technologies | - Insufficient frequency of contact with customers on innovation  
- Local demand conditions do not confer an advantage on the cluster |
| **Government Policy** | - High State support for R&D and training; e.g., North Carolina State University communications educational programs | - Federal government local R&D investments deemed inadequate  
- Dissatisfaction with state and local business regulations (and taxation) |
| **Quality of Linkages** | - Center for Advanced Computing and Communication, an NSF Industry / University Cooperative Research Center and MCNC unify parts of cluster | - NC Telecommunications Association — the local cluster association — is not yet well established as an effective regional organization |

Source: Clusters of Innovation Initiative Regional Survey, Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School and In-person Interviews
Select Survey Results
Communications Cluster, Research Triangle

Factors
- Qualified scientists and engineers in your region are... 70% Ample, 21% Readily Available, 9% Scarce
- Specialized facilities for research are... 88% Ample, 9% Limited, 3% Scarce
- The available pool of skilled workers in your region... 61% Is sufficient, 12% Too small, 33% Too small
- Regional buyers for your business’s products and services are... 50% Ample, 21% Readily Available, 28% Scarce
- Regional specialized suppliers assist your firm with new product and process development... 23% Ample, 42% Frequent, 36% Scarcely
- Specialized suppliers of your business’s materials, components, machinery, and services are mostly available... 39% Ample, 26% Readily Available, 36% Scarce

Demand
- Feedback from regional customers to improve your business’s products/services is... 44% Ample, 28% Readily Available, 26% Scarce
- Regional specialized suppliers assist your firm with new product and process development... 23% Ample, 42% Frequent, 36% Scarcely
- Specialized suppliers of your business’s materials, components, machinery, and services are mostly available... 39% Ample, 26% Readily Available, 36% Scarce

Related and Supporting Industries
- Regional competition in your industry is... 36% Ample, 9% Readily Available, 55% Scarce
- Ample support for state and local government investment in R&D... 24% Ample, 30% Readily Available, 46% Scarce
- Businesses in your region share information openly with other businesses... 36% Ample, 39% Readily Available, 26% Scarce

Rivalry
- Regional competition in your industry is... 36% Ample, 9% Readily Available, 55% Scarce
- Ample support for state and local government investment in R&D... 24% Ample, 30% Readily Available, 46% Scarce
- Businesses in your region share information openly with other businesses... 36% Ample, 39% Readily Available, 26% Scarce

Government
- State and local government support for investment in R&D (e.g., funding business incubators, creating consortia) is... 24% Ample, 30% Readily Available, 46% Scarce
- Businesses in your region share information openly with other businesses... 36% Ample, 39% Readily Available, 26% Scarce

Attitudes
- Regional competition in your industry is... 36% Ample, 9% Readily Available, 55% Scarce
- Ample support for state and local government investment in R&D... 24% Ample, 30% Readily Available, 46% Scarce
- Businesses in your region share information openly with other businesses... 36% Ample, 39% Readily Available, 26% Scarce

Note: July 2001, n=33
Source: Cluster of Innovation Initiative Regional Web Survey

Regional Foundations of U.S. Competitiveness
Clusters

Agenda

- The Economic Performance of Regions
- The Composition of Regional Economies
- The Evolution of Regional Economies
- The Determinants of Regional Competitiveness and Innovative Capacity
- Clusters

The Development of Clusters

- Creating and Implementing a Regional Economic Strategy
- Action Agendas for the Public and Private Sectors
The Process of Cluster Development
History of the San Diego Biotech / Pharma Cluster

1955
- Salk Institute Founded

1960
- Scripps Research Institute founded

1976
- Burnham Institute founded
- UCSD Connect founded

1985
- Biomedical Industry Council founded
- Hybritech sold to Eli Lilly

1991
- Nanogen founded

1992
- Novartis Agricultural Discovery Institute founded

1998
- Biocom founded

Source: Clusters of Innovation Project
Anchor Companies
Spin-outs in the San Diego Biotech / Pharma Cluster

Source: CONNECT, University of California, San Diego
The Importance of Anchor Firms

Representative Interview Quotes

<table>
<thead>
<tr>
<th>Region</th>
<th>Quote</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pittsburgh</td>
<td>“FORE Systems and Free Markets have acted as anchor firms, spinning out such firms as Co-Manager, Laurel, AxelLife, and Yourfit. But it was the university professors that spun-out those firms and others, such as Lycos and IGATE Technologies. The universities have been critical to the development of the IT sector and continue to create new firms.” — Professor</td>
<td></td>
</tr>
<tr>
<td>Research Triangle</td>
<td>“The partner in our firm thought the region was promising and established an office in the Research Triangle in the early 1980s. He left by the late 1980s and things drifted because there weren’t enough Fortune 1000 companies in the region to make it work.” — Business Services Executive</td>
<td></td>
</tr>
<tr>
<td>San Diego</td>
<td>“Linkabit is this region’s Fairchild. (Fairchild was the “mother firm” of semiconductor industry in Silicon Valley.) Many future start-up CEOs got their start at Linkabit and were trained under Irwin Jacob’s tutelage.” — Communications Executive</td>
<td></td>
</tr>
<tr>
<td>Wichita</td>
<td>“We came to Wichita because Bombardier but we also recognized the value of being near the other important OEMs such as Boeing, Cessna and Raytheon. Wichita is the air capital of the world — if you’re a supplier, you need to be here.” — Aerospace Supplier Executive</td>
<td></td>
</tr>
</tbody>
</table>

Source: Clusters of Innovation Initiative Regional Interviews
Opportunities at the Intersection of Select Clusters in Massachusetts

The Development of Clusters

Health
- Medical Information Processing
- Medical Software
- Medical Devices
- Biopharmaceuticals
- Medical Research
- Think Tanks
- Research Organization
- Knowledge Creation

Information Technology
- Networking
- Telecommunications
- High Capacity Computers
- Software
- Consulting
- Universities
- Medical Outcomes Measurement
- Tertiary Hospital Services

Knowledge Creation
Public / Private Cooperation in Cluster Upgrading
Minnesota’s Medical Device Cluster

Context for Firm Strategy and Rivalry

- Aggressive *trade associations* (Medical Alley Association, High Tech Council)
- Effective *global marketing* of the cluster and of Minnesota as the “The Great State of Health”
- Full-time *“Health Care Industry Specialist”* in the department of Trade and Economic Development

Factor (Input) Conditions

- Joint development of *vocational-technical college curricula* with the medical device industry
- Minnesota *Project Outreach* exposes businesses to resources available at university and state government agencies
- Active medical technology licensing through *University of Minnesota*
- State-formed Greater Minnesota Corp. to *finance applied research*, invest in new products, and assist in technology transfer

Demand Conditions

- State sanctioned *reimbursement policies* to enable easier adoption and reimbursement for innovative products

Related and Supporting Industries

Joint development of *vocational-technical college curricula* with the medical device industry

Minnesota *Project Outreach* exposes businesses to resources available at university and state government agencies

Active medical technology licensing through *University of Minnesota*

State-formed Greater Minnesota Corp. to *finance applied research*, invest in new products, and assist in technology transfer
The Development of Clusters

- An explicit cluster development program
  - Conscious efforts can meaningfully raise cluster competitiveness and innovative capacity

- Recruiting for clusters
  - Recruitment strategies should target strong clusters, or clusters which overlap with other clusters
  - Regions should identify gaps within clusters, and seek to attract companies to fill them
Agenda

- The Economic Performance of Regions
- The Composition of Regional Economies
- The Evolution of Regional Economies
- The Determinants of Regional Competitiveness and Innovative Capacity
- Clusters
- The Development of Clusters

Creating and Implementing a Regional Economic Strategy

- Action Agendas for the Public and Private Sectors
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>State Department of Economic and Community Development (DECD) reorganized to include Industry Cluster and International Division</td>
<td>Industry Cluster Initiative</td>
<td>“Partnership for Growth” legislation submitted to Governor and legislature</td>
</tr>
<tr>
<td></td>
<td><strong>Call to Action</strong> — 120 Connecticut business leaders are engaged by the Governor</td>
<td><strong>5 Industry Cluster Advisory boards</strong> created:</td>
<td>Governor and legislature unanimously approve first Cluster Bill:</td>
</tr>
<tr>
<td></td>
<td>- Manufacturing</td>
<td>- Manufacturing</td>
<td>- $7 million for cluster activation and projects</td>
</tr>
<tr>
<td></td>
<td>- Financial Services</td>
<td>- Financial Services</td>
<td>- 6% R&amp;D tax credit now available for smaller firms</td>
</tr>
<tr>
<td></td>
<td>- Telecommunications &amp; Information</td>
<td>- Telecommunications &amp; Information</td>
<td>- Lengthen R&amp;D tax credit carry forward from 5 to 15 years</td>
</tr>
<tr>
<td></td>
<td>- Health Care Services</td>
<td>- Health Care Services</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- High Technology</td>
<td>- High Technology</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Cluster advisory boards finalize and prioritize recommendations for the legislative session</strong></td>
<td>Recommendations and presentation to Governor and legislative leadership</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Implementation of cluster initiatives begin</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Establishment and first meeting of Governor’s Council on Economic Competitiveness and Technology</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Bioscience cluster activated</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Connecticut’s Cluster Development Initiative

**Timeline**

<table>
<thead>
<tr>
<th>1999</th>
<th>2000</th>
<th>2001</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- The quasi-public **Connecticut Economic Resource Center (CERC)** becomes the implementation arm for the cluster initiatives outside of government.

- **Second Cluster Bill** submitted and unanimously approved by Governor and legislature:
  - Net operating loss (NOL) carry forward -- from 5 to 20 years
  - Tax credit exchange established to help smaller firms capitalize tax credits
  - $4.5 million for cluster initiative over the next 2 years

- **Aerospace Component Manufacturers cluster** activated

- **Software / IT cluster** activated

- **Metals Manufacturing cluster** activated

- **Maritime cluster** activated

- **Plastics cluster** activated
Creating and Implementing a Regional Economic Strategy

- A shared economic vision helps elicit broad support and coordinate activities

- Strong leadership is a necessary part of any successful economic development strategy

- An overarching organization for economic development helps coordinate and routinize the process

- Broad-based collaboration is needed for development strategies to succeed

- Rigorous analysis is an important early step in implementing a regional strategy, but mechanisms for translating ideas into action are necessary

- Regions need to overcome transition points in the development of their economies

- Regions often encounter a common set of pitfalls
Creating and Implementing a Regional Economic Strategy

Creating the Capacity to Act

Shared Economic Vision
- A process of building consensus
- Important role for all stakeholders
- Prioritization of next steps

Leadership Committed to Shared Vision
- Committed participation of chief executives from industry, academia, and government

Architecture for Economic Development
- An institutional structure to formalize:
  - Consensus building process
  - Chief Executive participation

Important role for all stakeholders
Prioritization of next steps
Leadership Committed to Shared Vision
Shared Economic Vision
Architecture for Economic Development
Leadership from the Public and Private Sectors

**Government in Research Triangle**

- “The state wooed IBM with cheap labor, land and proximity to universities. Governor Sanford’s involvement was crucial.”
  - University Leader

- “Governor Hunt made it easy for us [a major communications firm] to move here.”
  - Communications Executive

- “Technical institutes and community colleges were key in turning around the workforce. Governor Hodges started the community college system, and Governor Sanford really made it what it is.”
  - Research Triangle Park Leader

- “Political leaders nurtured business. Governors Hodges, Sanford, Hunt being the most notable.”
  - Community Leader

**Private Sector in Atlanta**

- “Regions can thrive only after they find a personality or driving force. Usually this is a business leader who has had success and then can motivate others. Regional groups should make this person the ‘cause celebre’ and publicize the success story in order to stimulate new business.”
  - Local CEO

- “People and companies like Charles Brewer (Mindspring), Bert Ellis (IXL), John Yates all launched their way to success in [the mid-1990s]. These young guys represented the spawning of a new generation that inspired a lot of people.”
  - Venture Capitalist

- “Ben Dyer (Peachtree Software), Jeff Levy (Relevant Knowledge), and Leland Strange were early entrepreneurs who started numerous companies, assisted many more and now, in fact, have started their own incubators.”
  - Local CEO

Source: Clusters of Innovation Initiative Regional Interviews
Organizing to Compete
Massachusetts Governor’s Council on Economic Growth and Technology

Governor’s Council on Economic Growth and Technology

Industry Cluster Committees
- Advanced Materials
- Biotechnology and Pharmaceuticals
- Defense
- Marine Science and Technology
- Medical Devices
- Software
- Telecommunications
- Textiles
- Information Technology

Functional Task Forces
- International Trade
- Marketing Massachusetts
- Tax Policy and Capital Formation
- Technology Policy and Defense Conversion

Issue Groups
- Cost of Doing Business
- Financing Emerging Companies
- Health Care
- Western Massachusetts
- Business Climate
- Competitive Benchmarking
An Economic Vision for Wichita
New Directions

Successes of Current Development Strategies

- **Defensive:** Preserve scarce labor supply; recruit new companies; withstand cyclical downturns; respond to crises
- **Enhance Efficiency:** Improve physical infrastructure; lower the costs of doing business
- **Celebrate Entrepreneurial Heritage:** Proud history of entrepreneurial activity
- **Build Strong Companies:** Support for important local firms; attract others opportunistically
- **Improve Incrementally:** Enhance efficiency and compete on price

Targets of New Development Strategies

- **Offensive:** Proactively harness Wichita’s many advantages and potential advantages; create new advantages
- **Foster Innovation:** Move to advance segments of the value system and new businesses
- **Enable New Entrepreneurs:** Develop linkages between industry, academia, and the venture capital community
- **Build Strong Clusters:** Build upon existing strengths to develop core clusters, exploit cross-cutting opportunities; and create new clusters and businesses (e.g., aviation services, regional medical center)
- **Bold Strategy:** Create new strategies to break constraints and energize the community
Economic Development Strategy

Common Pitfalls

- Failure to communicate needs to other important actors (e.g., government, universities, and institutions for collaboration)
- Cluster-killing competitive strategies of firms
- Discouraging the entrance of local rivals
- Neglecting investment in the engines of innovation: universities and research centers
- Neglecting physical infrastructure
- Government regulations discouraging investment and innovation
- Focusing on narrow geographic areas
- Biases towards “high tech” clusters (e.g., IT and Biotech)
- Ignoring traditional strengths
- Recruiting big companies, not building competitive clusters
- Inattention to commercialization issues
- Insufficient cross-disciplinary collaboration
Agenda

- The Economic Performance of Regions
- The Composition of Regional Economies
- The Evolution of Regional Economies
- The Determinants of Regional Competitiveness and Innovative Capacity
- Clusters
- The Development of Clusters
- Creating and Implementing a Regional Economic Strategy

Action Agendas for the Public and Private Sectors
Federal Government

- Invest in the foundations of science and technology
- Improve the innovation policy context
- Allocate federal resources in ways that reinforce cluster development
- Provide better data for measuring regional economic composition and performance
- Encourage the development of regional economic development strategies that stress innovation
State Governments

- Invest in the foundations of science and technology
- Sponsor state programs that encourage cluster development
- Focus business recruitment around strong clusters
- Create a regional dimension to state economic development strategies
- Improve information systems to regularly collect data and measure progress
Regional and Local Governments

- Strongly support K–12 education
- Upgrade core business infrastructure
- Develop a regional strategy that involves all stakeholders
- Encourage cluster development
Universities and Research Institutes

- Recognize the important role of universities in regional economic development

- Create and support technology transfer offices

- Align university curricula to meet the needs of local clusters

- Actively participate in cluster development efforts

- Support company start-up efforts by professors and students
University-Industry Institutions for Collaboration

Patents Issued to North Carolina State University, 1980-1999

- **Research Building 2** built (tenants include NASA, Nanoscale Lab)
- **Corporate Building 1** built for ABB Power T&D Company’s HQs
- **Center for Research in Textile Protection and Comfort** built (partners include BASF, Ciba-Geigy, DuPont, Hoescht, Levi-Strauss, Monsanto, and 48 other companies)
- **Partners Building 1** built (tenants include Bayer Corp., Eastman Kodak Company)
- **Research Building 1** built (tenants include GreenVest, Viatec Research)
- **Centennial Campus** founded at North Carolina State University

Centennial Campus expands to include over 65 companies

Source: US Patent and Trademark Office

Regional Foundations of U.S. Competitiveness
Cluster-specific Institutions for Collaboration

- Promote cluster awareness
- Engage in ongoing diagnosis of cluster’s competitive position
- Develop training and management programs
- Actively participate with government in recruitment efforts
- Widen institutional membership to include all cluster constituents
Cluster Specific Institutions for Collaboration

Cluster-Specific Institutions

- Firms in Cluster
  - Joint-Research
  - Joint-Lobbying
  - Community Efforts
  - Collaboration

- Educational Organizations
  - Specialized Training
  - Specialized Education
  - Commercialization
  - Research

- Government
  - Recruitment
  - Promotion
  - Expansion Support
  - Research
  - Lobbying
  - Funding

- Informal Networks
  - Lobbying
  - Funding
  - Commercialization

- Joint-Research
- Joint-Lobbying
- Community Efforts
- Collaboration
- Specialized Training
- Specialized Education
- Commercialization
- Research
- Recruitment
- Promotion
- Expansion Support
- Research
- Lobbying
- Funding
- Lobbying
- Funding
- Commercialization
Firms

- Recognize the importance of location to competitive advantage
- Take an active role in improving the regional competitive environment
- See the cluster as a competitive asset
- Find your cluster
- Contribute actively to cluster development activities
Contacts

- www.isc.hbs.edu

- www.monitor.com

- www.compete.org
CLUSTERS of INNOVATION:
Regional Foundations of U.S. Competitiveness

SAN DIEGO
Pharmaceuticals / Biotechnology
Communications

WICHITA
Plastics
Aerospace Vehicles and Defense

ATLANTA
Financial Services
Transportation and Logistics

PITTSBURGH
Pharmaceuticals / Biotechnology
Production Technology

RESEARCH TRIANGLE
Pharmaceuticals / Biotechnology
Communications

NATIONAL CLUSTERS of INNOVATION MEETING
Washington, D.C. December 13, 2001