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Overview of the Status of a Key Enabling Technology

DOE Visiting Speaker Program

Washington DC January 12th 2009

Eugene G. Arthurs, CEO SPIE



Points

- SPIE – who we are & why we might know something
- Photonics – pervasive and enabling
- R&D trends
- International view
- Back in the USA
- ITAR etc.



Do You Know?

Yes, primacy in S&T contributed greatly to our economic well being and our national security. This was the glorious era of Bell Labs, RCA (Sarnoff), Hughes Research, Xerox Parc, IBM Research labs etc.

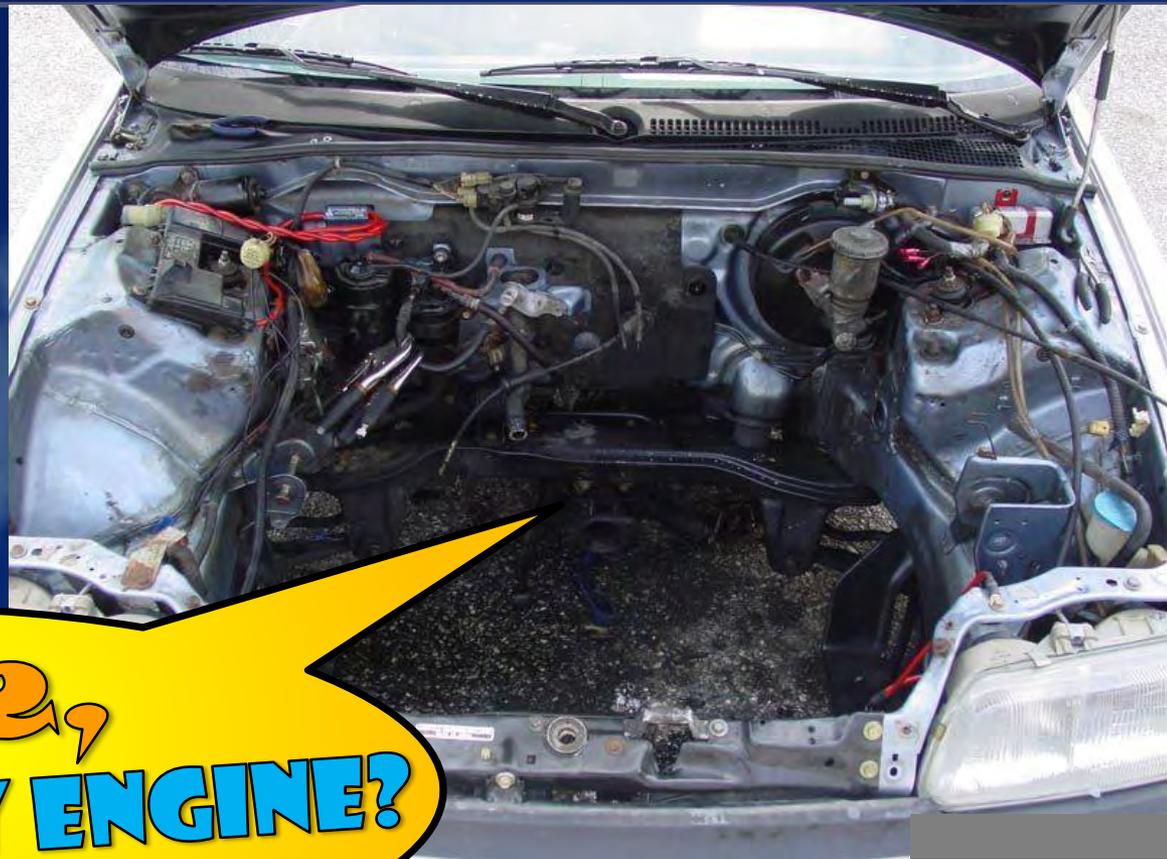
But the world has changed. Other nations are challenging us in science, but perhaps more important they are a lot more effective at translating S&T into economic advantage.



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In the U.S.,
something is
missing!

Or :



**DÜDE,
WHERE'S MY ENGINE?**

Bell Labs, Xerox PARC, RCA Labs, IBM Yorktown Heights, UTRC, Hughes Labs etc., “all changed, changed utterly”

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What is SPIE?

- International not-for-profit technical society founded in 1955 in southern California
- 190,000 active constituents representing 143 countries
- ~17,000 members, 60+ % in US, 460 Corporate members, 4,375 Student members
- More than half US members work in industry
- ~38,000 attendees at 26 SPIE technical conference and 16 exhibitions in 2008
- 7 peer reviewed journals published
- 267,000+ technical papers in SPIE Digital Library



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One Way Of Segmenting The Photonics World

Entertainment

Telecom
InfoTech

Defense and Security

Lighting & Energy

Industrial
Manufacturing

Transportation

Analytical

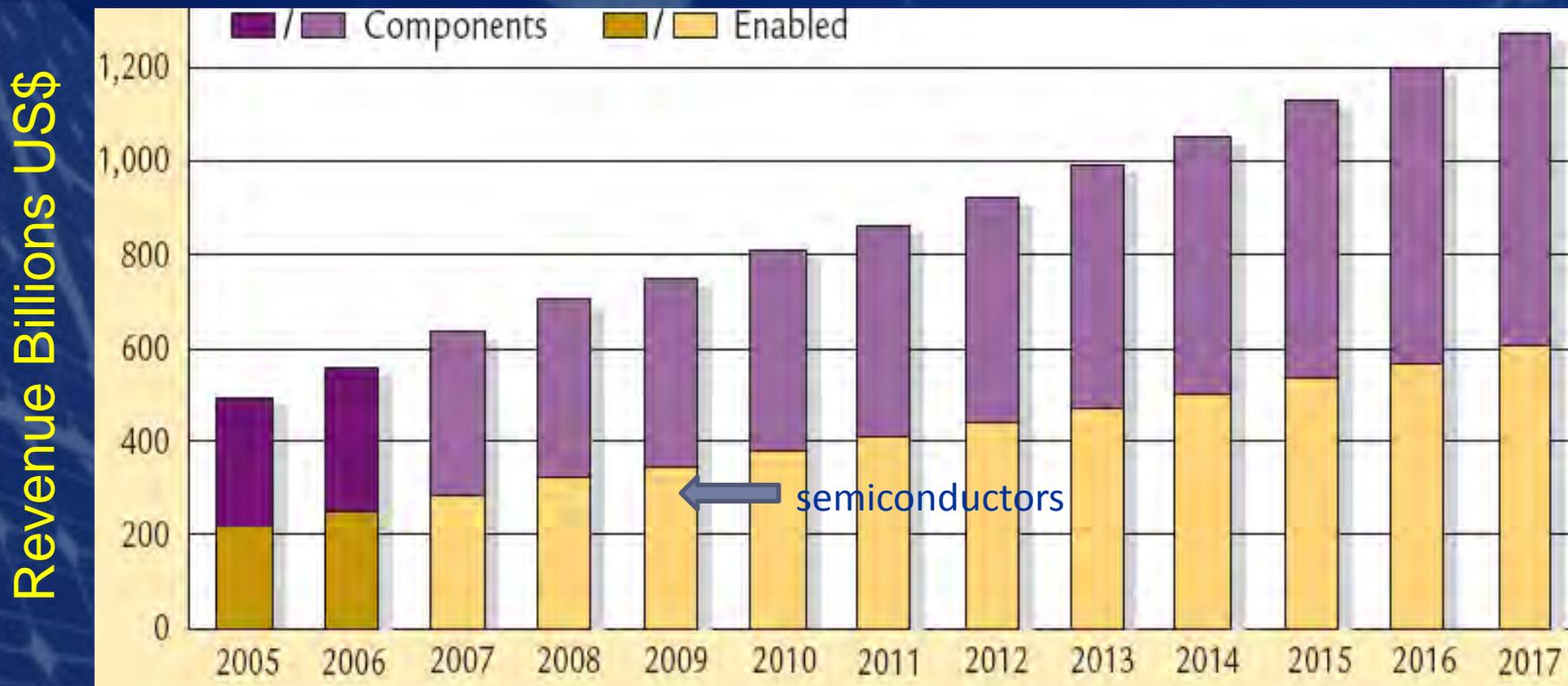
"Research"

Health &
Life sciences



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Market estimate for photonics and photonics enabled products



Information derived from OITDA and other organizations.

Graph by OIDA

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SPIE Why aren't we winning!?

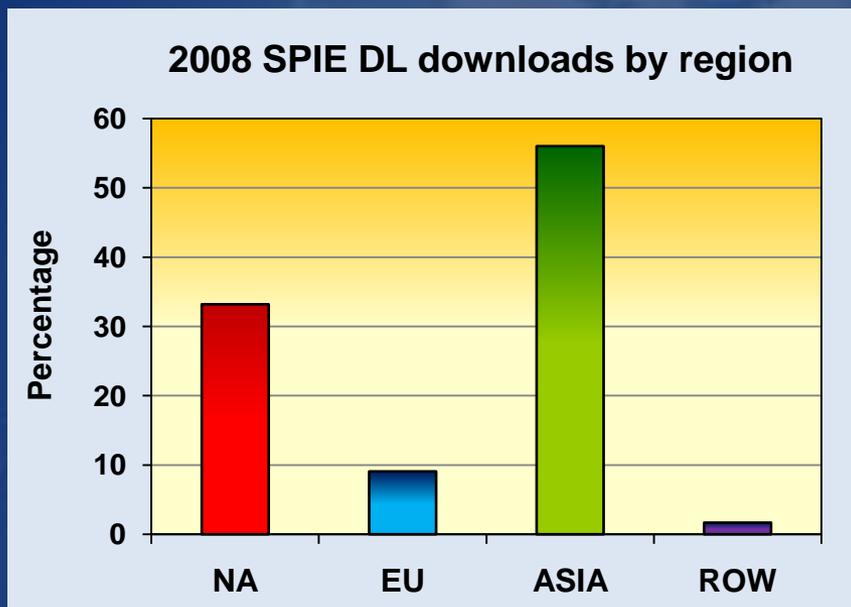
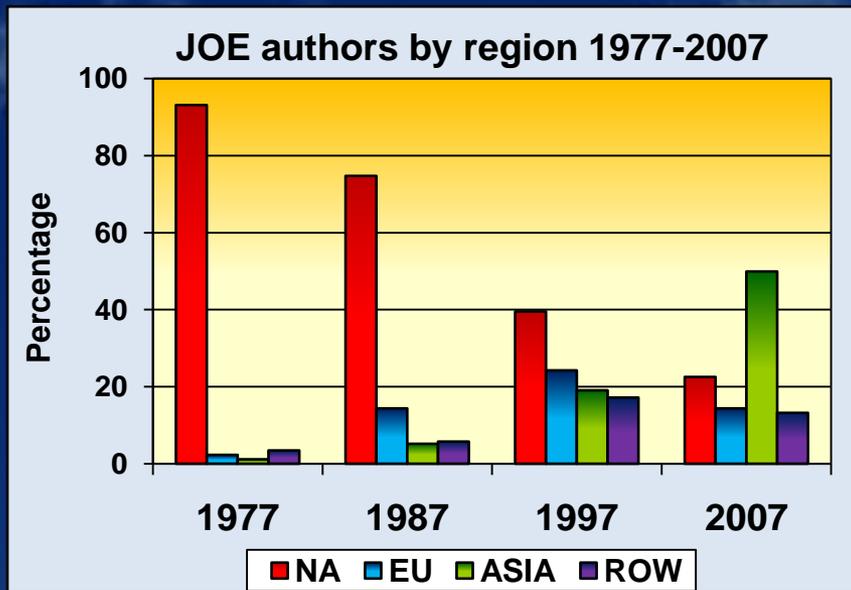
Most photonics inventions generated in the US

Who have been the big winners in photonics markets?

Japan, Korea, Taiwan, Germany

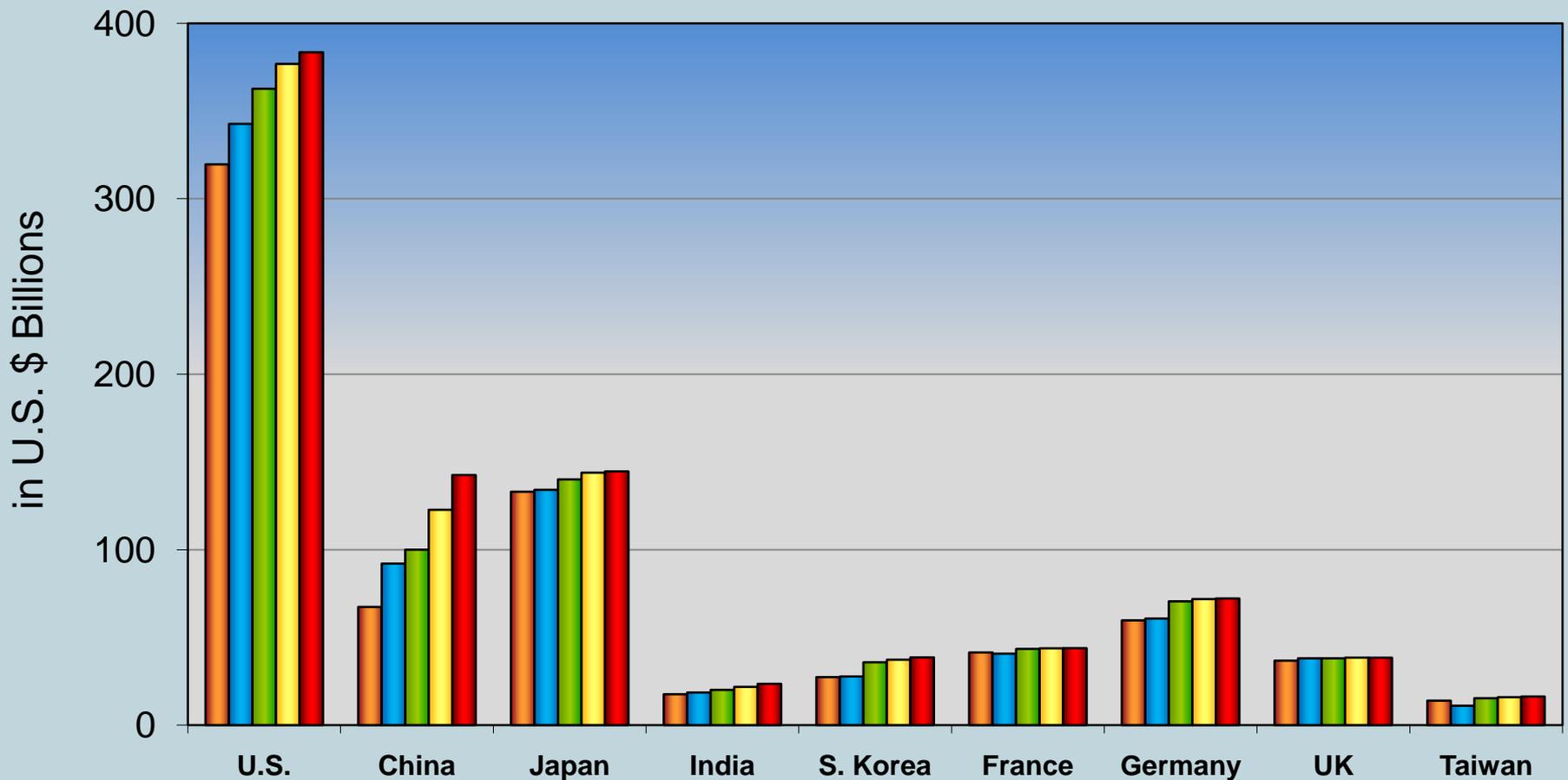
Who is working hard to profit in the future?

Korea, Taiwan, China, Germany, EU



R & D Spending (GERD PPP)

2005 2006 2007 2008* 2009*



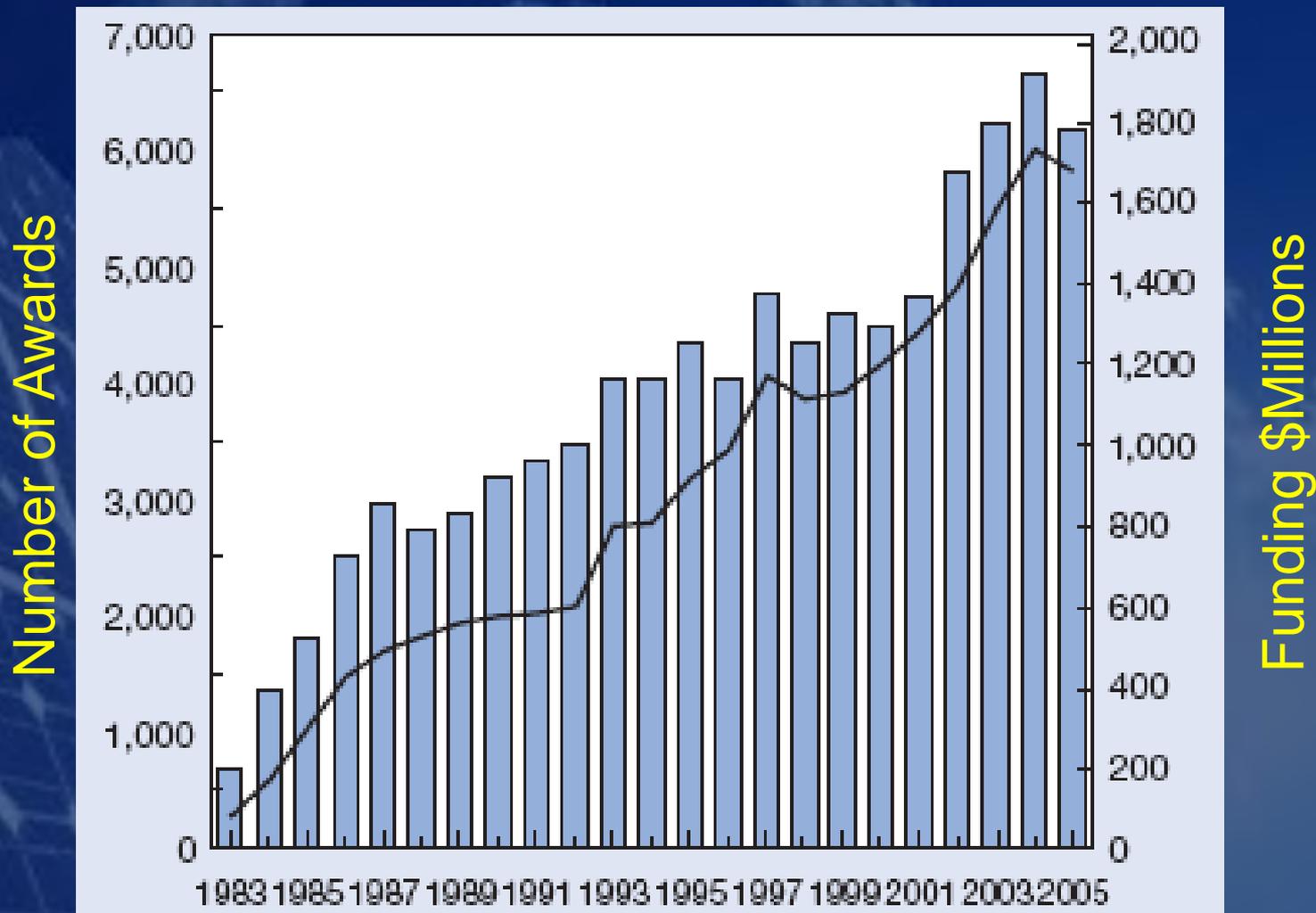
Sources: IMF WEO (October '08), OECD, NSF Data, Battelle R&D Report, SPIE data

*estimates



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The SBIR Advantage?



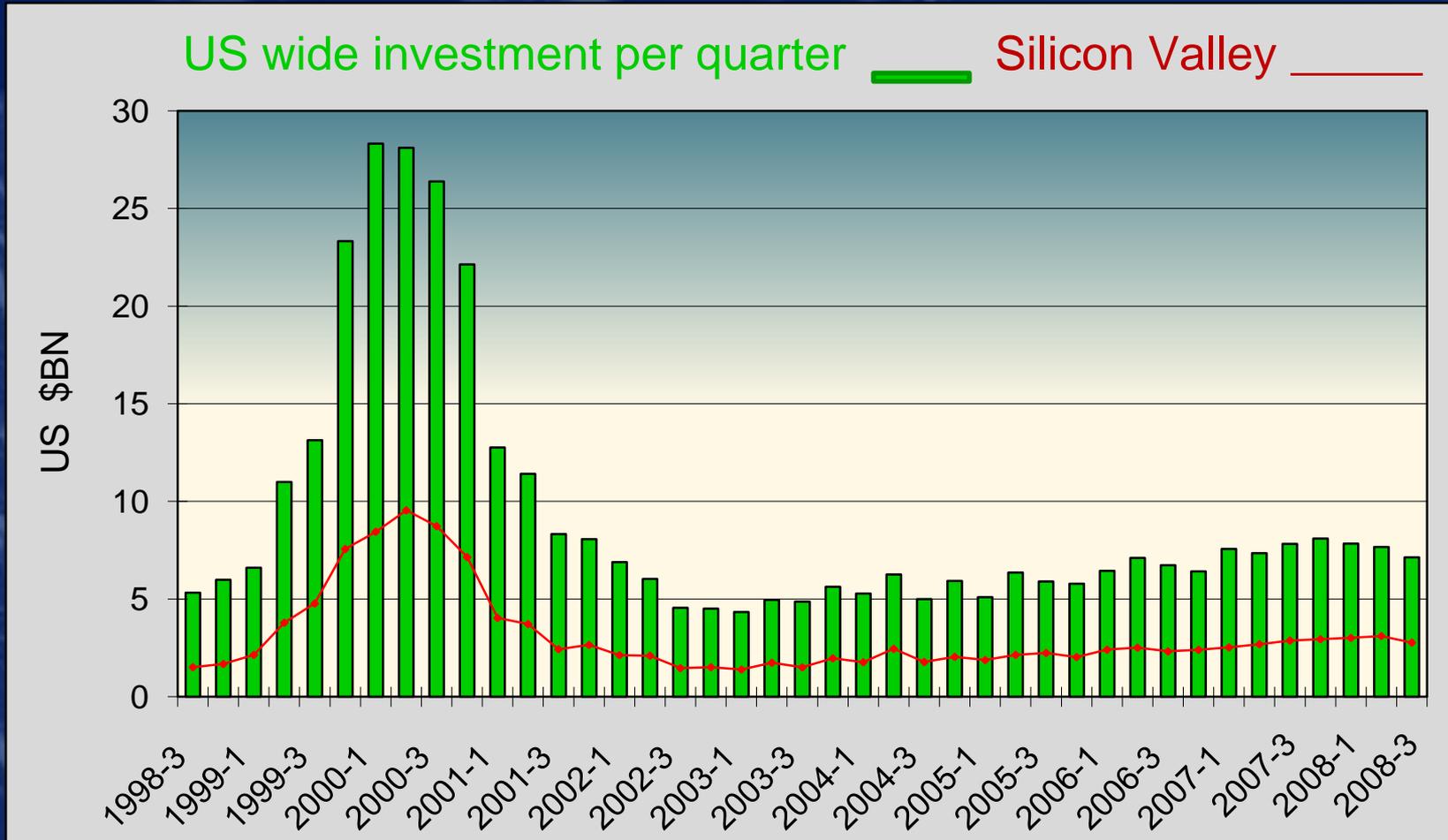
Source: NSF S&T Indicators 2008

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Who's responsible for investing in basic research

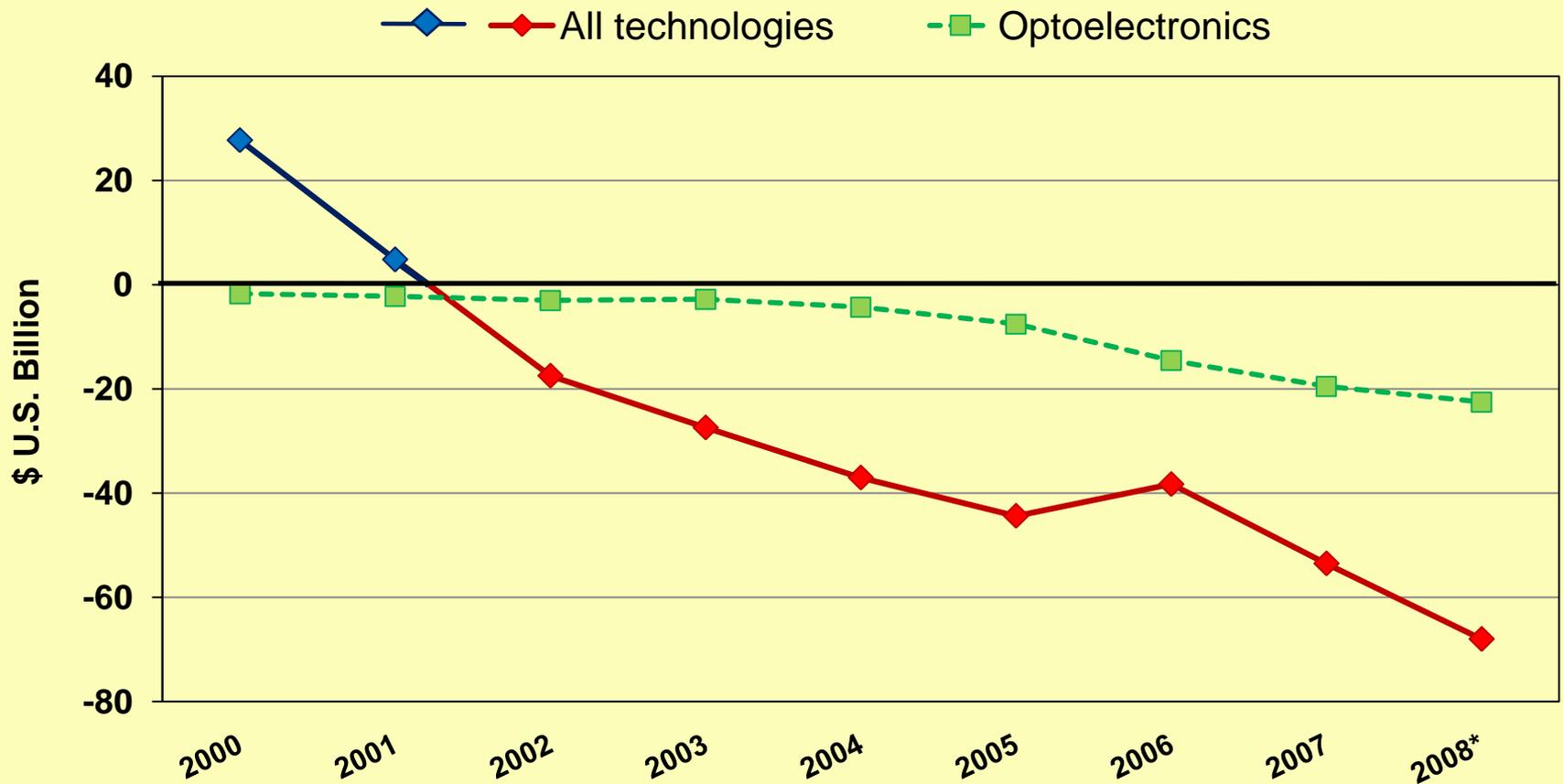


US Venture Capital Investment Trends

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U.S. balance of trade for "Advanced Technology Products"



source: US Census Bureau
2008* = projection

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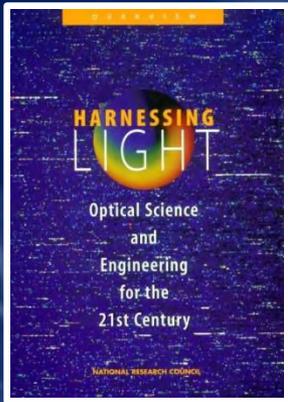
Top 10 High-Tech Exporters

Billions of 1997 USD: Council on Competitiveness

1986	2005
USA (\$65)	China (\$406)
Japan (\$53)	USA (\$284)
Germany (\$31)	Japan (\$212)
UK (\$24)	Germany (\$183)
France (\$14)	S. Korea (\$167)
Netherlands (\$9)	Hong Kong (\$157)
Italy (\$8)	Taiwan (\$145)
Switzerland (\$8)	Singapore (\$126)
Taiwan (\$7)	Malaysia (\$99)
S. Korea (\$7)	UK (\$95)

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EU study puts EU share of world photonics market, €228 billion in 2005, at 19%.
246,000 jobs

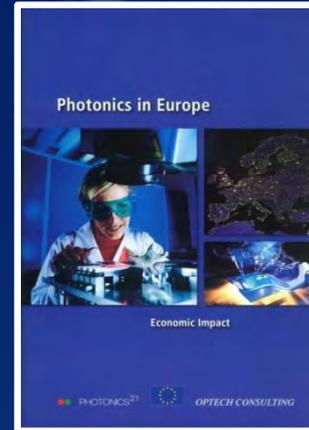


1998

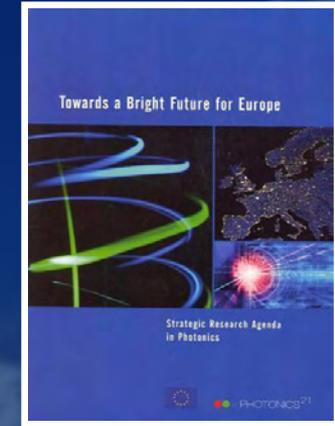
Focused German effort includes clusters, networks, and conference and trade fair support



2000



2008



2006

LIVRE BLANC SUR L'OPTIQUE

Bilan des forces et faiblesses de l'optique en France
Décembre 2003

ministère délégué
recherche et nouvelles
technologies

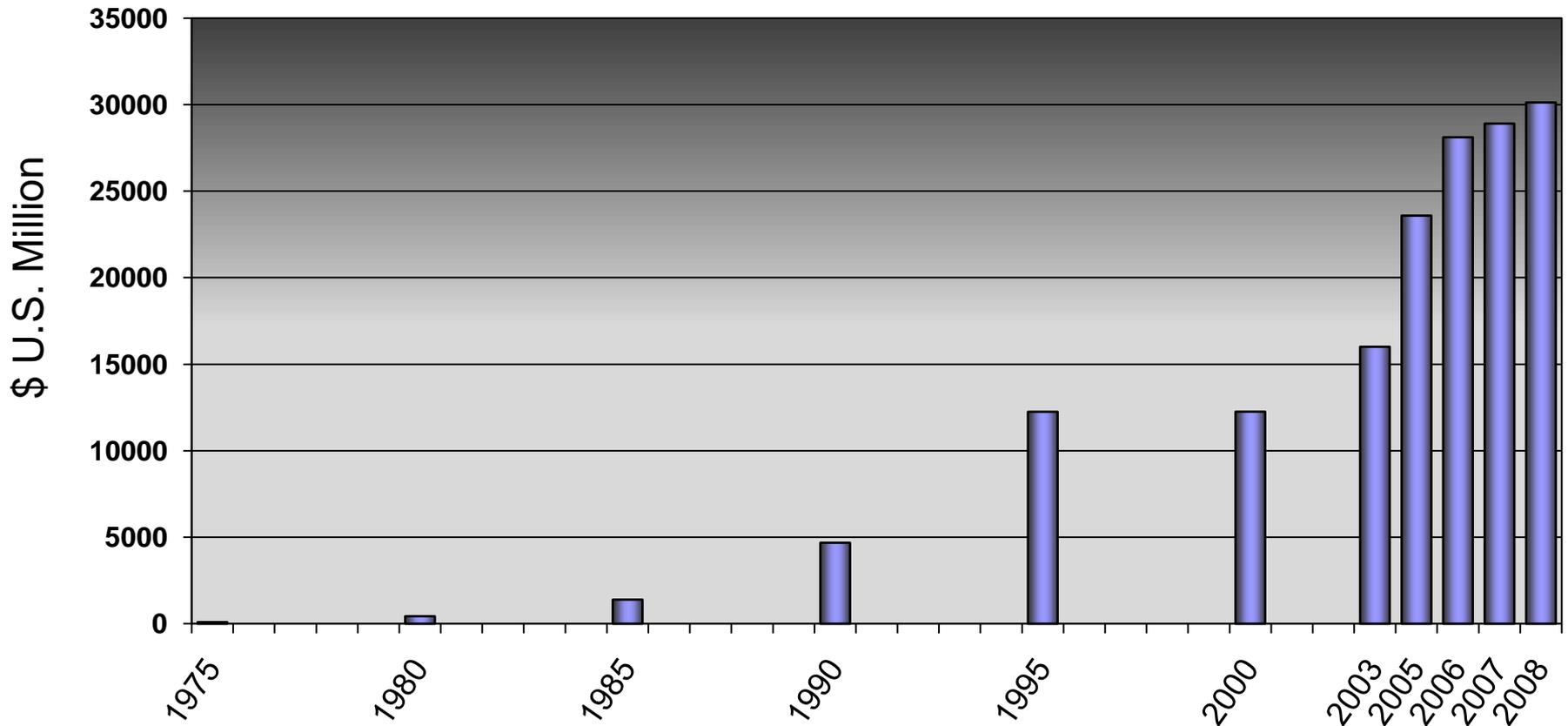
2003



2006

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Korea R&D Expenditure Growth 1975-2008



1960 ~ 70's

- Korea Institute of Science & Technology(KIST)(1966)
- Ministry of Science & Technology(MOST)(1967)
- Technology Development Promotion Law(1972)
- Korea Industrial Technology Association(KOITA)(1979)

1980's

- National R&D programs
Accreditation system of industrial R&D centers(1981)
- Industrial R&D support policy launched
 - Tax credit on R&D(1981), Military service exemption(1981), Customs duties credit(1983)

1990's

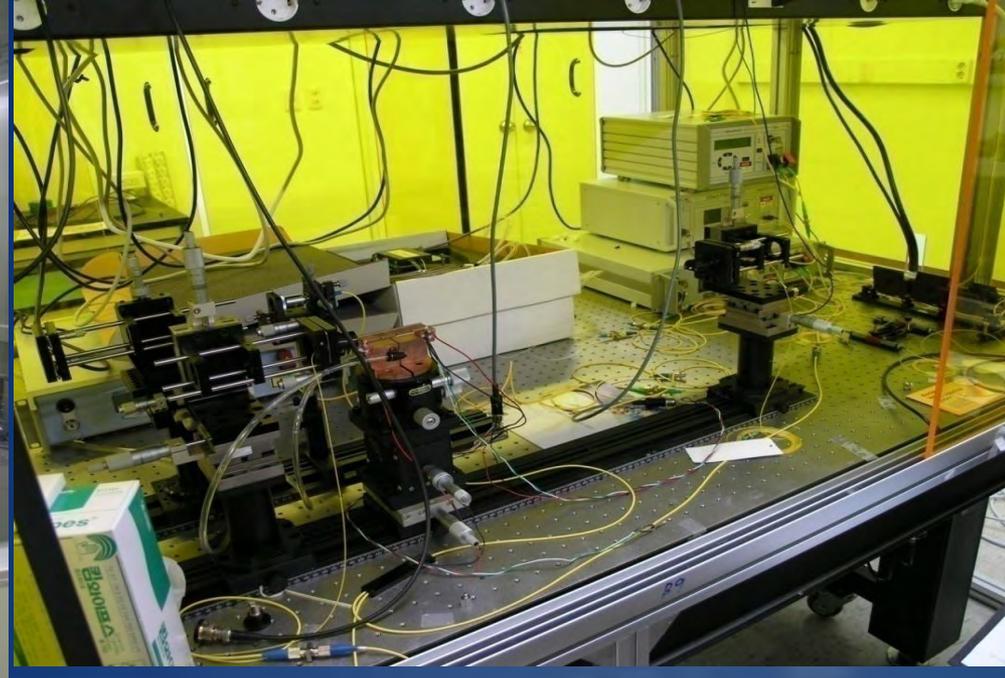
- Increase in the number of industrial R&D centers
- Industry-led NIS: over 75% of national R&D investment
- Industrial R&D restructuring : Asian Economic Crisis(1997)
 - Venture Promotion Act: Surge of Venture Companies' R&D centers

2000's

- Established world leadership in several areas: ICT, shipbuilding, automobiles, TFT-LCD, etc
- Increasing inflow of foreign R&D centers

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World class photonics
R&D in Gwangju –
strong funding; labs with
the latest equipment



Taiwan – focus on markets

Locations of Science Parks

Total : 3,746 hectares



2007 sales of
Science Parks
~\$62bn

Taiwan has a powerful
Ministry of Science and
Technology and National
Science Council

Controls research
funding and in addition to
detailed attention to the
national S&T
performance has a more
economic impact related
set of metrics



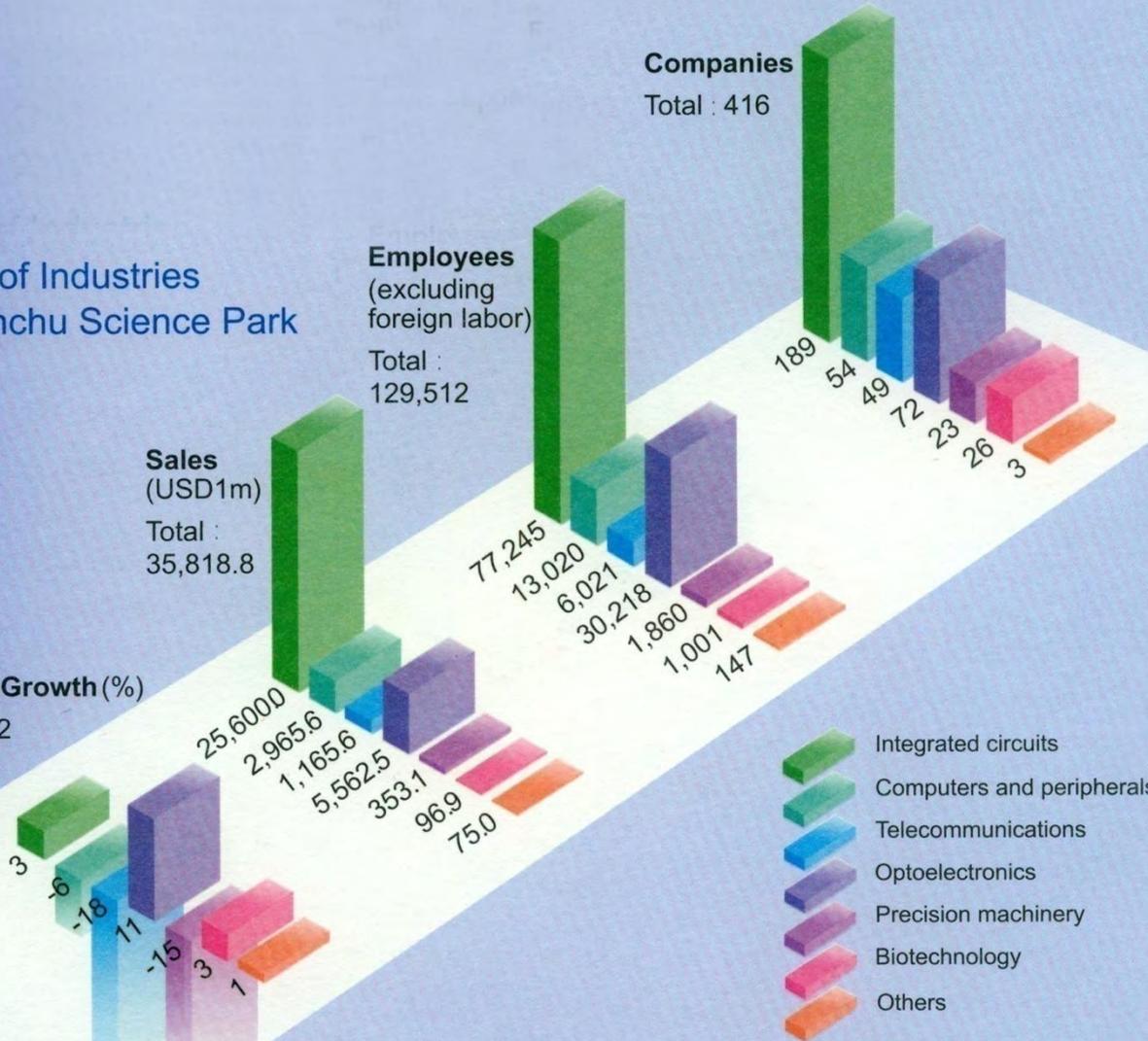
Overview of Industries in the Hsinchu Science Park 2007

Sales
(USD1m)
Total :
35,818.8

Employees
(excluding
foreign labor)
Total :
129,512

Companies
Total : 416

Sales Growth (%)
Total : 2





Key Factors for Rapid Growth of OP Industry in Taiwan

- **Policy** : Long-term strategic promotion from the government
 - Taiwan has developed photonics technology for over 20 years.
 - Taiwan government provides incentives for private enterprises to invest in the photonics fields.
 - The success of **Taiwan's** science parks.
- **Human Resources** :
 - **To recruit overseas Chinese talents**
 - Targeting experienced oversea Chinese engineers
 - **Systematic training of local scientists and engineers**
 - Providing resources for photonics-related programs and projects
 - **Development of related technical sectors**
 - Information technology, semiconductors, optics, materials and mechanical engineering, etc.
- **Venture Capital** :
 - **Strong VC investments and capital market**



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Semantics

“Designed by Apple in
California
Assembled in China”

NOT STATED:
Of components
manufactured in Japan,
Taiwan & China

Likely supplier Hon Hai, aka
Foxconn, a Taiwanese
company ca. \$52 bn
revenues, 450,000
employees mostly in China





SPIE Needed:

- a new US innovation ecosystem
- metrics for the 21st century



The Parking Lot at the Bell Labs, Holmdel during a Business day in 2006



"Basically, I set out to destroy the 'black box model,' which says technology magically appears and therefore all the government needs to do is fund basic research. It's okay [for the government] to fund some technology research if there is a social objective, so long as the social objective is anything but economic welfare. What we don't understand is that we can't depend on a few large companies and their research labs the way we did in the days of Bell Labs, GE, Xerox PARC and Sarnoff. Those days are gone and if you look around the world, you see more governments use proof-of-concept research built around the technology cluster model. Policy makers in the United States need to understand that is where the world is going and if we don't pony up we're going to be left behind. Europe took decades of sub par growth to finally wake up, but the jury is still out on us."Gregory Tasseley, author of the Technology Imperative

Aren't you listening?



Dr. John Marburger of the US OSTP
Science Advisor to the President,
May 2008

- Science competes for funding as part of a diminishing discretionary budget.
- Economic impact is a priority, along with health and national security
- ***Science must make its case –we have been very poor at this***



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“Intel is a global enterprise that doesn’t need the US any more. Lots of reports, no will to act. We continue to subsidize 19th century technology--like in the \$290 billion farm bill--rather than the 21st century technologies that will allow us to remain competitive. We're fat, dumb, and happy.”

Dr. Craig Barrett Chairman of Intel,
at NAE May 2008



Cartoon: Economist April 2008

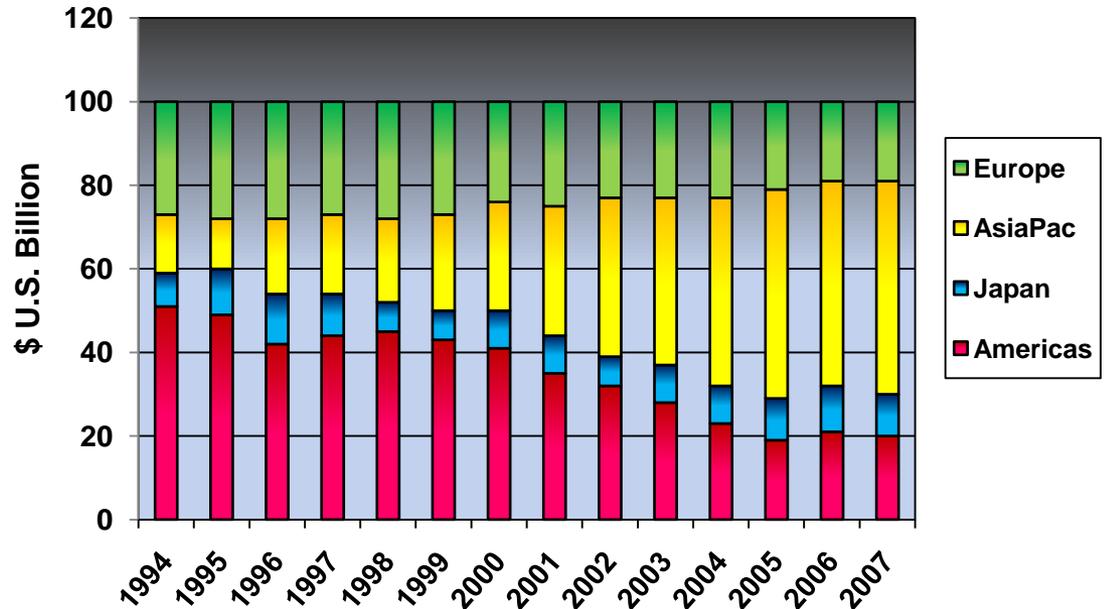
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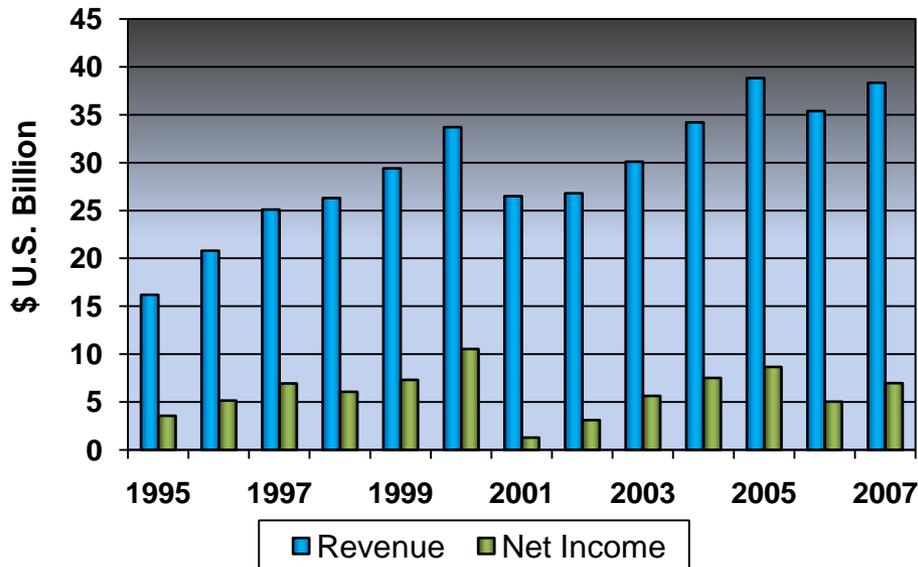
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Intel: 86,000 employees with >50% in the US. \$k 445 rev per employee

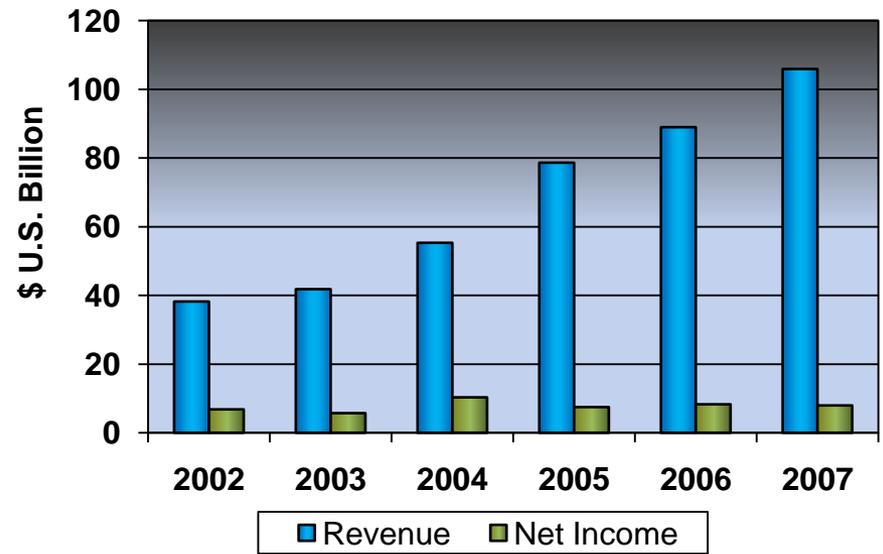
Source of Intel's Revenue by Geography



Intel



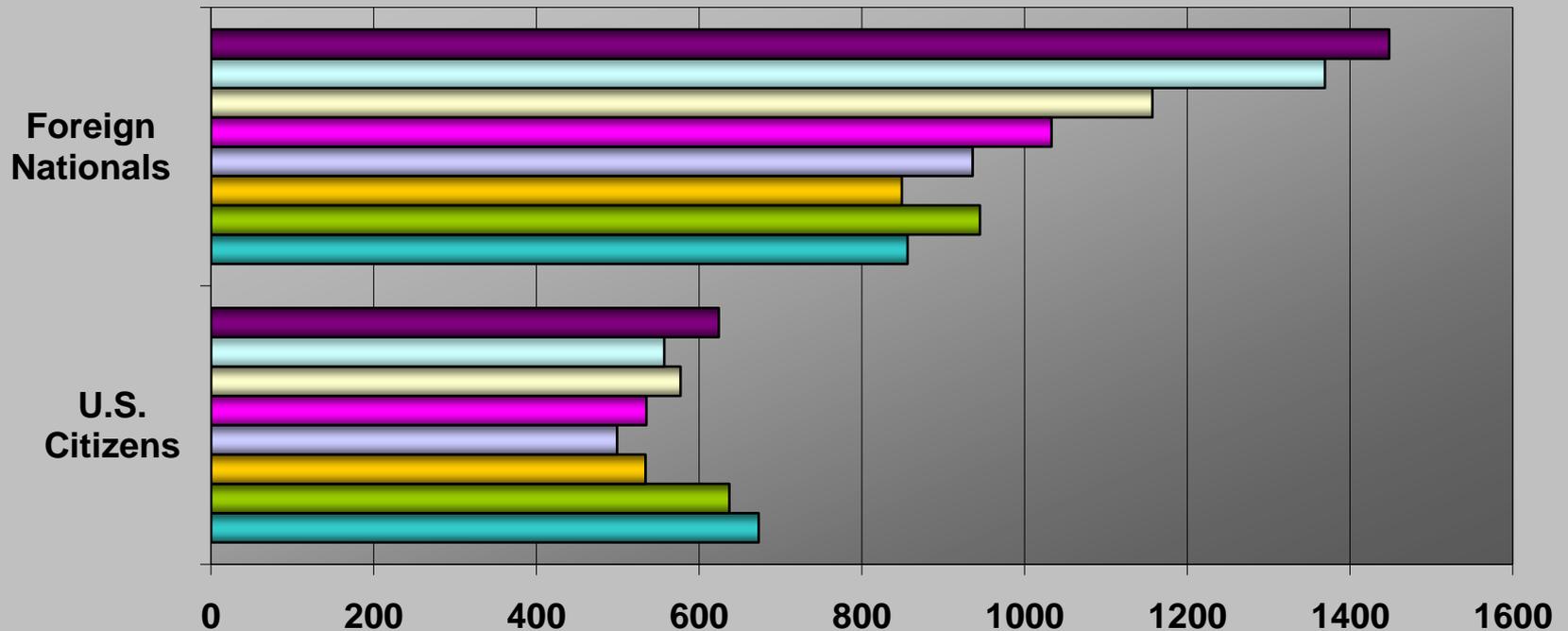
Samsung





EE PhDs in the U.S.

■ 2007 ■ 2006 ■ 2005 ■ 2004 ■ 2003 ■ 2002 ■ 2001 ■ 2000





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PISA Scores 2006

The triennial *Program for International Student Assessment* is sponsored by the OECD and tests 15 year olds. The 2003 study focused on “maths literacy”, the 2006 study focused on “science literacy”

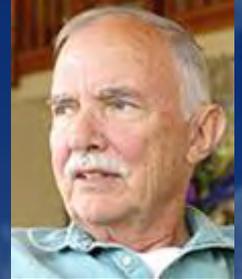
Finland	563
Hong Kong	542
Canada	534
Taiwan	532
Estonia	531
Japan	531
New Zealand	530
Australia	527
Netherlands	525
Liechtenstein	522
Korea	522
Slovenia	519
Germany	516
United Kingdom	515
Czech Republic	513
Switzerland	512
Austria	511
Belgium	510
Ireland	508
Hungary	504
Sweden	503
Poland	498
Denmark	496
:	
United States	489



Laissez faire is leaving US in the dust

“However the government continues to believe, wrongly, that market forces are sufficient to bridge the “valley of death” between basic research and commercial innovations without public policy support”

Lewis Branscomb, *Science*, August 2008



“The “science” is deafening. ... If current trends persist, the United States may well be on its way to become “America”, the land of the free and the home of the unemployed”

Norm Augustine. “Science” Editorial in AAAS Journal *Science*, 19th September 2008

Dr. Augustine was chairman of the U.S. National Academies committee that produced *The Gathering Storm* report in 2005

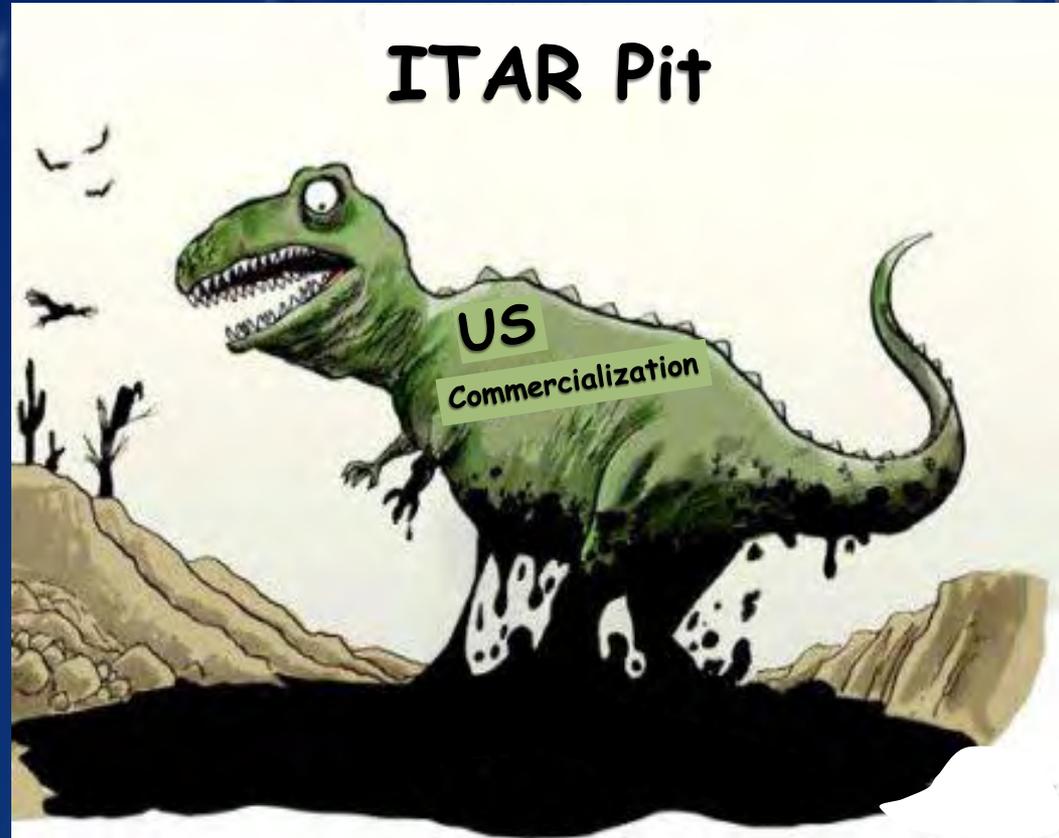




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Defense Related Trade Issues

- Wassenaar Arrangement
- ITAR
- CCL
- Deemed export
- Research exemption





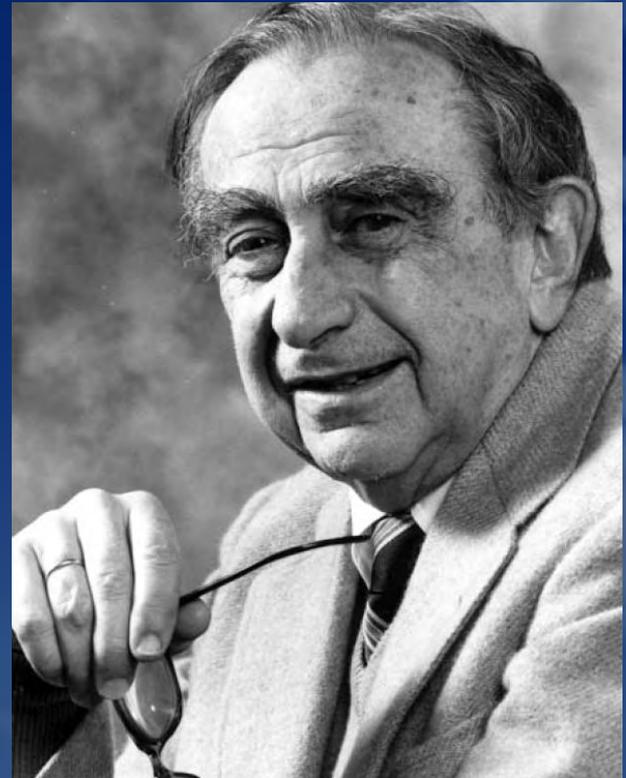
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ITAR

"We are drowning in secrecy -- to no purpose and to the detriment of science."

"We lead, not because we are better at keeping secrets but because we run faster"

"Secrecy, once accepted becomes an addiction"



Edward Teller, Father of the US H-Bomb.
(If he had tried to enter in 2008 he may not have gotten a visa)



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Thank You