Entrepreneurship

Promoting Government-Industry-University Partnerships

The Golden Triangle for Regional Economic Development

Jack M. Wilson, Ph.D.
President-Emeritus, University of Massachusetts
Distinguished Professor of Higher Education, Emerging Technologies , and Innovation

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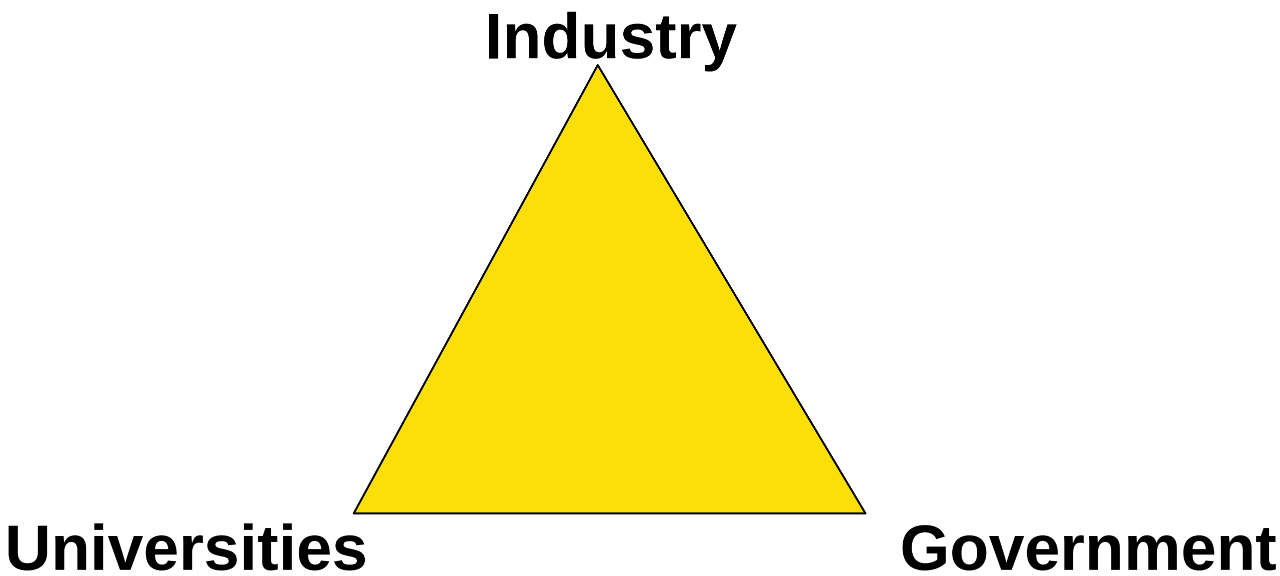
The (Golden) Innovation Triangle

Strategic alliances are the key to R&D and talent leadership -- and economic growth



Regional economic strategy

If you have the talent…

- ***the jobs will come***.

An economic strategy based on

- talent and innovation.

- Richard Florida in his book, the Creative Economy summarized many of the arguments for a talent driven regional economic strategy.

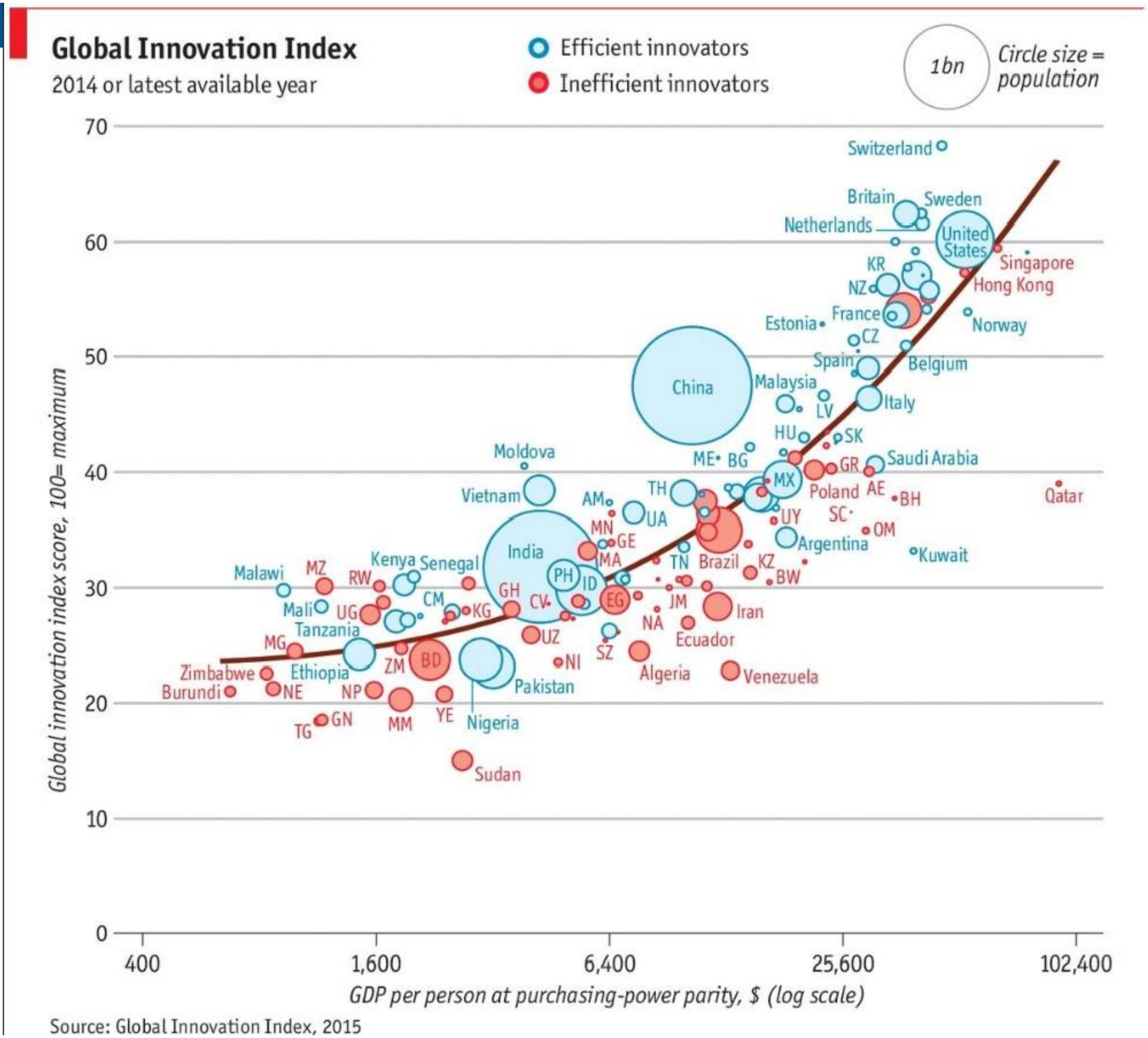
A talent strategy has been key to current administration

- To be first the world by 2020 in the proportion of college graduates.
  - -Address to Congress on Feb. 24, 2009.
- The US was tied for 6^{th} place at 30% according to 2006 data.
- The next administration will have a similar focus.

Why do countries care?

Because the more innovative that a country is the larger is their GDP per person.

The economic development of countries is very dependent upon innovation.



http://www.economist.com/blogs/graphicdetail/2015/09/global-innovation-rankings?fsrc=scn%2Ffb%2Fte%2Fpe%2Fed%2Ftheinnovationgame

Talent Clusters

- Talent clusters are concentrated geographic pools of talent focused on a particular technology or specialized discipline.
- They support and attract business
- Three key factors:
  - Proximity matters.
  - Critical mass is important.
  - Clusters need **stars** and **supporting talent**.

Government led –industry & academic partners

- Massachusetts Governor Deval Patrick led -→

- Mass Life Science Center ($ 1 Billion)
- Mass Clean Energy Center
- John Adams Innovation Institute
- Mass Technology Collaborative
- Information Technology Collaborative
  - Mass Green High Performance Computing Center
- Mass Life Science Collaborative
  - Industry-Academic group to advise in MLSCcreation/operation
  - Co-Chairs: Presidents Susan Hockfield (MIT), Jack Wilson (UMass), Drew Faust (Harvard), Henri Termeer (Genzyme)
- Mass Defense Technology Initiative
  - Chair: Jack Wilson –Public & private univ. Military & industry partners

Innovation Eco-system changing

The Eco-system drives university-industry-government partnerships

- **Open innovation:**
  - Organizations are moving from internal to external sources of opportunity. Decline of internal corporate labs, expanding corporate alliances between large and small companies, acquisition
- **Technology convergence:**
  - Innovation occurring through multi-disciplinary collaborations
- **Shared intellectual resources and facilities:**
  - Research budgets outstrip individual capabilities and funding
- **Applied science**
  - Increasing emphasis on applied research vs basic research.
  - Caution in order -applied science relies upon the results of basic research and too little funding for basic research will reduce future opportunities.

Global Entrepreneurship

- Global Entrepreneurship has flourished over the last 50 years.
- Major changes in world governments, economic systems, and cultural interactions
- These have created an environment in which entrepreneurship has become a significant factor in regional economic development, global geo-politics, and even cultural change.

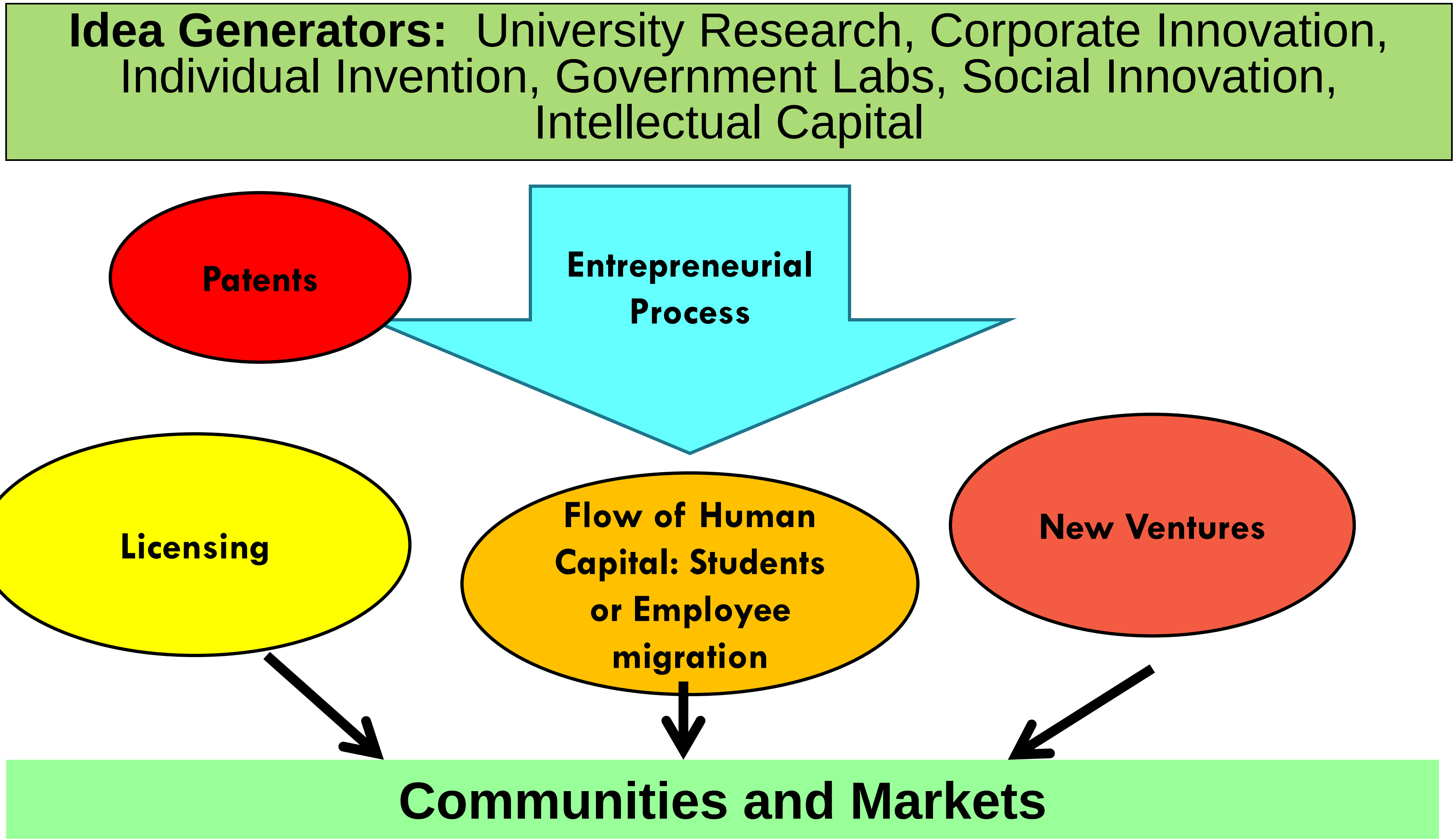
Global Entrepreneurship – the Three Key Factors

- Three significant issues that have enabled much of this innovation.
  - **Technology advances**: The incredible advances in technology – particularly in computing and the internet, but also in the life and medical sciences.
  - **Trade Liberalization**: The dismantling of barriers to trade and the movement of goods and ideas across borders that has found expression in world trade organizations like the WTO and in multi-national trade agreements like the European Union (EU), North American Free Trade Agreement (NAFTA) and many others.
  - **Freer movement of people**: The opening of borders to a much freer movement of people who emigrate and immigrate to find better opportunities in education and employment.

Where do opportunities start

- Technological opportunities almost always start with breakthroughs in new technologies. Those breakthrough can come from:
  - University research labs
  - Industry research labs like Bell Labs, Google Labs, IBM Labs, General Electric Labs, Phillips Research Labs,
    - Industrial laboratories are generally seen as sources of incremental innovation rather than radical innovation.
      - http://www.jstor.org/discover/10.2307/1828511?uid=3739696&uid=2129&uid=2&uid=70&uid=4&uid=3739256&sid=21104913961097
    - Over the last three decades, the center of gravity of research has shifted further toward universities and away from industrial laboratories.
    - The biotech industry has been an exception –particularly in the applied research areas.
  - Government research laboratories like FermiLab, Argonne National Laboratories, Sandia, National Institutes of Health, National Institute of Standards and Technology, and others.
- To get to market they need to either be licensed to existing organizations or used to develop new ventures.
- Students who graduate and then go into existing organizations also carry the intellectual property with them into their new positons. This is an important flow of ideas into the marketplace or community.

From Idea to Market or Community Use



The virtuous value chain

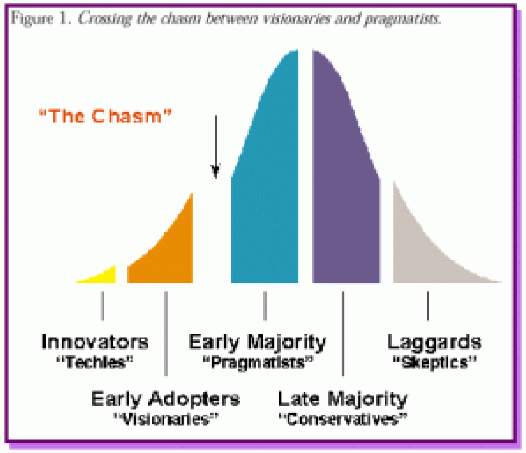
- Research
- Applied Research and Development
- Licensing to new or established ventures

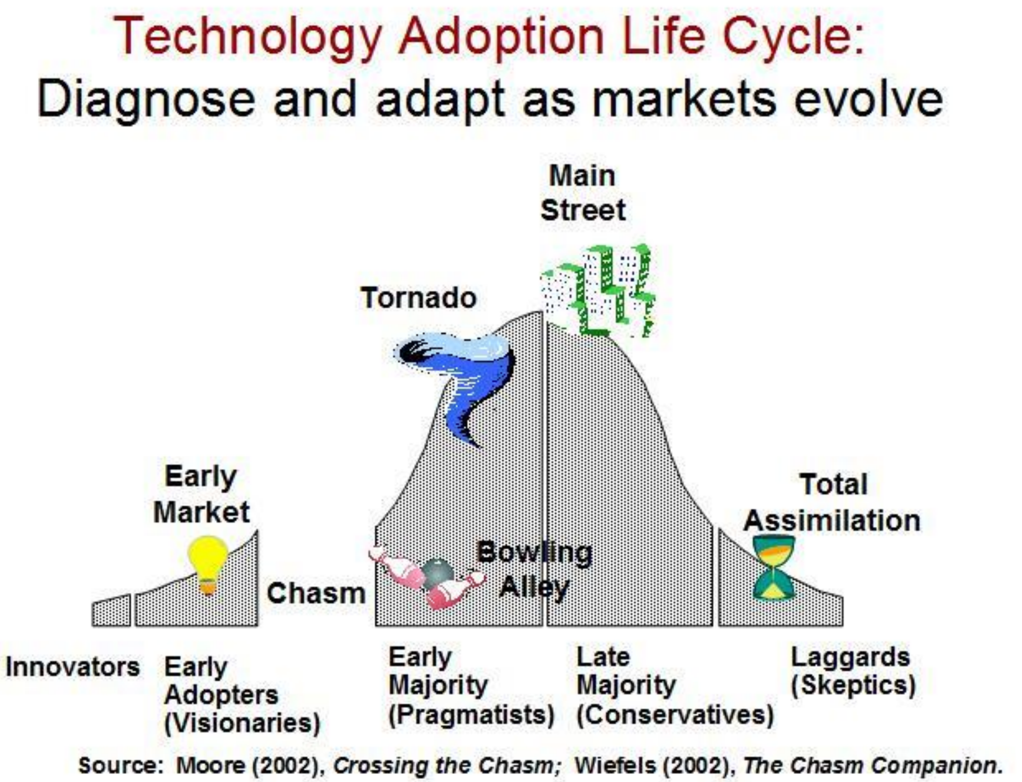
- New venture
- Business plan
- Elevator speech
- Early stage funding from bootstrapping, friends and families, angels, loans, or other sources such as the Small Business Innovation Research (SBIR) program.
  - http://sbir.nih.gov/
- Establish company structure (Corporate, partnership, LLC, sole proprietorship, etc)
- Prototyping the product or service
- Middle stage financing from venture capitalists or others
- Growth of new company
- Exit strategy
  - Acquisition
  - IPO –Initial Purchase Offer for stock
  - Remain a private business

- Licensing to established ventures
- New Product Development process.

Crossing the chasm

- Early market – the early adopters
- Chasm –getting from the early adopters to the early majority.
- Bowling Alley –once established in the early majority
- Tornado – as the innovation moves from early majority to late majority it becomes a tornado of adoption.
- Main Street –we made it!
- Total Assimilation
  Now it is old news!





Two Key Concepts

- Joseph Schumpeter –Harvard University economist from Austria
  - **Creative Destruction** – 1934- new products and technologies make old products and technologies obsolete
- Clayton Christensen –Harvard University Management
  - **Disruptive Innovation**-1997 – new products begin in new, unexplored markets but grow in quality and capability to displace older markets.
    - Mini-computer disrupted mainframes and were in turn disrupted by PC's.
    - Steel mini-mills created poor quality steel at low prices to take the least profitable part of the steel market. They then grew to displace the old-line steel companies.
- Often the established companies never see it coming.
  - http://www.claytonchristensen.com/key-concepts/
  - http://en.wikipedia.org/wiki/Clayton_M._Christensen
  - http://en.wikipedia.org/wiki/Disruptive_innovation

World Changing

- Thus the world can change due to new technologies either directly because the new technology displaces the old directly (**Creative Destruction**) or because the new technology enables an indirect entrance into the market at the low end of price and sophistication –but then grows to devour the entire market (**Disruptive Innovation**)
- Examples of creative destruction:
  - Records were replaced by tapes which were replaced by compact discs (CDs) which are being replaced by network based digital delivery.
  - Movie theaters were partially replaced by loaned video tapes from stores (Blockbuster) which were replaced by mailed out video discs (NetFlix) which are being replaced by network delivery of video (NetFlix, Youtube, FIOS, Xfinity, Amazon, DirectTV, etc.)
  - The Polaroid Instant Camera was replaced by digital cameras.
- Examples of disruptive innovation:
  - Floppy disk drives captured the home market but then replaced the business market.
  - Steel mini-mills learned to make rebar, the cheapest, lowest quality, and least profitable steel product, but then learned to make better quality steel and took away the higher profit market from big steel.
  - Personal computers captured the low end home market, but then displaced mainframes and mini-computers in the business market.

Creating the Entrepreneurial University

- Deshpande Conference on the Entrepreneurial University
  - National speakers and esteemed colleagues discuss best practices and emerging opportunities
  - Developing Entrepreneurial Universities: Culture & Ecosystems
  - Entrepreneurship in the Curriculum
  - University Research Commercialization and Startups
  - Emerging Trends & Topics

Collaboration

- Collaboration has been difficult in Massachusetts in the past, but it is getting much better.
- MGHPCC represents a major departure in this history.
- Mass Medical Device Development Center (-M2D2) is another example.
- Recently we announced a Joint Venture with Raytheon –
  - RURI –the **R**aytheon **U**MassLowell **R**esearch *I*nstitute
  - $ 5 million project
- NERVE Center –
  - **N**ew **E**ngland **R**obotics **V**alidation and **E**xperimentation Center
- Cyber Security is the next most likely major opportunity for Collaboration

Massachusetts Green High Performance Computing Center (**MGHPCC)**

A partnership between 5 universities

MIT	UMass	Boston University	Northeastern University	Harvard University
$736.1M	$468.7M	$280.8M	$61.3M	$462.3

Total Research Revenue in 2009 of $2,009,078,000 ($2.0B)

(Source NSF: http://www.nsf.gov/statistics/nsf11313/content.cfm?pub_id=4065&id=2)

With additional support from the commonwealth and industrial sponsors

Mass Green High Performance Computing Center

- 5 leading research universities, EMC, Cisco and state committed -501(c3) formed
- $95 M from universities, state, industry, tax credits. (plus ~$80M equipment)
- Site selected/acquired, tech. requirements identified, planning/design completed
- John Goodhue (former VP at Cisco), appointed as Executive Director
- Several joint proposals submitted –some granted
- Construction completed in 2012

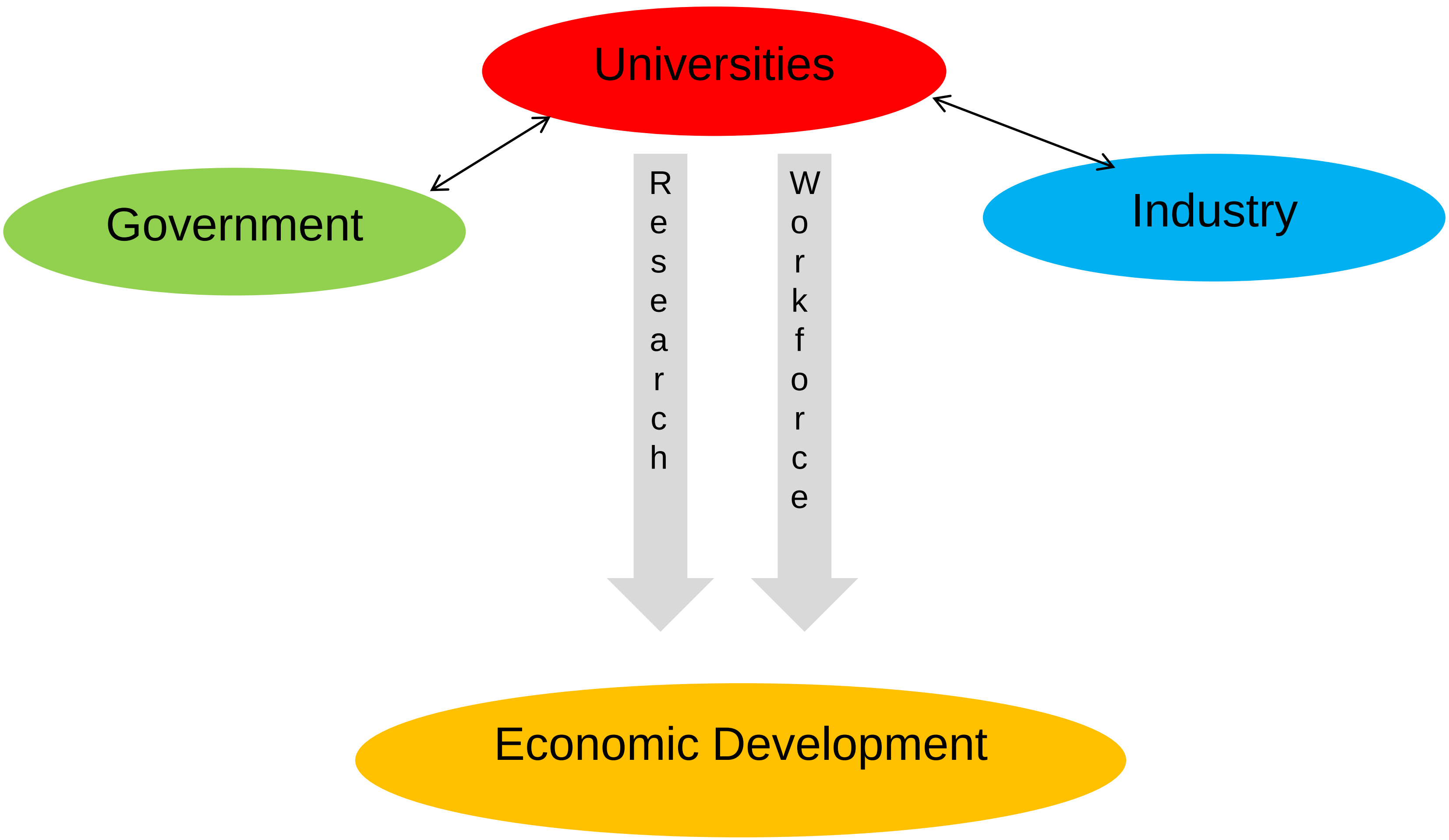
Promoting a Culture of Collaboration

- UMass Lowell Medical Device Development Center

UMASS M2D2
Massachusetts Medical
DEVICE DEVELOPMENT CENTER

- $4M 16K-sq-ft incubator
- Goal is to bridge gap between invention…production.
- Industry-funded ‘New Venture’ competition for region’s device startups
- Full at opening
- Joint Lowell, Medical School

The Partnership



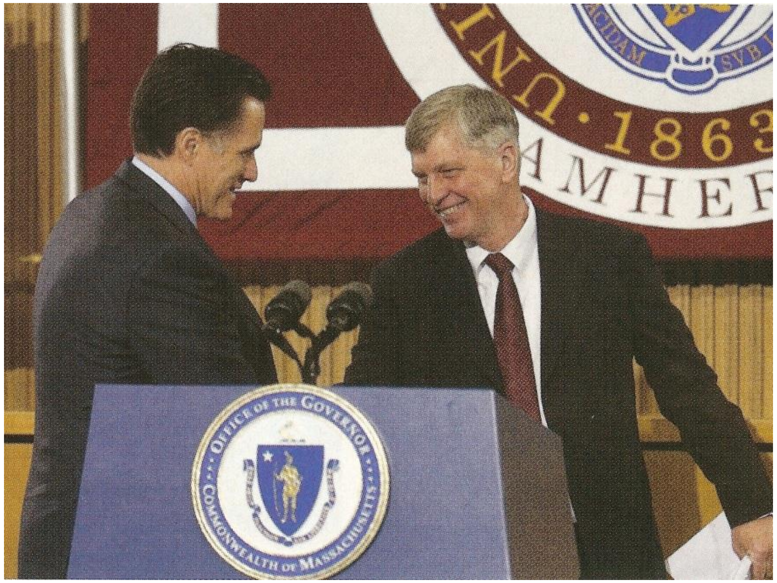
2004 – 2016 State Investments

Annual strategic investments in sector-specific centers:

- **Life Sciences** – Life Sciences Center, up to $100 million, 10 years
- **Tech** – MA Tech Collaborative, $10 million - new five year commitment in 2012
- **Clean Energy** – Clean Energy Center, $29 million into energy generation; $14 million into company building, R&D, workforce development
  - *Each structured, funded, operated differently*

Technology Transfer

- Formation of the Massachusetts Technology Transfer Center in 2003 by Governor Mitt Romney
- Designed to serve the needs of ALL Massachusetts Universities in partnership with Industry and major research universities that were already well engaged.



Cyber Centers

- NSA –Nat. Centers of Academic Excellence
  - - Cyber Operations, Research, Education
  - Northeastern University is one of the four centers
- DHS:National Cybersecurity Center (NCSC)
- Carnegie Mellon CyLab:
  - http://www.cylab.cmu.edu/
- UMD's Maryland Cybersecurity Center (MIT Lincoln Labs)
- Purdue University
  - http://www.purdue.edu/discoverypark/cyber/
- Deloitte Center for Cyber Innovation
  - http://www.deloitte.com/

PreCompetitive Collaborative Centers

- Sematech
- Carnegie Mellon
- M2D2
- MGHPCC
- Massachusetts Tech Transfer Center

Sematech Partners

Over $500 million in funding from DARPA

Sematech Partners

4DS
Advanced Micro Devices
Aixtron
Altera
Analog Devices
Applied Materials
Applied Seals NA
ASML
Atotech
AZ Electronic Materials
centrotherm
CNSE
Core Wafer Systems
Dai Nippon Printing
DNS Electronics
Dow Electronic Materials
Edwards, Ltd.
FEI
Freescale
Fujifilm
GLOBALFOUNDRIES
Hewlett-Packard
Hoya
IBM
Infineon Technologies
Inpria
Intel
Invensas
JSR Micro
KLA-Tencor
Kumho Petrochemical
LSI Corporation
Macronix
MATHESON
Micron Technology
National Institute of Standards and Technology (NIST)
NEXX Systems
Nissan Chemical Industries, Ltd.
NXP
ON Semiconductor
Pall Corporation
Panasonic
Qualcomm
Renesas
Samsung
Semiconductor Industry Association
Shin-Etsu
SK Hynix
Soitec
Solid State Equipment Corporation
Spansion
STMicroelectronics
Sumitomo
SUSS MicroTec
Texas Instruments
Tokyo Electron Limited (TEL)
Tokyo Ohka Kogyo Co., Ltd. (TOK)
TSMC
Vishay Semiconductor
Winbond

UMass Role

- Research Growth
- Commercial Ventures - Intellectual Property
- President's S&T fund established 2004
  - to build research enterprise, promote collaboration and enhance the state economy -- $8 M investment has leveraged $200 M in new R&D awards
- Creative Economy Fund
- Crossing the chasm –CVIP Tech. Dev. funds
- UMass Medical School Life Sciences Moment Fund
- Incubators
- Great graduates carrying IP into workforce

S&T Initiatives Fund

History: Investments to date totaled **$7.5M,** and have generated additional funding of $207M in federal, industry and private foundation funding. Examples include:

- **Center for Hierarchical Manufacturing** (UMass Amherst) - Research & education center received a five-year NSF grant to serve as the agency's Nanoscale Science and Engineering Center (NSEC).

- **Massachusetts BioManufacturing Center(s)** (Dartmouth and Lowell) – S&T investments helped both campuses position themselves for large state investments in new research facilities.

- **Massachusetts Medical Device Development Center (M2D2)** (Lowell and Worcester) – Has provided medical device prototyping services and research collaborations to more than 100 startups across the state.

- **UMass Center for Clinical and Translational Science** (system-wide project led by UMass Worcester) - Funds assisted in the creation of a UMass Medical School-led, system-wide clinical and translational research center funded by the National Institute of Health.

- **Center for Personalized Cancer Therapy** (Boston, in partnership with Dana-Farber / Harvard Cancer Center) – Joint project to address racial, ethnic & socioeconomic disparities in cancer incidence, morbidity and mortality.

UMass Life Sciences Moment Fund

- Created in 2008 to spur inter-campus collaboration and strengthen the University's clinical & translational research.

- Individual awards up to $100,000 for 1 year; up to $150,000 for two years

- Goals: New devices, therapies, vaccines; high-risk, high-reward studies.

Global Massachusetts 2024 *GOALS*

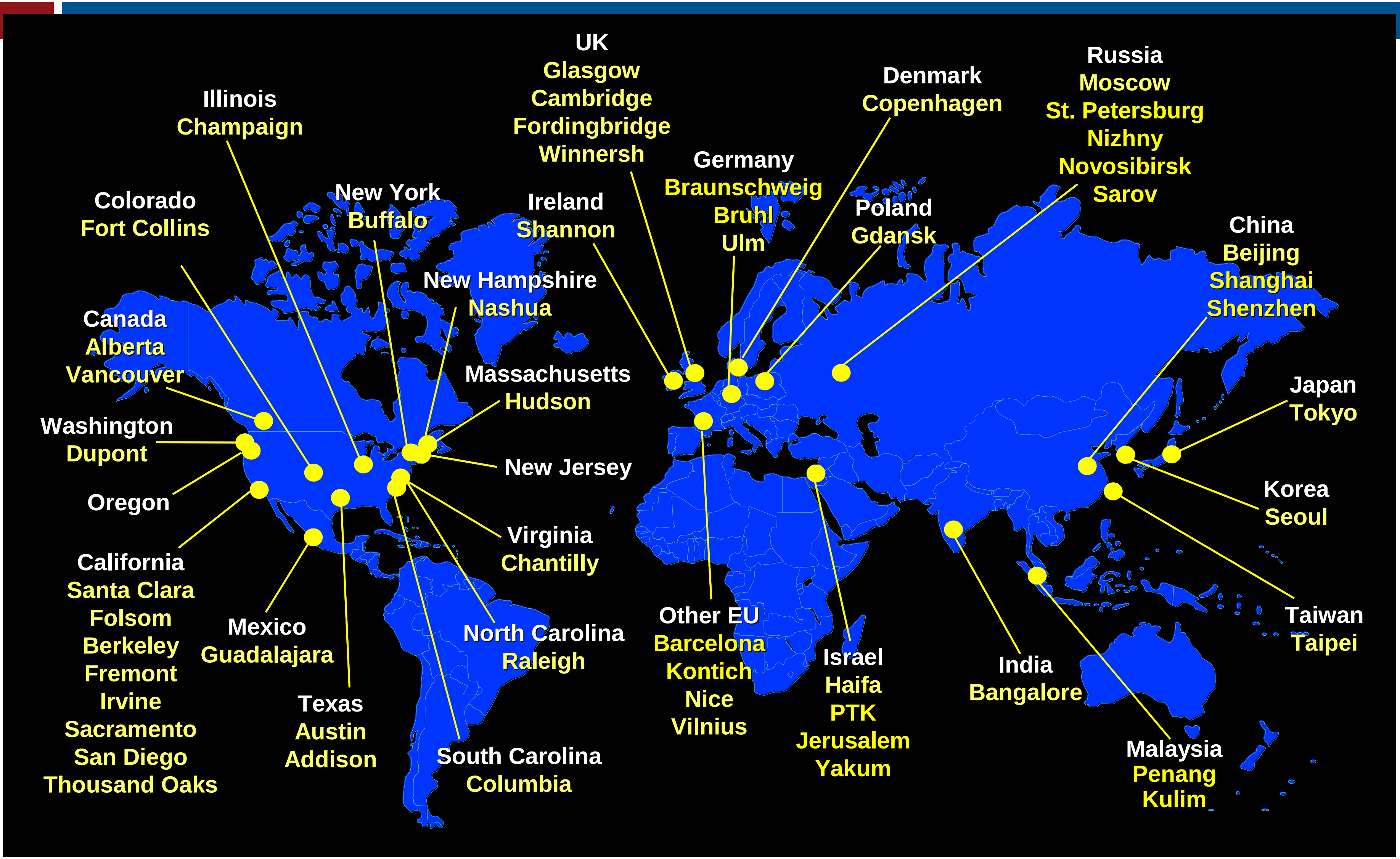
- **Establish a vision** for success over the next decade in key technologies and sectors

- **Develop strategies** to achieve the vision. Collaborative research and talent initiatives
to win globally where we choose to compete

Global Massachusetts 2024 *STRATEGIES*

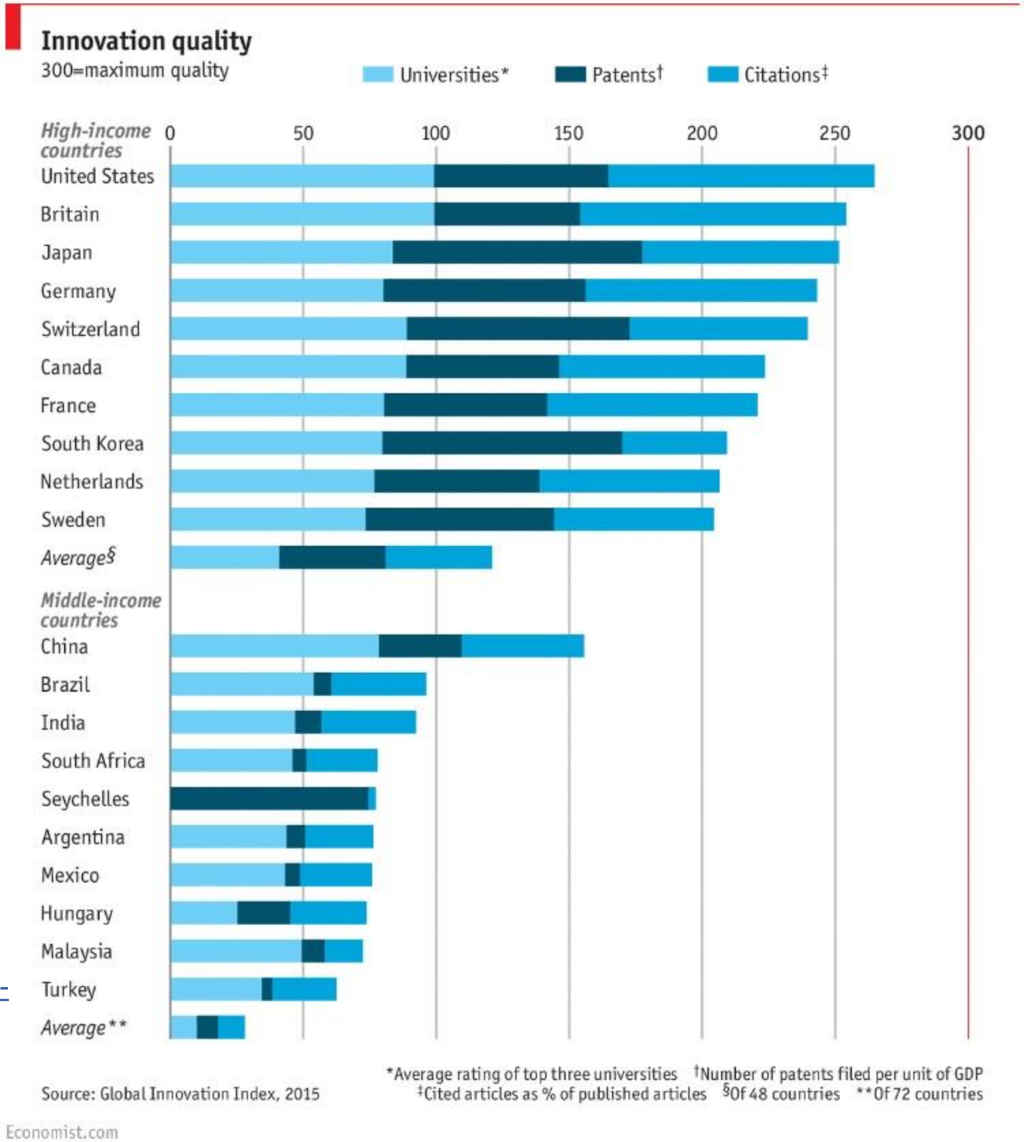
- Create **Research Centers of Excellence** to expand next-generation technology initiatives
- Establish **Talent Partnerships** to enhance university-industry collaborations
- Set goals for **College Success** - a K-12/college partnership
- Build a focused **International Strategy**

We are not alone: Intel R&D (2008)



Global Innovation Quality

Great Research Universities are a key to innovation quality.



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Massachusetts: benefiting from R&D and Globalization.

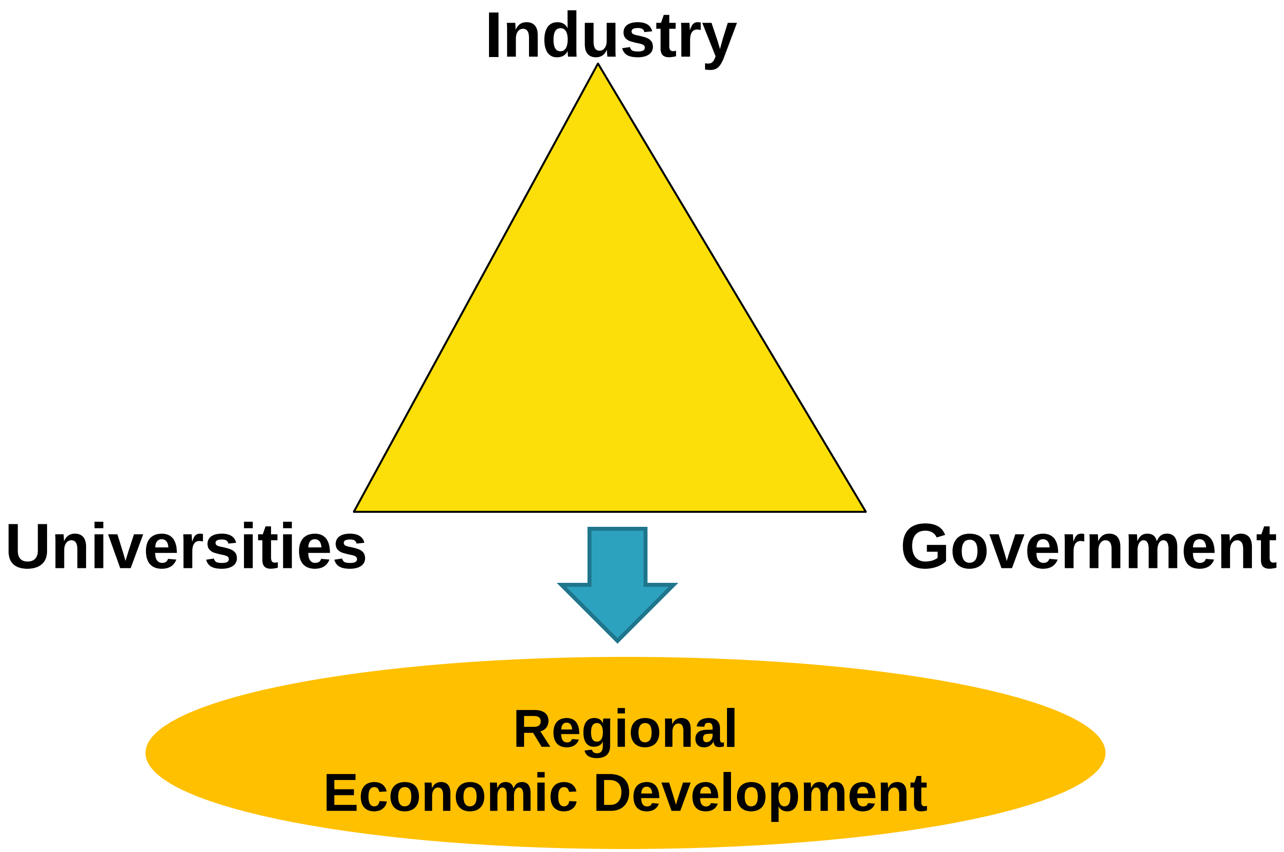
The Boston/Cambridge area has particularly benefited as biotech firms have wanted to locate in Kendall Square to be near to the very best R&D on the subject.

- Biogen, Genzyme, Amgen, Novartis, Alnylam, Vertex, Microsoft, Google, Millennium.. And 150 others!

- There is a thriving, albeit much smaller, biotech cluster in Worcester that depends upon the presence of the UMass Medical School for its Nobel Prize winning research and the UMass Medical Center as a suitable place for clinical trials.
- The UMass Lowell Mass Medical Device Development Center (M2D2) benefits both from its links to the UMass Medical School and its proximity to the eastern Mass medical industry.

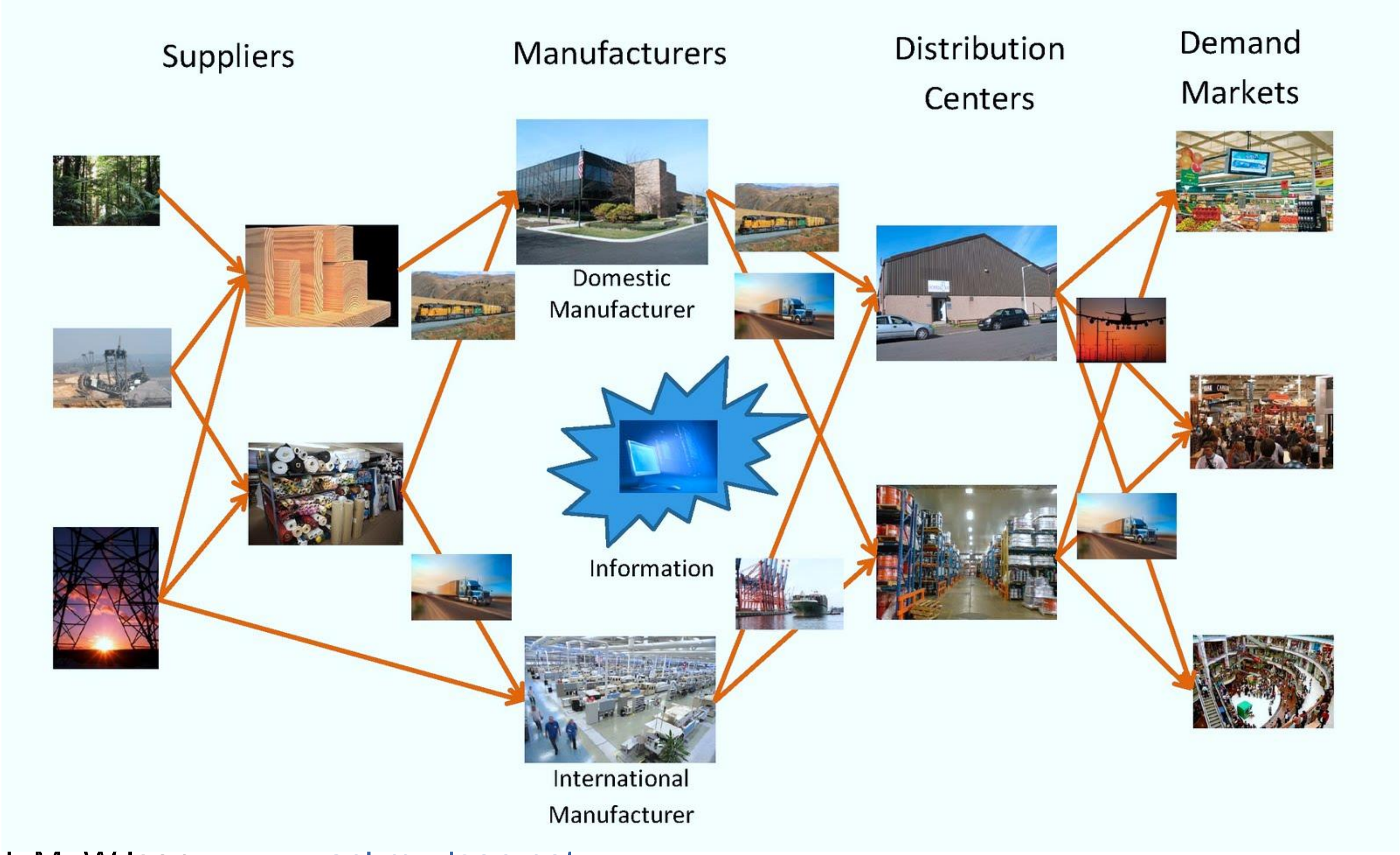
Thank you!

Strategic alliances are the key to R&D and talent leadership -- and economic growth



Supply Chain Management

- Anna Nagurney, UMass Amherst Professor, has provided an excellent analysis of the role that networks and information flow can play in creating a global supply chain.
  - http://annanagurney.blogspot.com/2012/01/how-us-can-compete-and-win-in-global.html
    - Role of Networks and Information in the Supply Chain
      - http://supernet.isenberg.umass.edu/dart.html

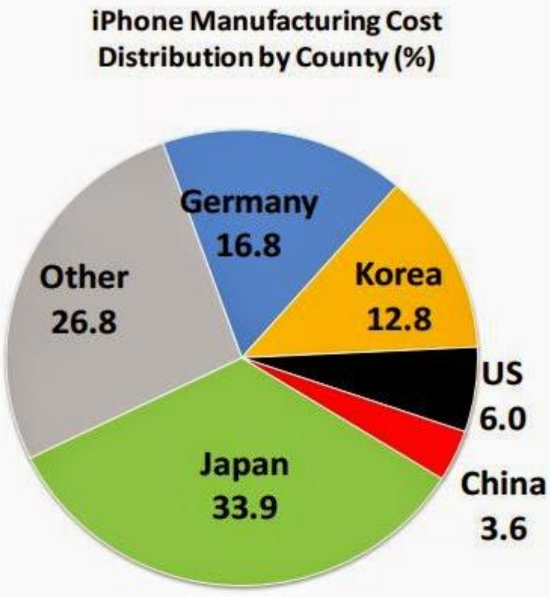


Apple Global Supply Chain -iPhone

Table 1 . Apple iPhone 3G's Major Components and Cost Drivers

Manufacturer	Component	Cost (USD)
Toshiba (Japan)	Flash Memory	$24.00
	Display Module	$19.25
	Touch Screen	$16.00
Samsung (Korea)	Application Processor	$14.46
	SDRAM-Mobile DDR	$8.50
Infineon (Germany)	Baseband	$13.00
	Camera Module	$9.55
	RF Transceiver	$2.80
	GPS Receiver	$2.25
	Power IC RF Function	$1.25
Broadcom (USA)	Bluetooth/FM/WLAN	$5.95
Numonyx (USA)	Memory MCP	$3.65
Murata (Japan)	FEM	$1.35
Dialog Semiconduct or (Germany_	Power IC Application Processor Function	$1.30
Cirrus Logic (USA)	Audio Codec	$1.15
Rest of Bill of Materials		**$48.00**
Total Bill of Materials		**$172.46**
Manufacturing costs		**$6.50**
Grand Total		**$178.96**

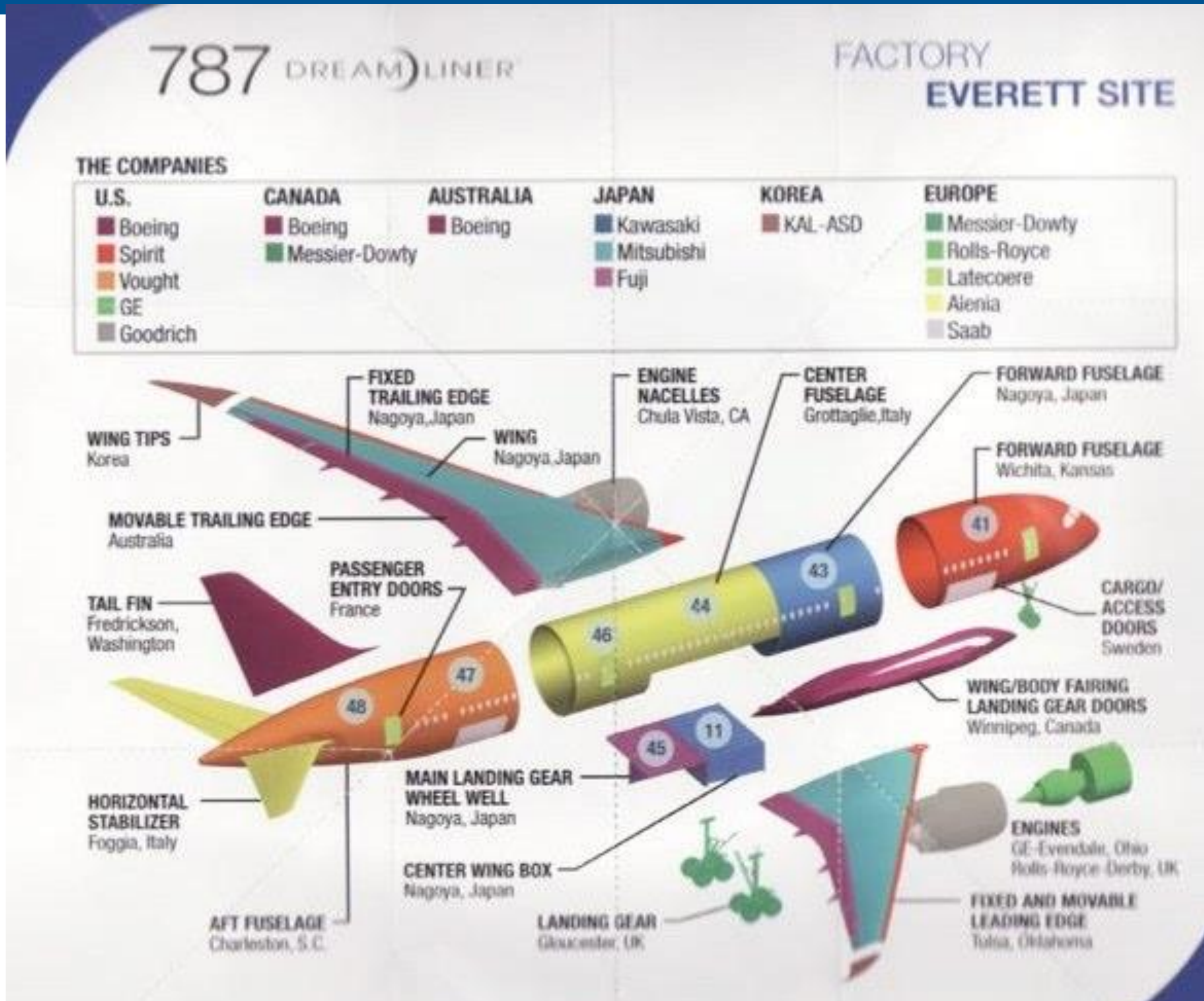
http://tomjconley.blogspot.com/2014_10_01_archive.html



Source: Xing and Detert (2010)

http://consultantsmind.com/2013/12/17/10-reasons-supply-chain-is-not-bori

The Boeing 787 is another great supply chain example



www.boeing.com