International Conference on Innovation in Energy Technologies

“National Innovation Systems and US Government Policy”

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INNOVATION is a hot subject!

Which wins the Google contest for most URLs?

• Saddam Hussein	• 1,430,000 hits
• Tony Blair	• 1,430,000
• George W. Bush	• 1,960,000
• Harry Potter	• 3,180,000
• Innovation	• 6,650,000
• OECD	• 6,440,000

Presentation Outline
Key features of the US System of Innovation

- Henry Ergas dynamic model of high tech innovation
- Gap between Research System and Financial System.
  - who funds the initial innovation?
- Radical innovation in large corporations
- Geographic concentration of innovation performance
  - networks and social capital.

Complexity of innovation systems for energy technologies

- Research-based innovations are required for alternative sources of renewable energy, storage, and applications.
- Evolutionary improvements in existing energy systems to gain marginal efficiencies.
- Infrastructure development is a critical barrier to new energy modalities.
- Influence of public policy at all stages.
  - Government interests in sustainability, independence and environmental acceptability

Radical Innovation vs Incremental Growth

- Virtually all economic growth comes from incremental improvements in productivity, products and markets
  - Markets will drive it
  - Private investment and finance it
- But the sources of Schumpeterian "creative destruction" giving competitive advantage to new industries come from radical innovations.
- Are markets sufficient to reward and therefore stimulate radical innovations in firms large, small and new?

New technology	Radical innovation
Today's business	New Market

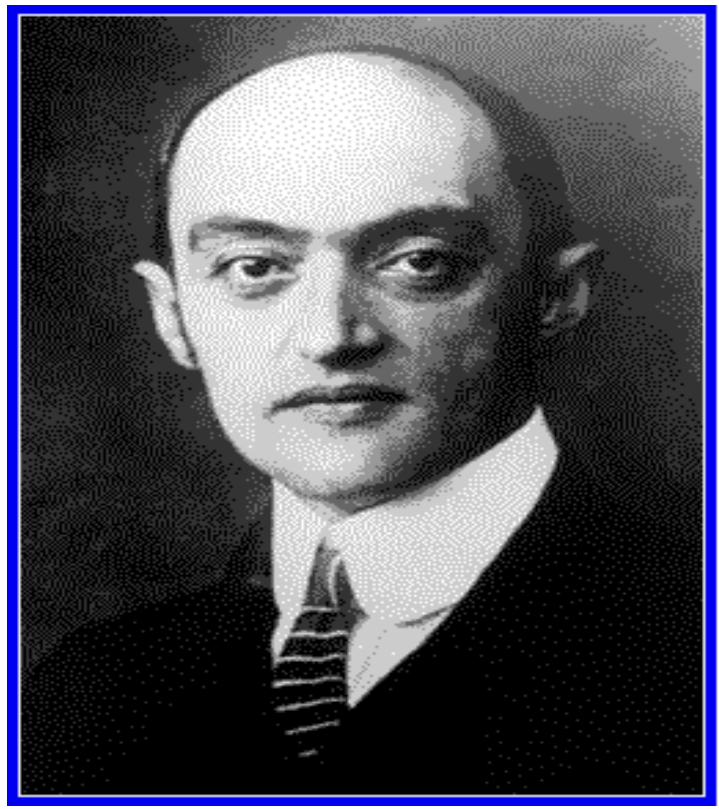
Joseph A. Schumpeter (1883-1950)

From *Capitalism, Socialism and Democracy*. 1942

"Creative Destruction"

- "The fundamental impulse that… keeps the capitalist engine in motion comes from the new consumers, goods, the new methods of production or transportation, the new markets, the new forms of industrial organization that capitalist enterprise creates."

- "This process of Creative Destruction is the essential fact about capitalism. It is what capitalism consists in and what every capitalist concern has got to live in…."



[pp 82-85 in the Harper publication NY, 1975]

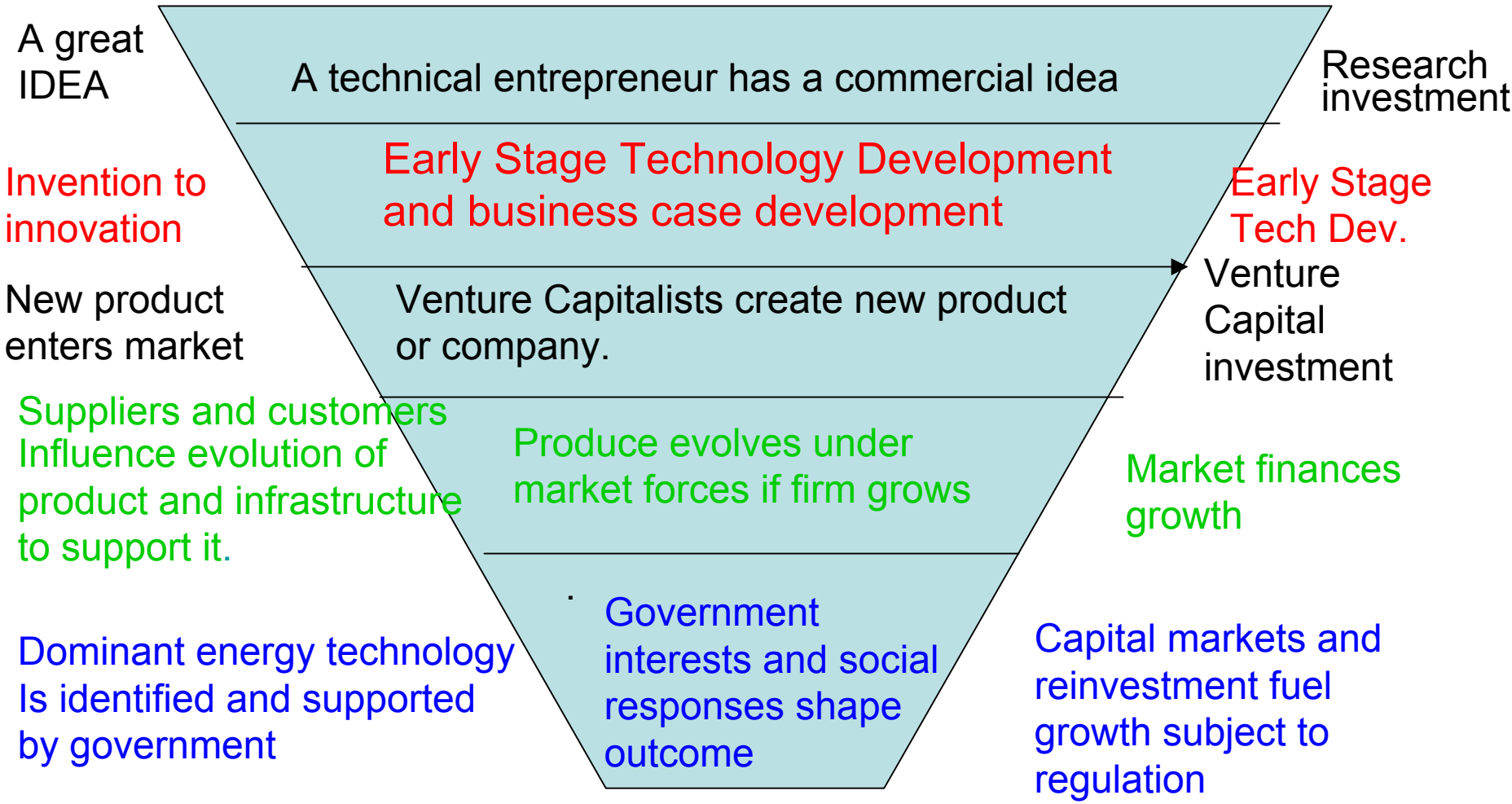
Schumpeter's Gloomy Prediction (1942)

- Schumpeter understood the power of radical innovation to revitalize a maturing economy
- But Schumpeter failed to anticipate the science-driven innovation in the second half of the 20th century:
  - Rise of venture capital (ERISA allows private equity invest.)
  - Rise of public investment in S & T ($117 billion in FY 2003)
  - Outsourcing of innovations by large firms
  - Tax incentives for new firm creation and risk taking
  - Bayh-Dole Patent Act cedes patents to universities performing government sponsored research.
  - Rise of the Creative Class (R. Florida 2002)
  - New sources of seed investment

Henry Ergas' dynamic model for technical innovations

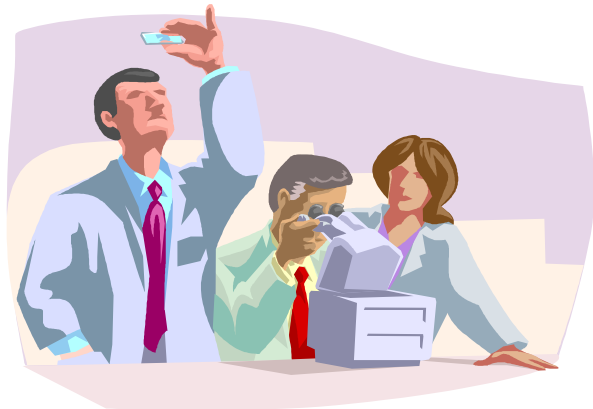
- Research and development
  - All steps from conception to market entry
- Application
  - Initial production and sales
- Adaptation
  - Response of suppliers and customers to use of product, evolution of product function
- Social response
  - Regulation, training, infrastructure & social capital

The high-tech innovation process for new energy systems



The Chaotic, Creative path from Invention to Innovation

- We think we understand the research and invention enterprise, much of it publicly funded.



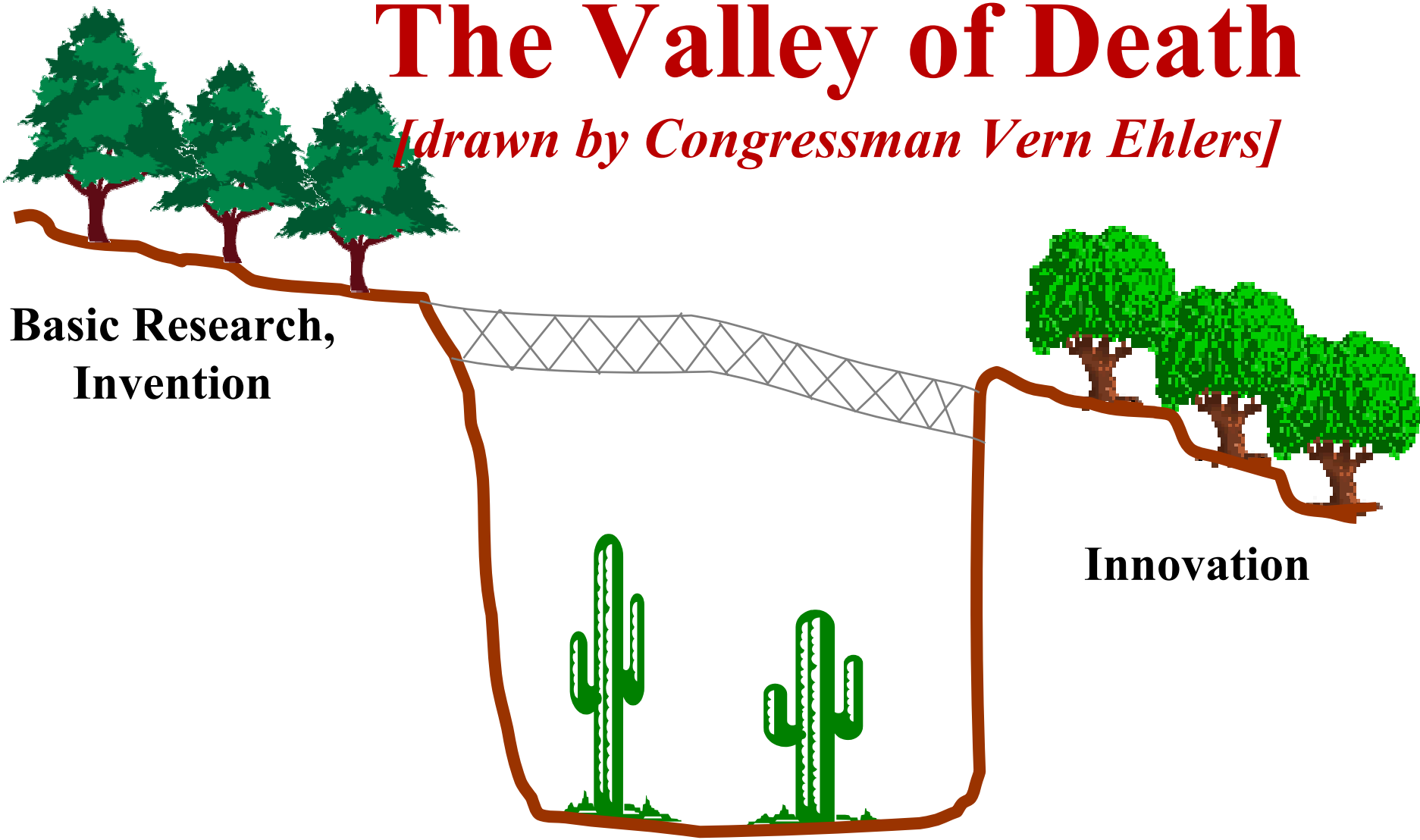
- We think we understand the financial and business world which creates wealth.

- But do we understand what goes in between?

Figure 1. Early-Stage Technology Development (ESTD) Along the Iterative Path From Invention to Innovation

The Valley of Death

[drawn by Congressman Vern Ehlers]



"Valley of Death"

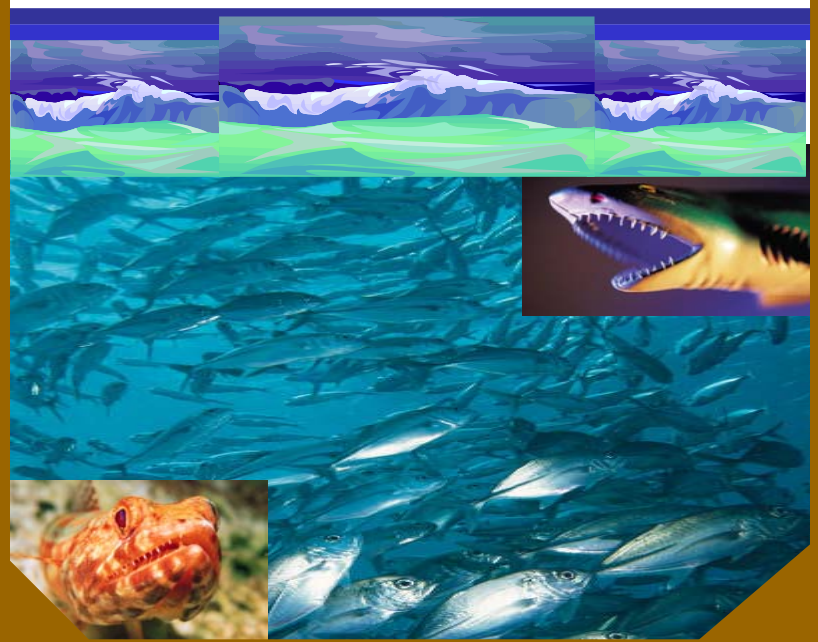
LMB 7/3/01

The Darwinian Sea

The Struggle of Inventions to Become Innovations

Research & Invention

ESTD



Innovation:
new products
new business

"Struggle for Life"in a Sea of Technical and Entrepreneurship Risk

Gap between Research System and Financial System.

Who funds the initial innovation?

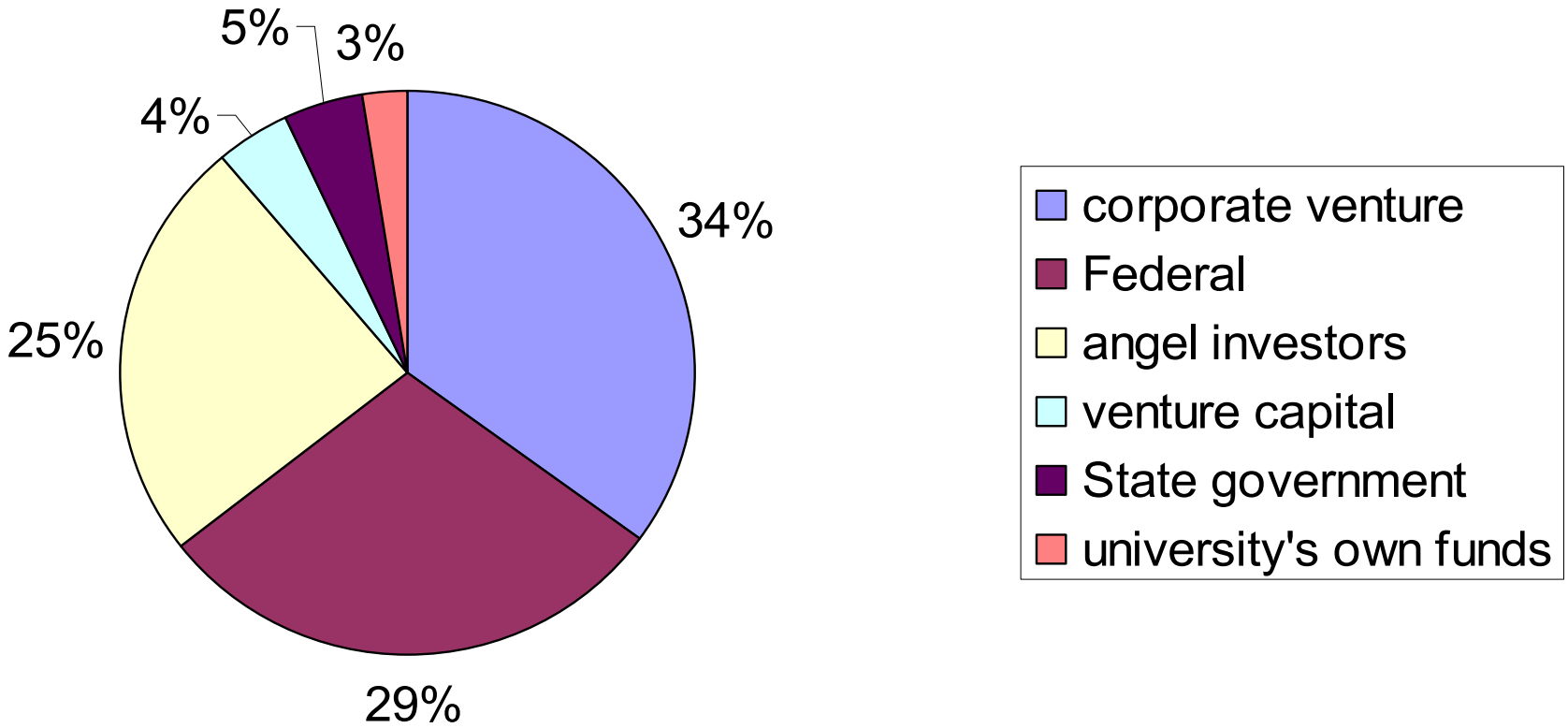
How is the trip across the Darwinian Sea financed?

- There are no reliable data; reports to government are not required.

- Congressmen (and the administration) think Venture Capital covers this need.
  - They are wrong, only 4% of VC goes to seed or pre-first stage investment.

- Our research shows there are three main sources
  - Corporate outsourcing of research through seed venture funding
  - Government R&D programs promoting high tech innovation to enhance growth in the economy
  - Angel investors who also serve as mentors of startups

Average percentage distribution of sources of finance for the invention – innovation transition drawn from high and low estimate models



---Branscomb and Auerswald 2003

Relatively little US effort goes into ESTD for radical innovations

- On the research shore:
- US national R & D expenditures — $ 290 B

- Crossing the Darwinian Sea
- Turning inventions into radical, tech-based innovation — $ 5.4 to 35.6B
- Early Stage Technology Development by large firms — $ 13.2 B

- On the business shore:
- Venture Capital Investment — $ 21 B
- Gross Domestic Product — $9,800 B

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-- year 2002 estimates for the US---

Why is support from government, from angels, and from industry important?

- Government: funds research and can extend it into potential economic value, and can encourage geographic diversity of innovation and new firm creation.
- Angels: bring not only unique skill at assessing and accepting risk but also mentoring of newly minted technical entrepreneurs.
- Industry: has great difficulty supporting out-of-core innovations but has best opportunity to create the infrastructure required when it does.

“Angels” got that name from sponsors of Broadway theatre.

Today some 200,000 private equity investors in high-tech, new ventures.

A tiny fraction of them are high tech Angels creating new companies based on new science for new markets.

Who are they?

Technical entrepreneurs who have “been there, done that” and now nurture new firms to repeat the miracle of high tech innovation.

CAN YOU IDENTIFY THESE FUTURE ENTREPRENEURS WHO LATER BECAME ANGELS?

BILL GATES; [microsoft]

MITCH KAPOR; [lotus]

FRED GIBBONS [software pub.]

Hans Severeins, Founder

BAND OF ANGELS, Palo Alto, CA

1998

The **Band of Angels** is a group of 100 former and current high tech executives and entrepreneurs who provide counsel and capital to startup companies. Band members have founded companies such as Cirrus Logic, Symantec, National SemiConductor and Logitech. Since 1994, Band members have placed more than $110 million into more than 140 start-up companies.

Universities and high-tech innovations (Y2000)

- **8,500 patents filed by US universities**
- **$1.26B in royalties to US universities from 4,346 licenses in FY2000.**
- **454 spin-off companies from universities**
- **US universities took equity interest in 56% of those deals --- up 46% from 1999.**
- **Research universities are now creating their own seed Venture Capital funds260 university spin-offs created from university license or IP. (U.S. Assoc. of Univ. Technology Managers number now about 400)**

  – Data from Association of University Technology Managers (AUTM) www.autm.net

Universities as sources of commercial innovations

- Most business entrepreneurs focus on building small scale ventures that offer at most small, incremental improvements on existing goods or services
- Most academics build stable careers out of small, incremental contributions in increasingly narrowly defined disciplines.
- As knowledge advances and markets become increasingly complex, pressures grow on both entrepreneurs and academics alike to "define your niche" and subsequently "stick to your knitting."

- **Entrepreneurial "star scientists" are exceptional because they are able to both**
  - **focus (for academic success) and**
  - **integrate (across disciplines and from science to the market).**

Federal Innovation Support independent of Gov't missions

- **Advanced Technology Program (ATP) managed by NIST in Dept. of Commerce**
  - Cost sharing of technology research leading to radical innovations of high economic value
  - Unsolicited proposals from firms, all industries
- **Small Business Innovation Research (SBIR)**
  - All R&D agencies must buy 2.5% from small business as SBIR contracts
  - Small grants, does not fund commercialization

Nanophase Technology Corp., Romeoville IL.

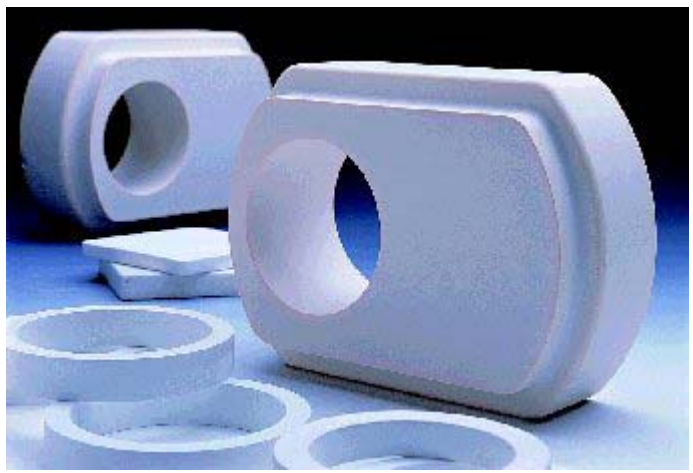
Nanophase began with 2 employees, spun off from Argonne Lab in 1990.

Invention: Physical Vapor Synthesis →

Small initial support from Caterpillar because of promise of ceramic tractor engines.

ATP grant $944,000 in 1992.

First commercialized as cosmetic.



Now sales of $5.4 million, sales growth per year 35 %

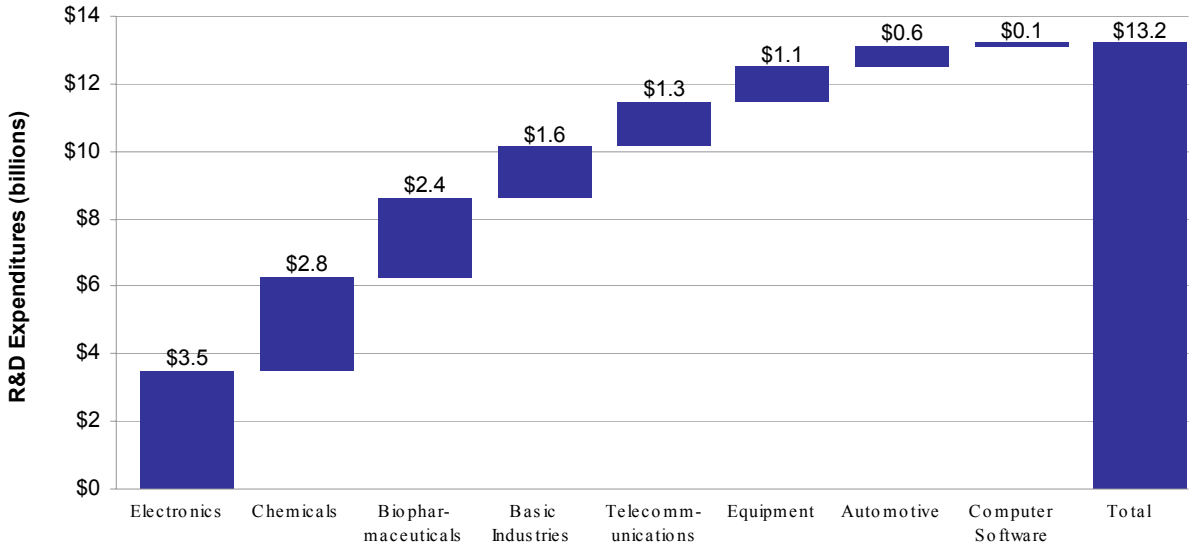
53 employees, listed on NASDQ

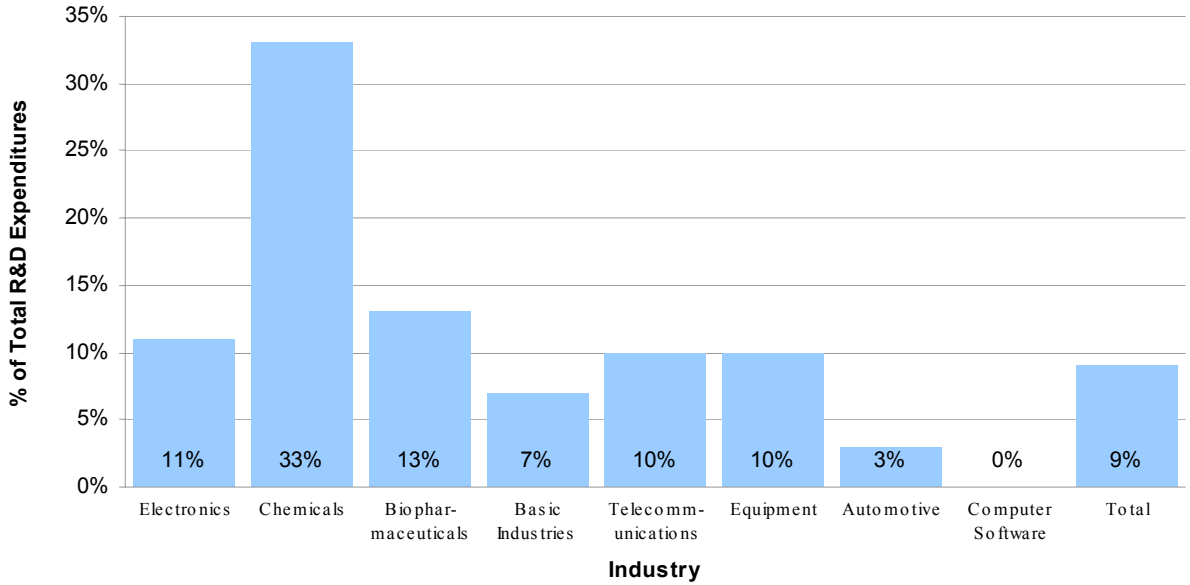
Catalysts, Sunscreen, Cutting tools Ceramic bearings, coatings for computer monitors and contact lenses.

Radical innovation in large corporations

Figure 4. Estimated ESTD Spending by US Corporations

ESTD investments are concentrated in a handful of industries…





What you will find at www.intel.com

Intel Capital Portfolio

View by Fund

Intel® 64 Fund

The Intel 64 Fund is a quarter billion dollar equity investment fund that invests in technology companies developing innovative enterprise solutions for Intel® Itanium™ based servers and workstations.

Intel® Communications Fund

The Intel Communications Fund is a $500M equity investment fund that invests in technology companies developing innovative networking and communications solutions. The fund supports development of technologies and companies that are complementary to the Intel® Internet Exchange Architecture, CT Media™ software, Intel® Personal Internet Client Architecture and Intel® XScale™ Microarchitecture.

Geographic concentration of innovation performance – networks and social capital

Geographic and Industry sector concentration of innovation investments

- Skew of private investments to IT, retail, medical & biotech (76 % of total in ‘99)
- Skew of private investment to CA, MA, NY, TX (67 % of total in ’99)

Geographical concentration of Patents and Innovations (U.S. 1982)

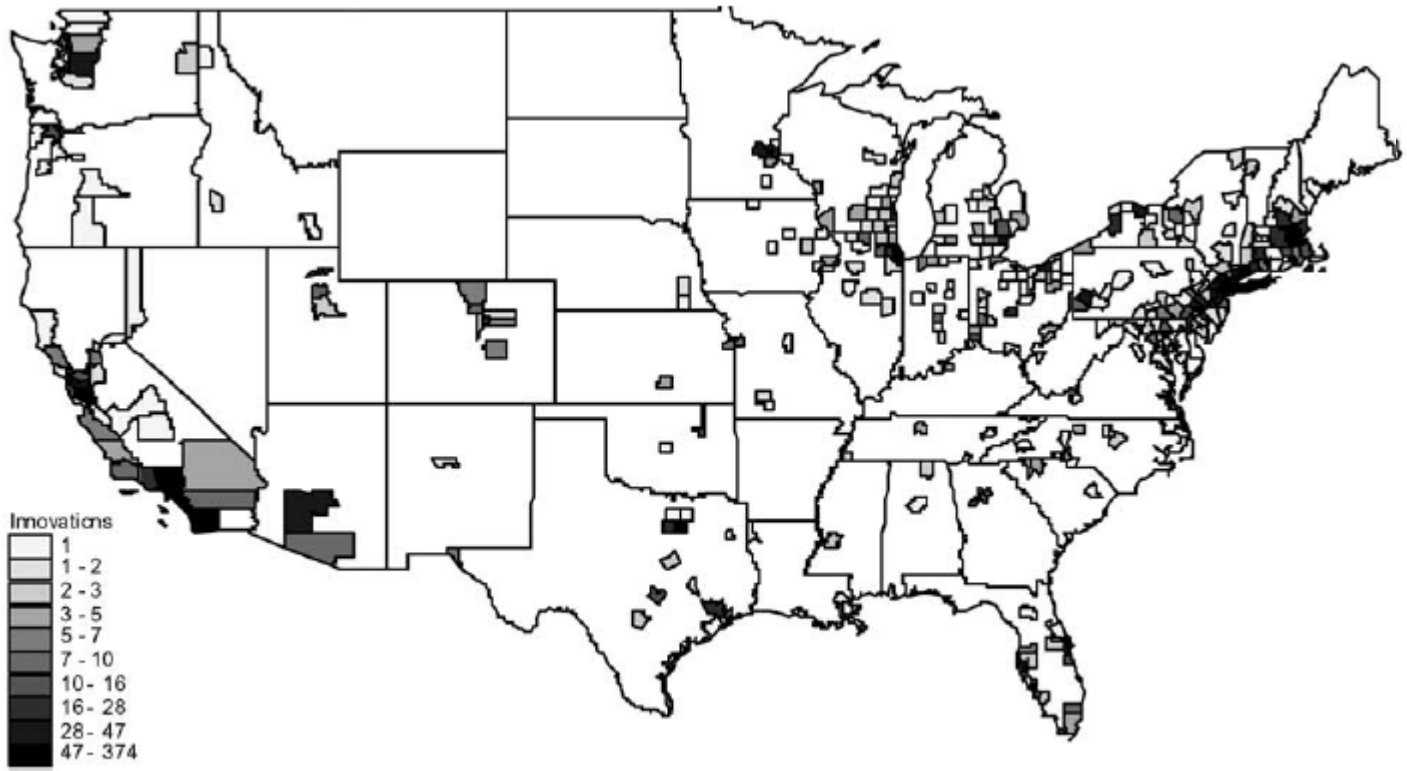


Fig. 1. The spatial distribution of innovations, 1982.

Source (Acs, Anselin, and Varga 2002); “innovation” counts from the U.S. Small Business Administration

Percent of patents to converted to innovations (1982):

- San Jose (**Silicon Valley**) innovations/patents = **57%**

  (highest among all U.S. metropolitan statistical areas with 100+ patents)
- **Albany/Schenectady/Troy** (New York): **0.3%**

  (lowest among all U.S. metropolitan statistical areas MSAs with 100+ patents)

A patent in San Jose is 190 times more likely to lead to an innovation than one in Albany.

Why US innovation is so concentrated: Social Capital: trusted networks for innovation

- Opportunities are captured locally
  - of Si Valley & Boston vs. Cleveland & Albany
  - Building on, vs. displacing existing economy
  - 80% of university based startups in same state.
- Using the tools of innovation policy with local government to increase social capital.
- Partnerships and consortia may enhance – or be evidence of -- social capital.
- Richard Florida's discovery of the correlates to a community's innovation potential.

  - Richard Florida, *Rise of the Creative Class: And How It's Transforming Work, Leisure, Community and Everyday Life* – Basic Books 2002

Conclusions

- Markets for energy technology are complex, a mix of public and private, and a mix of dominant and radical technologies.
- Risks associated with introduction of new energies technology are uncommonly high.
  - Delay in acceptance due to economics, installed technologies and infrastructure
  - Uncertainties due to instability in public policy
- Subsidies to bring new ideas to a sound business case (ESTD) must come from government
- Established firms rarely innovate outside core business
- Current innovation models are not adapted to mixed public-private industries with highly expensive fixed infrastructure and strong public regulation.

It’s not the “R”.
It’s not the “D”.
It’s the “&”.

- Phil Auerswald

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