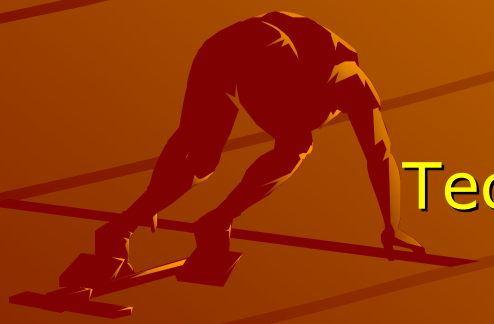
INCREASING THE VELOCITY OF INNOVATION

American Association for the Advancement of Science

2004 Forum on Science and Technology Policy – April 23, 2004



William B. Bonvillian

Legislative Director & Chief Counsel to Senator Joseph Lieberman

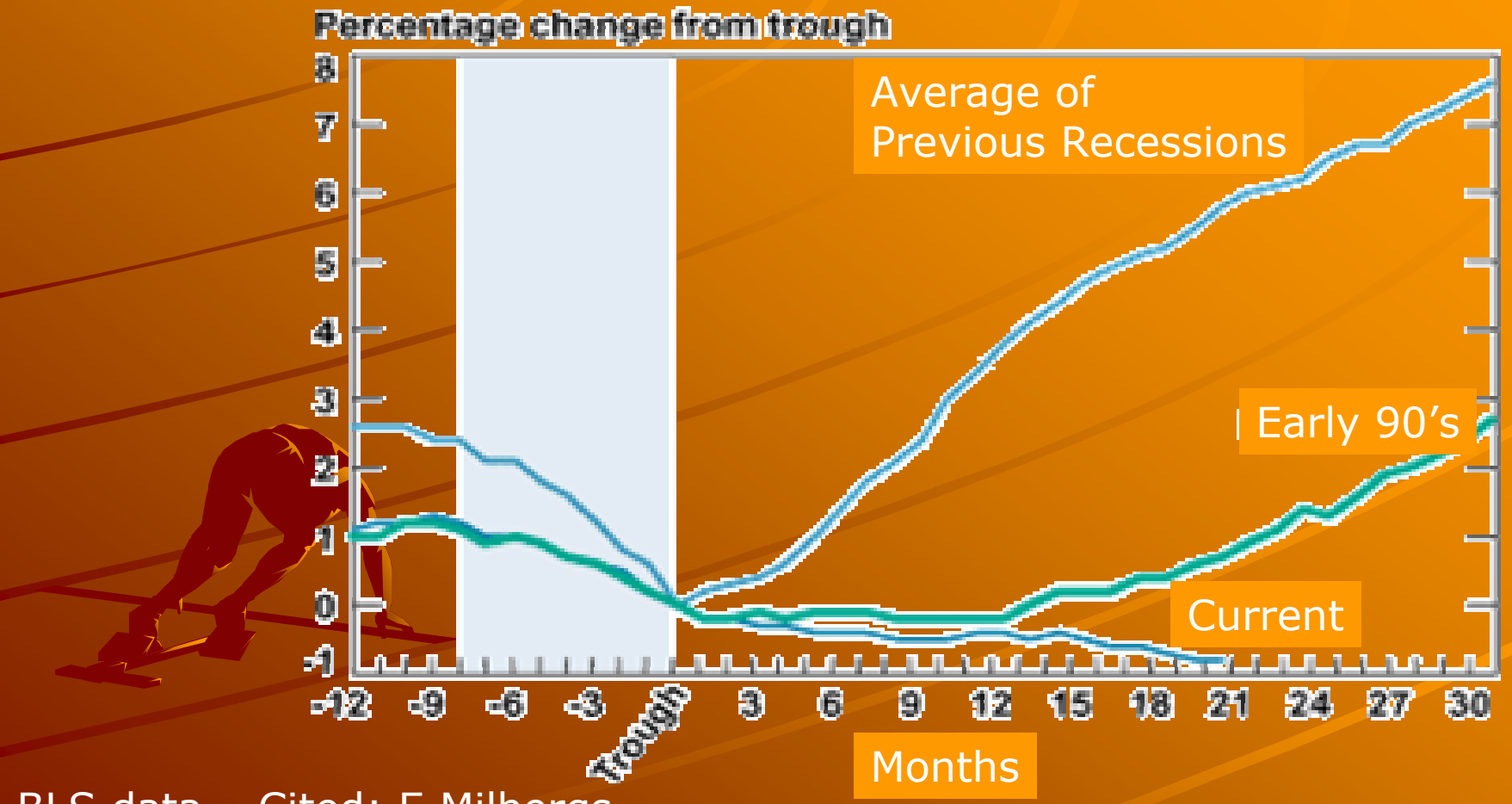
BACKDROP: Economic Realities Forcing New Public Policy:

Economy facing major structural changes –

- ----companies recover without creating jobs
- ----globalization challenges
- ----loss of mfg. & outsourcing IT services
- ----major demographic shift –
- ----what will a new economy look like?

threatening process…

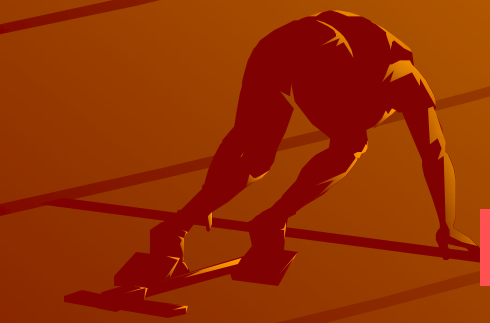
Payroll Job Growth in Recoveries

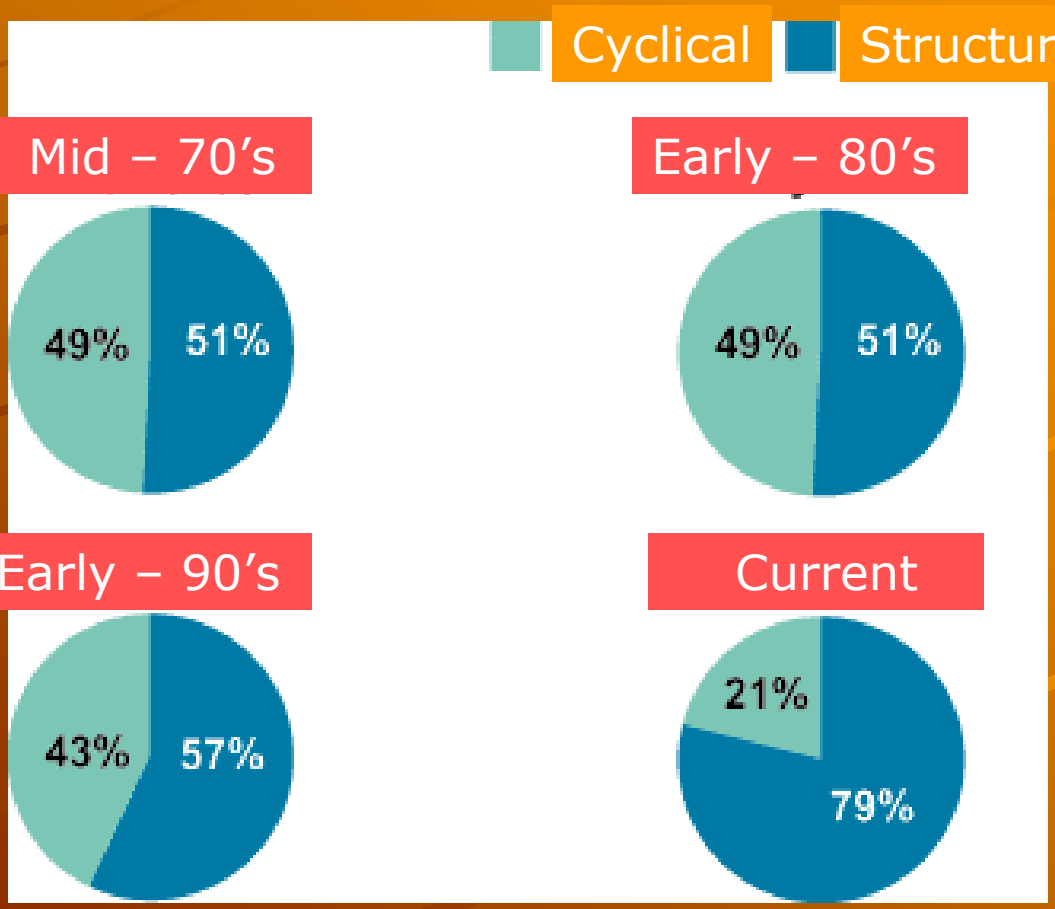


BLS data – Cited: E.Milbergs, Innovation Metircs, NII, 1/2004

Sources: U.S. Bureau of Labor Statistics; authors' calculations.
Note: The shaded area indicates the length of the 2001 recession.

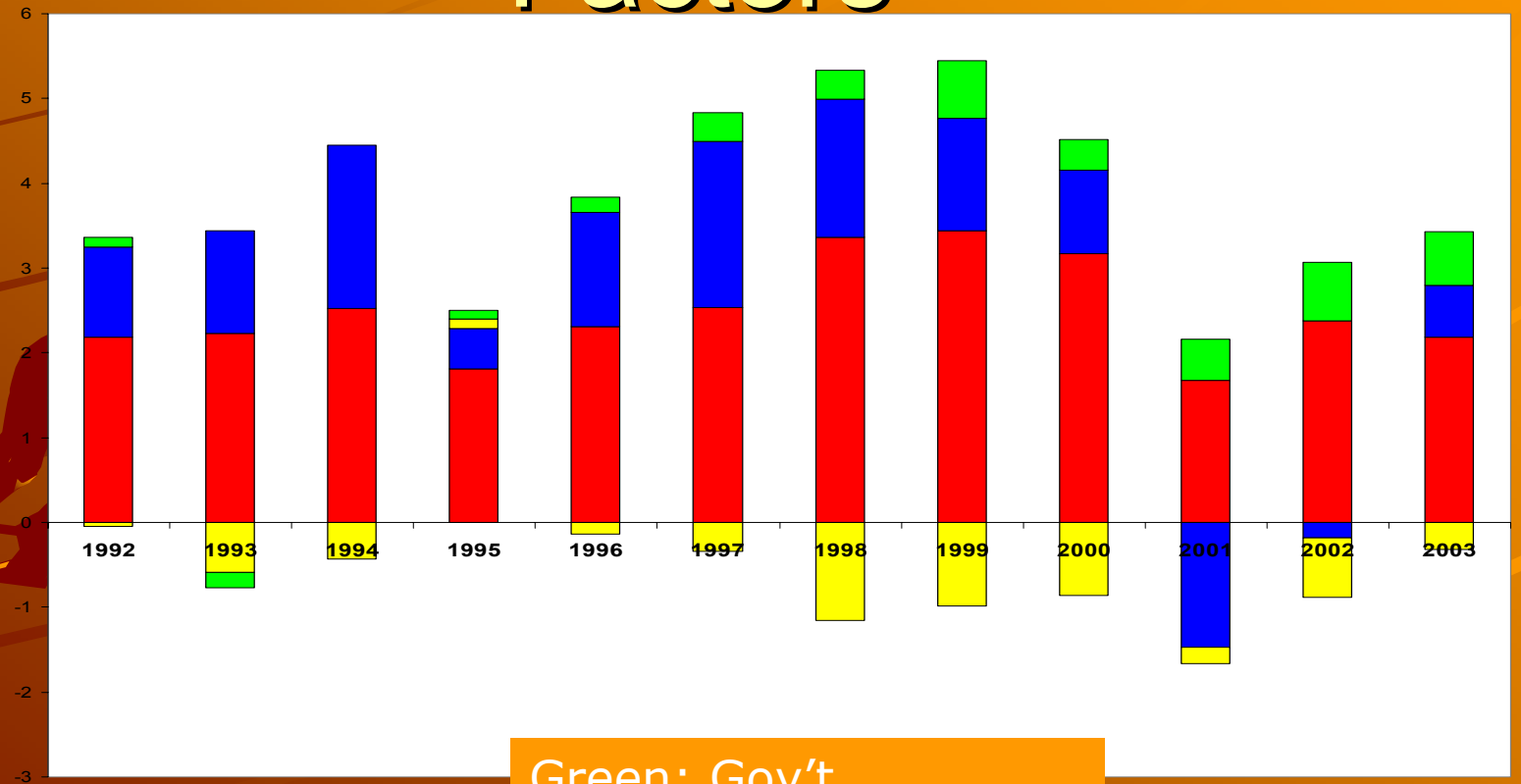
Number of Jobs Lost to Structural vs. Cyclical Change in Recessions





BLS Data; Cited In E.Milbergs, Innovation Metrics,NII, 1/2004

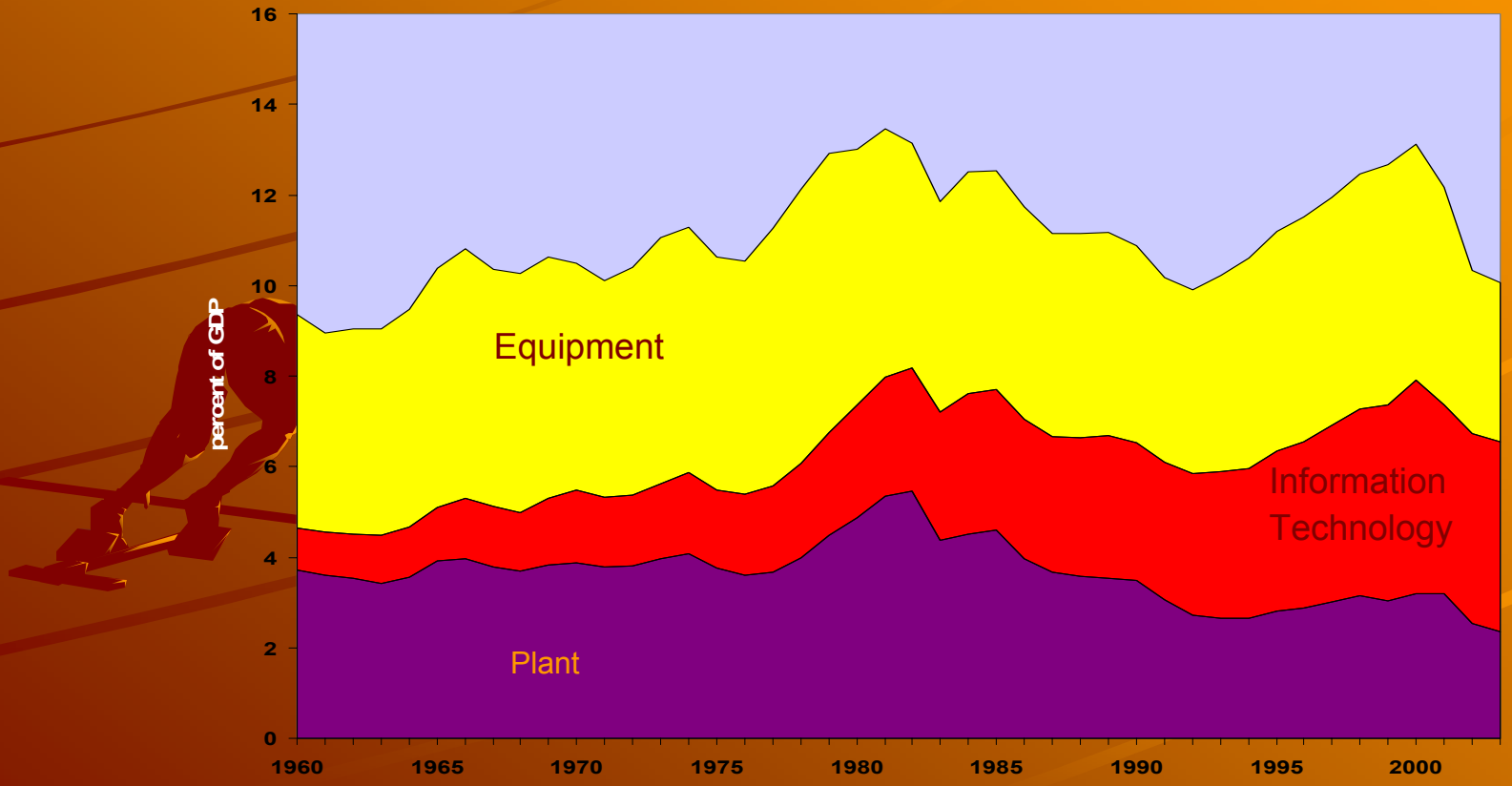
Contribution to GDP Growth: Business Investment vs. Other Factors



Source:
Dr. H. Rosen, 3/04

Green: Gov't
Blue – Business Invest.
Red - Consumption
Yellow: Trade

Investment in Plant, IT and Equipment 1960- 2003



Source: Dr. H. Rosen, 3/2004

Competitiveness Agenda Is Back on the Front Burner:

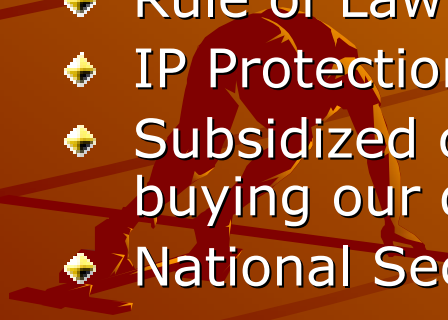
Our Competitiveness Agenda Then:

- Rode on New Innovation – IT Revolution
  - Computing and it's internet application
  - We kept Computing: Sematech and chip leadership, with Moore's Law as driver; added internet application
- Trade: unwilling to sacrifice auto sector, so import quotas and US production for Japan
- Grew Venture and Angel capital – provided fuel for entrepreneurs and innovations
- Were the 90's real? Real productivity gains
- Translated into widespread societal gains – real income gain, record homeownership, etc.

COMPETITIVENESS THEN AND NOW:

Japan:

- High-value, high-wage, advanced tech - "just like us"
- We have entrepreneurial advantage, they have Industrial Policy advantage
- Rule of Law
- IP Protections
- Subsidized currency, buying our debt
- National Security: allies



China: New Mix

- Low-value, low-wage, advanced tech
- Entrepreneurial
- Using Industrial Policy
- Limited Rule of Law
- IP Theft model – FBI: $300b/year
- Subsidized currency, buying our debt
- Nat'l security – peer competitor

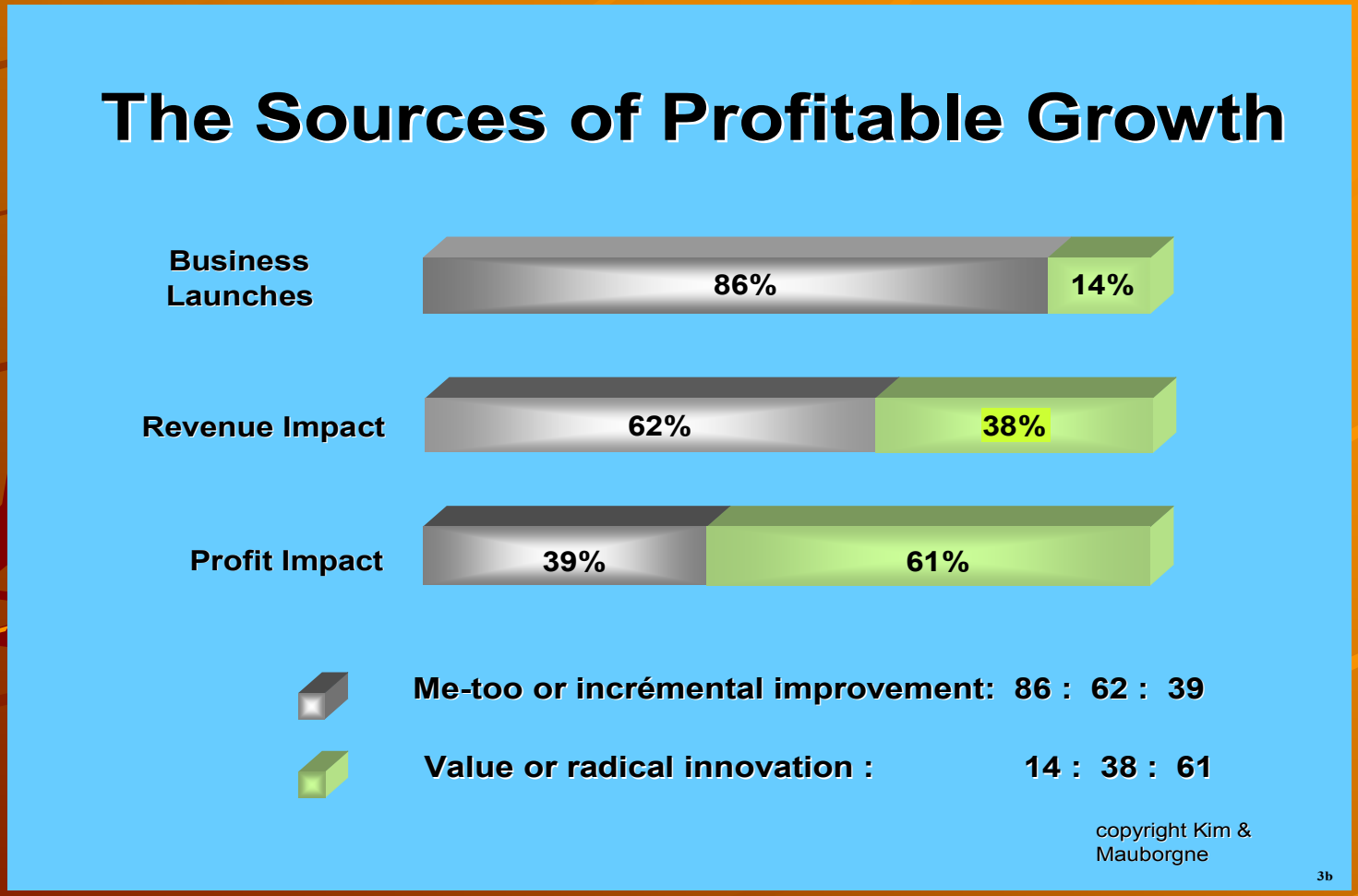
Economic Growth Theory

- Theory emerged in last Competitiveness period
- Economic Growth theory: Tech Innovation is key to 50+% of economic growth: Robert Solow, Nobel Prize
  - Railroads, electricity, telecomm, aerospace, computing, etc.
  - Develop Breakthrough – pile on applications, grow productivity throughout economy
- More important than traditional economic focus on Labor, Capital
- Federal role: R&D and educating/training talent
  - Also: fiscal & tax policy, standards, tech transfer, trade policy, procurement, intellectual property, legal system, regulation, antitrust, export controls, etc.
- No detailed measurements for tech innovation –few detailed benchmarks yet – only macro numbers
- 2 key macro factors: Feds supply about 2/3's of the R in R&D; fund much of sci/tech education

Classical vs. Growth Economics

- CLASSICAL: Mankiw, CEA: "Outsourcing is just a new way of doing int'l trade. More things are tradeable than in the past and that's a good thing…a plus for the economy in the long run"
- GROWTH: Clayton Christenson – "Destructive Technologies": low end entry and capability fuel the capacity to encroach into higher end markets (the Corolla to Lexus)
- Michael Porter: "If high-productivity jobs are lost to foreign rivals…long term economic prosperity is compromised"
- It's Location, Location, Location: "Clustering" of competitive circumstances "spurs upgrading by stimulating diversity in R&D approaches and providing a means for introducing new strategies and skills" – Porter
- John Zysman – "manufacturing matters" even in the information age - advanced mechanisms for production and the accompanying jobs are a strategic asset whose location can make a nation "an attractive place …to create strategic advantage"

Radical Innovation Yields Disproportionate Profit Impact



Kim and Mauborgne, Harvard Bus. Rev, 1/97,
Cited: E.Milbergs, Innovation Metrics, NII, 1/2004

WHAT'S THE POLICY RESPONSE?

- GROWTH ECONOMICS: INNOVATION IS THE BIG FACTOR IN GROWTH
- ONLY ONE MOVE: INNOVATE OUR WAY TO CONTINUING COMPETITIVE ADVANTAGE
- NEED TO INCREASE VELOCITY OF INNOVATION – THE SPEED WE BRING ON INNOVATIONS, SHORTEN THE INTERVALS, AND ASSUME WE CAN RETAIN COMPETITIVE ADVANTAGE FOR A PERIOD OF TIME
- Focus of following slides: MAJOR FEDERAL INPUTS TO THE INNOVATION SYSTEM…

FEDERAL INNOVATION CHALLENGES: 6 BASICS

Q: How do we make an innovation revolution if we don't have the metrics and benchmarks we need?

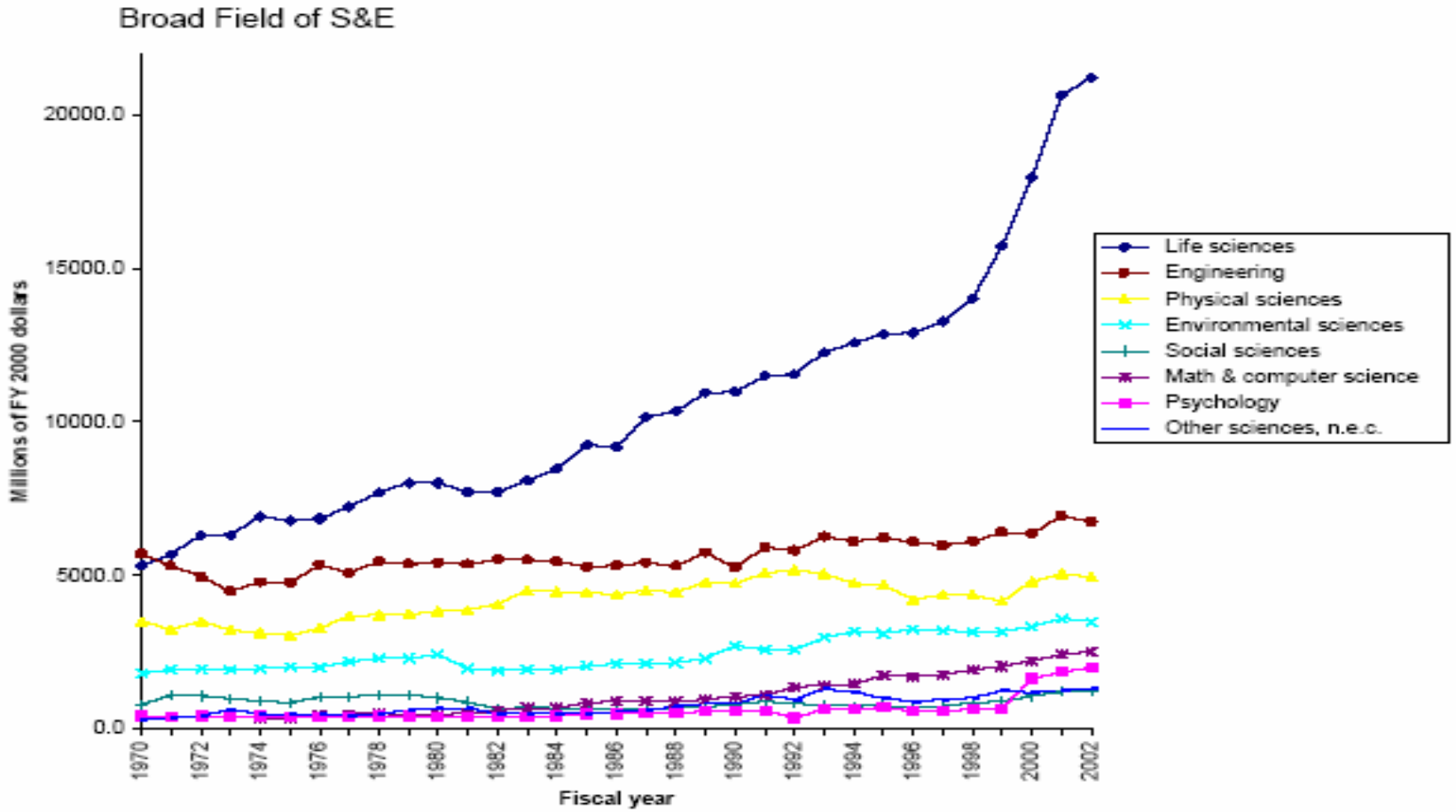
LOOK AT FED ROLE MACRO FACTORS:

- **R&D FUNDING**
- **TALENT**
- **ADVOCACY**
- **SCI/TECH ORGANIZATION**
- **INFRASTRUCTURE**
- **MANUFACTURING**

I. FEDERAL RESEARCH FUNDING:

FEDERAL R&D FUNDING PRIORITIES

Composition of R&D Funding Has Shifted To the Life Sciences

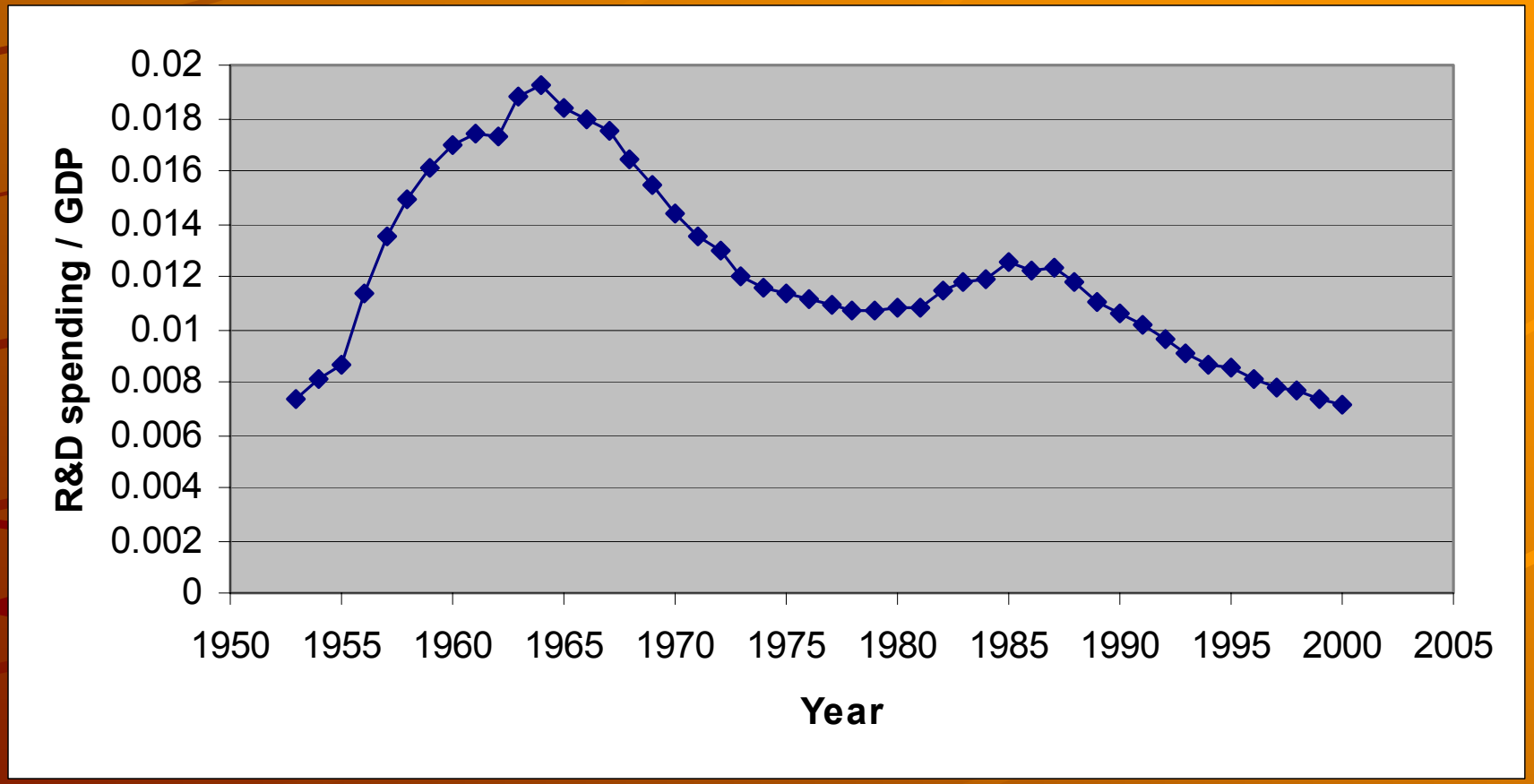


NOTE: FY 2001 and 2002 data are preliminary.

SOURCE: RAND, based on NSF, Federal Funds for Research and Development: Fiscal Years 2000, 2001, and 2002; and Federal Funds: Detailed Historical Tables: Fiscal Years 1951–2001.

Rand, based on NSF data; cited: E.Milbergs, Innovation Metrics, NII, 1/2004

Federal R&D Spending As a Percent of GDP



Source: NSF R&D and BEA GDP data

I. FEDERAL R&D FUNDING:

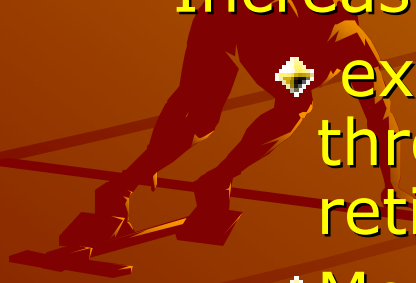
FEDERAL R&D ROLE DECLINING:

Federal share of R&D as % of GDP in decline

- Life science (NIH) –doubled ’98-’03, near $30b
- Physical science research continues decline as % of GDP

R&D FUNDING CAPACITY THREATENED:

Increasing pressure on Federal budget



- explosive short term debt -$500B deficits through decade, then baby boom retirement
- Medicare Trustees estimate $70 Trillion present value of federal unfunded liabilities
- Taxation capacity may be politically broken
- No science advocacy system to offset these trends

FY '05 EXAMPLE: BLEAK HOUSE/BLEAKER SENATE

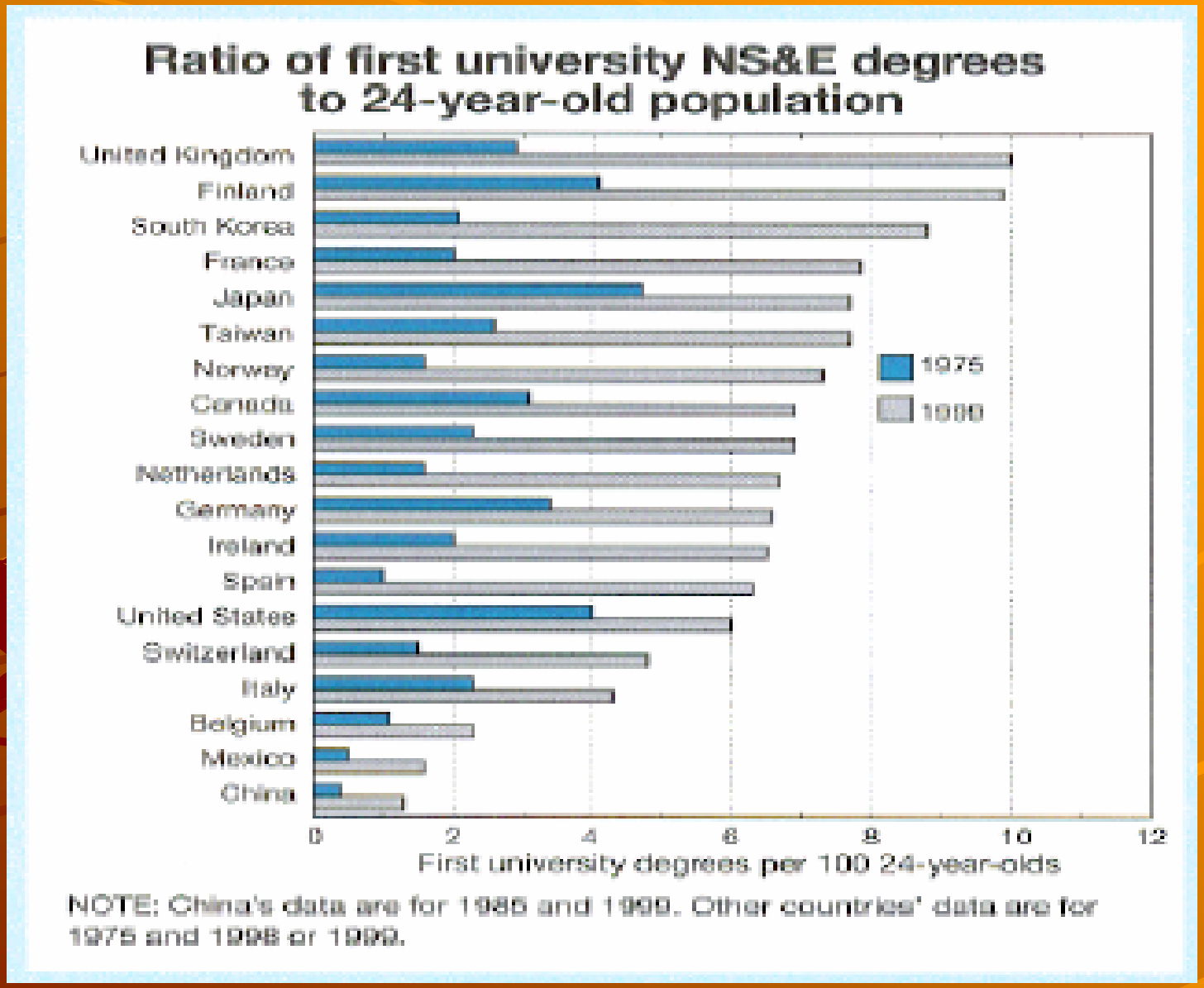
- '05 Budget Deficit projected to be $521B (last year: $347B), not including $50-80B Supp'l for Iraq
- Budget Resolutions will freeze domestic spending at '04 levels
- Huge Deficits forcing fundamental Cong'l processes to end:
- Budget process discipline already gone – paygo effectively ended
- End of Appropriations? – no approp's bills except Defense, Homeland, Milcon – Continuing Res. until after elections

OPTION: FUND NICHE R&D?

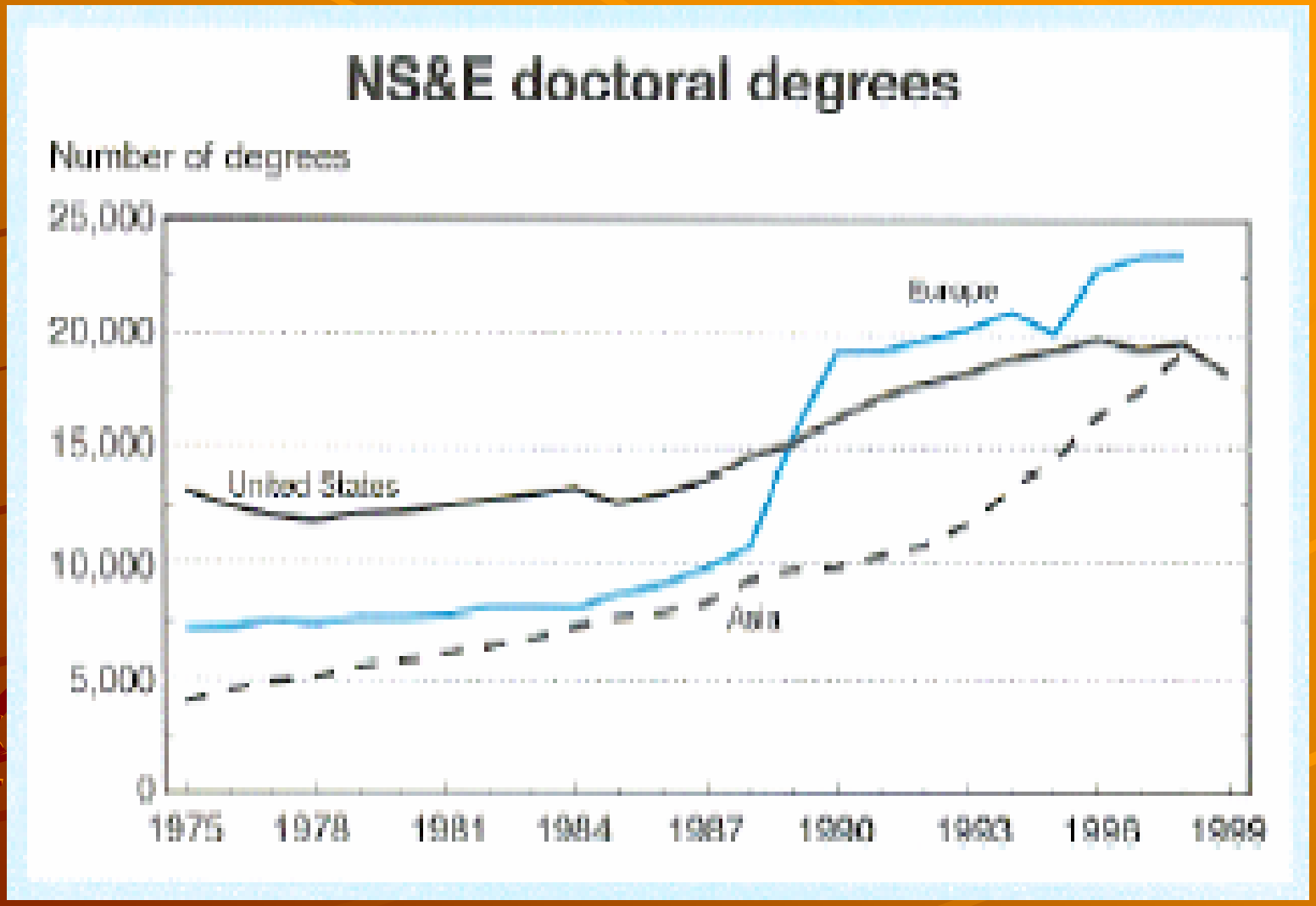
- Example of niche funding : nanotechnology funding, now $1b/year
- Niche R&D is risky – the research phase of R&D is high risk and payoffs unpredictable, which is why business can't fund – historic US pattern is fund a broad front of R&D
- But: with limited federal capacity we may no longer able to fund the broad front R&D process
- If so, have to get much more sophisticated at the risk selection process

II. TALENT:

- Prospector theory: # of prospectors impacts number of finds
- Don't fit your talent base to your economy; your talent base sizes your economy – it's dynamic
- Total # overall US degrees increased between '90 and '00
- But: science/engineering degrees declined same period



NSF, Indicators, 2002 –
Cited in E.Milbergs, Innovation Metrics, NII, 1/2004



NSF Indicators, 2002 – Cited, E. Milbergs, Innovation Metrics, NII, 1/2004

TALENT, continued

EDUCATION:

- No Child left Behind: major K-12 accountability/performance reforms; req'd "science-based reforms" 111 times -passed '01–but not funded –under systematic local attack as unfunded mandate
- Tech Talent bill: raise number of undergrad sci/tech degrees– passed '02 - but funding only $25m
- Declining federal R&D will reduce physical science degrees – direct tie to grad degrees

TALENT FROM ABROAD:

- Key to US tech leadership equation for a century
- But H1-b's, visa's down, and not staying
- Need to reverse disincentives, keep talent

III. ADVOCACY:

- KEY TO FEDERAL R&D AND TALENT FUNDING

  LIFE SCIENCES
  - Effective integrated industry, academia, grassroots effort
  - NIH funding tripled since early ’90’s

  PHYSICAL SCIENCES
  - Defense R&D has declined; not altered by big defense increases of last two years
  - Industry? Academia/Science Societies? Grassroots?
  - Limited advocacy effort

IV. ORGANIZATION:

- Organization equals delivery of science into economic and societal missions
- US - has same organizational structure since 1950
  - linear innovation replaced by dynamic model
- Science/Tech enterprise far more complex:
  - Not solo inventors – complex organizational networks with industry, univ's, gov't research
  - Networks for knowledge diffusion, knowledge application, collective learning
  - Need new models for Collaborative Science: Cross-discipline, cross-agency, cross-sector

V. PLATFORMS/INFRASTRUCTURE

- Tech seeds have to land on plowed fields ready for them – What are the platforms, the infrastructure that new innovations will land on? Ex.- Internet landed on computing
- IT revolution is only begun – to continue it needs extremely high speed BROADBAND
- DOD is building the GIG worldwide fiber optic/wireless – parallel system?

WHAT ARE OTHER INNOVATION PLATFORMS?

- DOD played historic platform role in computing/internet – but it is recapitalizing plant now and its new systems evolve glacially: 25 years
- But DOD's Networkcentric dictum suggests new needs – wireless R&D at fiber speeds?
- Aerospace: 7e7? Air Traffic Control?
- Green energy systems?
- Biotech – doesn't really affect productivity of economy, but could land on a sound Prescription Drug bill, socialized medicine
- Nano – could land on everything, from health care to manufacturing to defense – but have to do tech transition process
- RULE: NO PLATFORM NO INNOVATION

VI. MANUFACTURING

- Manufacturing Matters:
  - 90's – mfg. was 16% of economy but contributed 30% of US economic growth
  - Mfg. provides higher paying jobs – 23% higher than services – but we've lost 29m mfg. jobs since '01, the major factor in recession
  - Average mfg. job creates 4.2 jobs throughout the economy, 3x business/personal services
  - BEA "multiplier effect" – growth in one sector influences others – 2.43 multiplier for mfg, 1.5 multiplier in business services
  - Mfg is the currency of global economy – but US trade deficit in goods: $482b in '02 and growing (contrast: 1991: $67b; 1981: $22b)
  - Trade deficit with China - $120b for '03
  - Mfg. is close to innovation stage – key implementing player in innovation process

MANUFACTURING, continued

- **How can we stay in manufacturing? Innovate the Process**
- **Revolution in Manufacturing** – distibuted mfg., desktop mfg., small lot production as cheap as mass production,revolutionary materials, nano mfg. technology
- DOD has big stake in retaining US manufacturing capacity
  - DARPA agreementwith Mantech/Services for advanced mfg. R&D process
  - Mantech pilots for initial production for DOD production plants – testbeds/platforms
  - Manage the IP of results

INNOVATION VELOCITY SUMMARY:

- Need metrics to measure innovation strategies
- R&D Funding Challenge – face dark Federal budget picture for fed. R&D role
  - Niche R&D – how to make good picks?
- Must reverse funding and talent problems for physical science – affects all science
- Won't do much of anything without improved advocacy model
- Need new organizational models for cross- discipline, cross-agency work and to integrate innovation stages
- Need platforms for innovations to land on
- Need stronger manufacturing sector as innovation ally