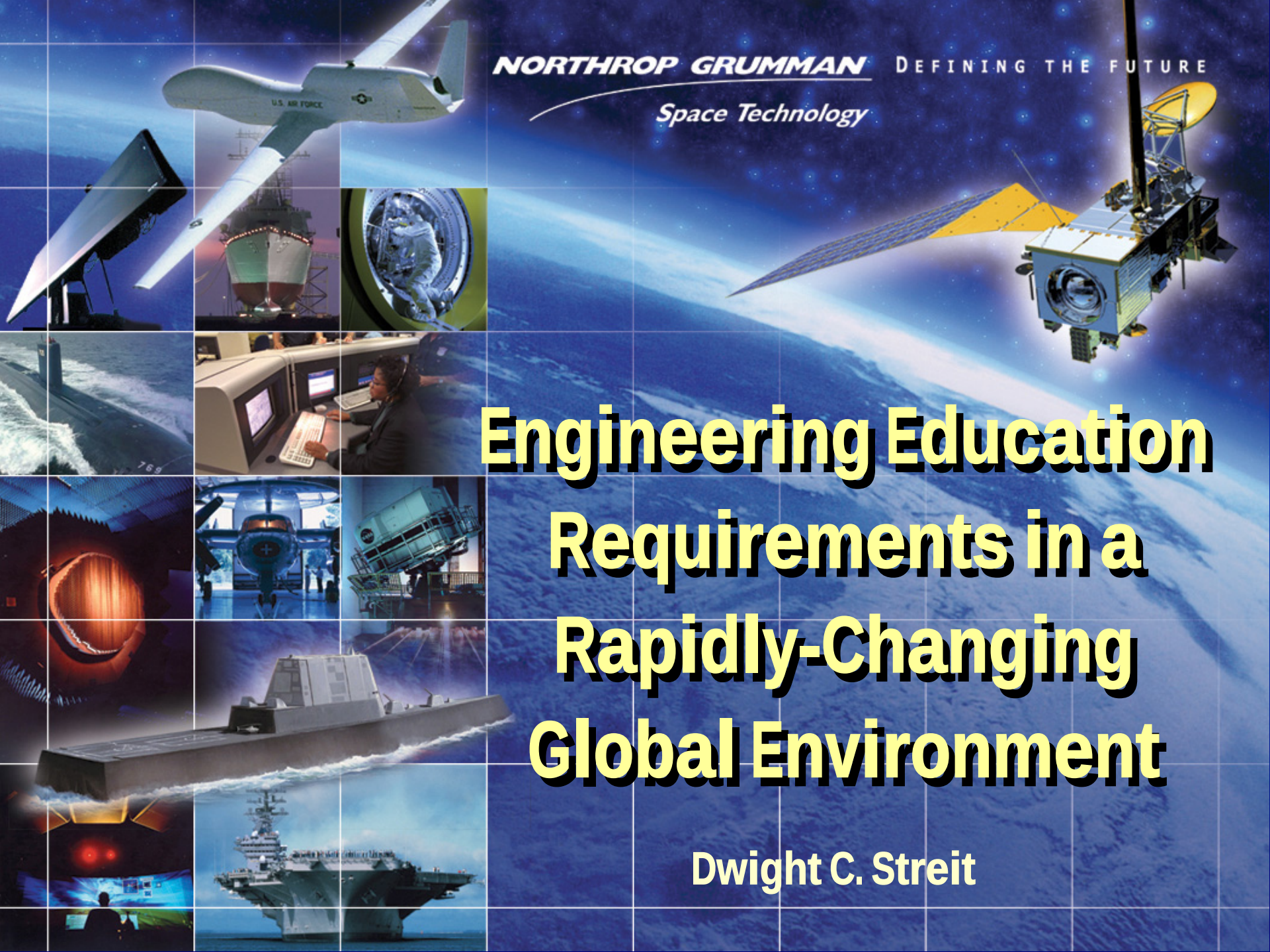


Engineering Education Requirements in a Rapidly-Changing Global Environment

Dwight C. Streit

Outline

- Northrop Grumman Overview
- Engineering Education Infrastructure Issues
- U.S. Engineering Leadership
- Aerospace Engineering Pressures
- Engineering Career Options
- University Research Importance
- Engineering Education Collaboration

Northrop Grumman Corporation

Electronic Systems

- Airborne Radars
- C4ISR
- Electronic Warfare
- Navigation & Guidance

Information Technology

- C4ISR
- Government IT Infrastructure
- Information Security/ Assurance

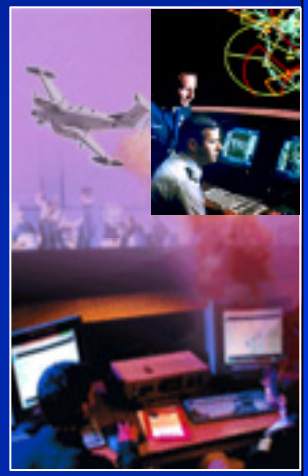
Integrated Systems

- Tactical Aircraft
- Long Range
- Unmanned
- Airborne Early Warning & Surveillance

Ship Systems/ Newport News

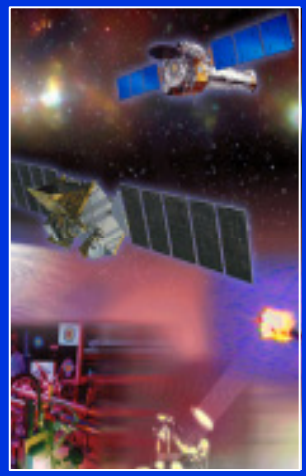
- Naval Systems Integrator
- Aircraft Carriers
- Attack Submarines

Mission Systems



- Command, Control and Intelligence
- Digitized Battlefield
- ICBM Systems Integration

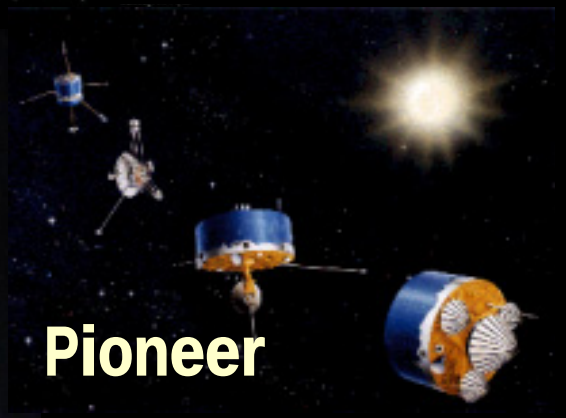
Space Technology



- Intelligence, Surveillance, Reconnaissance
- Electronic Systems
- Military Satcom
- Scientific Satellites
- Software Radios

$30B Company with 125,000 People
All 50 States and 24 Foreign Countries

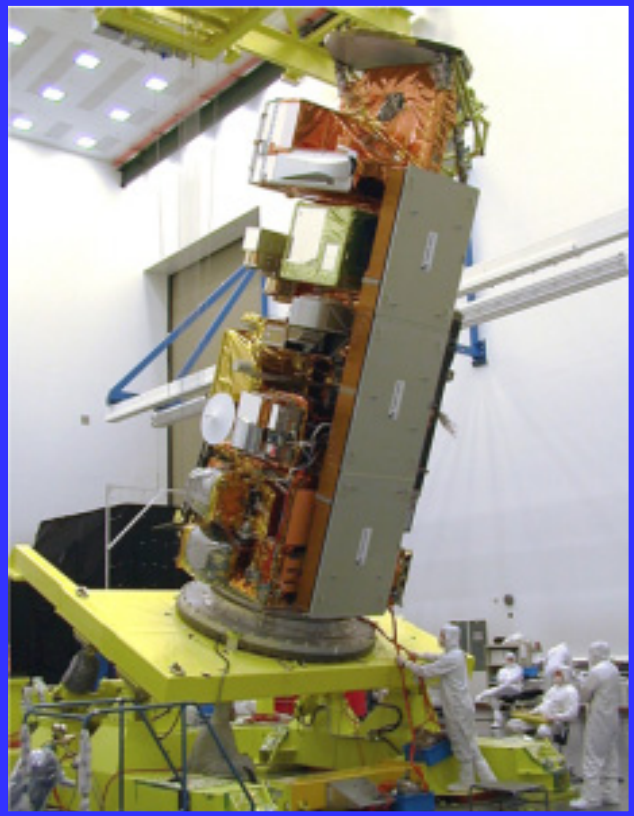
STL → TRW → NGST
Space Technology Since 1957



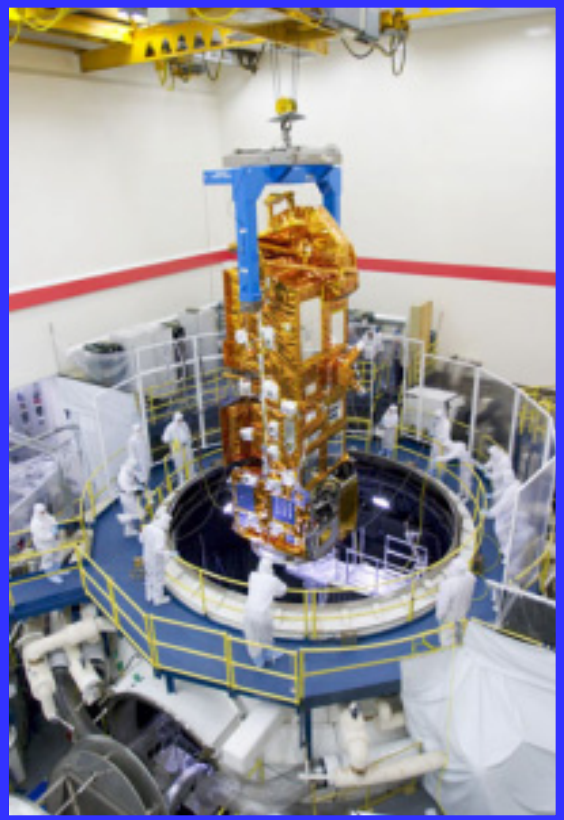
Recent Space Technology Satellites for NASA

Chandra
X-Ray Telescope
Launched 1999

Aqua
Earth Observing Satellite
Launched 2002



Aura
Earth Observing Satellite
Launched 2004

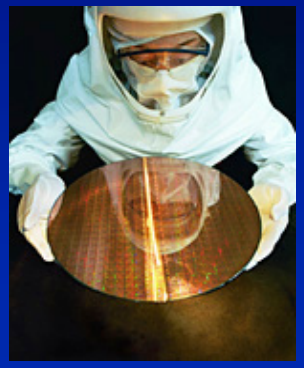


Engineering Education Infrastructure Issues

- Offshore movement of high technology resources
  - Semiconductors, chemicals, IT, services
- Education infrastructure problems
  - Middle and secondary school pipeline
  - U.S.-based engineering enrollments

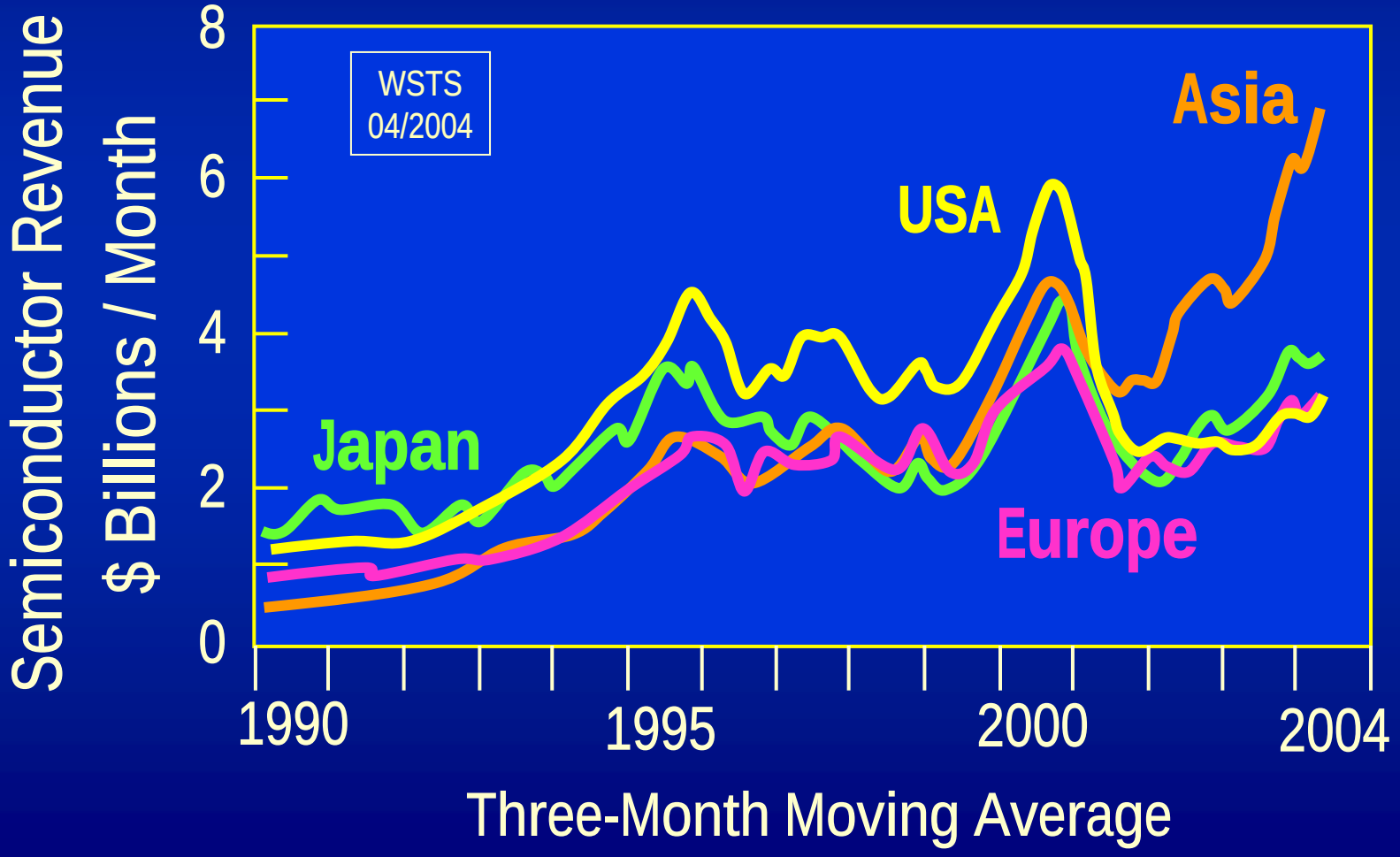
- Immigration issues
  - Reduced foreign applications to U.S. graduate schools
- Future aerospace workforce
  - Fewer graduates aggrevated by upcoming retirements

Semiconductor Fabs Migrating Offshore



- Semiconductor fabs moving to Asia
  - Design services now also in transition
  - R&D will follow design & manufacturing
- Negative impact to U.S. engineering leadership
  - Semiconductors remain a critical enabling technology
- Future impact to government and aerospace
  - Microelectronics leadership is key to national defense
  - Access to specialized chips may be affected
  - Impact is near but not yet hard felt

Semiconductor Leadership Moving to Asia



Off-Shore Movement of Chemical Plants

- Chemical manufacturing moving from U.S. to Asia
  - Over the past ten years, few new plants built in the U.S. but hundreds built in China
- This is an ominous sign
  - Technology follows manufacturing
  - U.S. chemical leadership at risk

- Future impact to government and aerospace
  - New chemicals enable new high tech materials
  - Chemical access in times of need may be impacted

Increased Demands on Energy Production

Oil Discovery

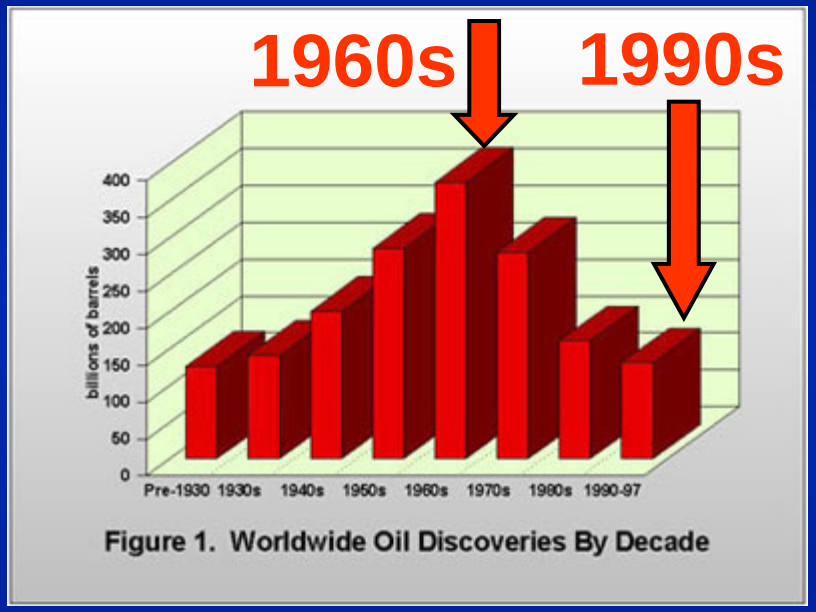


Figure 1. Worldwide Oil Discoveries By Decade

Oil Production

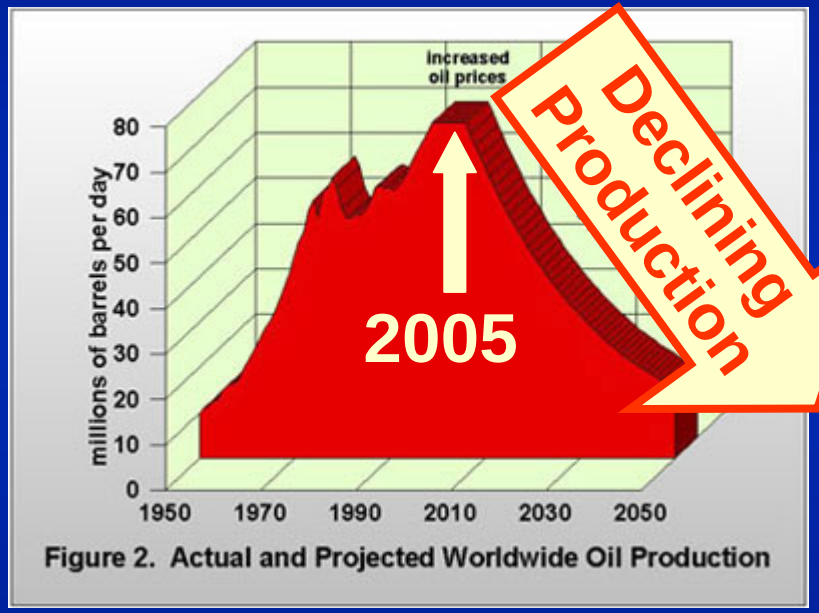


Figure 2. Actual and Projected Worldwide Oil Production

"New assessments of global oil reserves show the world faces a relentless oil-supply crisis within the next ten years."

Hunter Herron, President, Petroleum Equities Inc. (July 2000)

Erosion of U.S. Leadership in Engineering

- Lack of federal investment in basic research
  - Fundamental change with long-term implications
- Investment shift from engineering to biology
  - STEM investment has remains virtually flat
  - Bio investment has doubled over past ten years
- Restrictive immigration policies
  - Foreign applications to US graduate schools down 28%
  - Applications from China down 45% in 2004
  - Unintended consequence: retained talent abroad

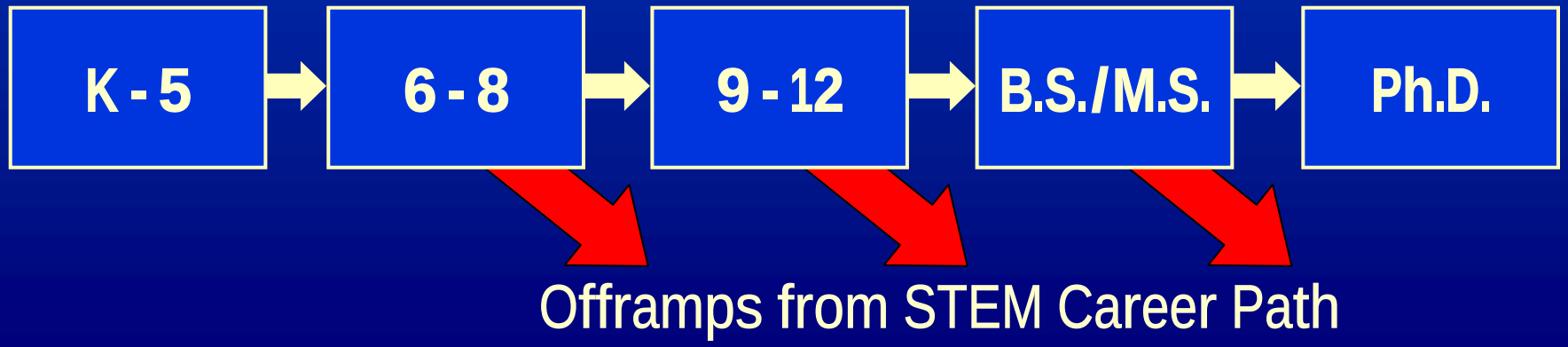
Lamar Alexander, *Science* 18 Feb 2005
Chair, Senate Subcommittee on Education

Continued Erosion in Math and Science Skills

- Well-known issue remains unresolved
  - Problem-solving skills of American grade-10 students significantly lower than peers in 25 countries
- Problem is systemic but teachers are key
  - Need to create highly-qualified teaching force
  - 260,000 new high school science and math teachers needed by 2008 school year
- Business, education and government collaboration
  - Long-term tactics needed to solve systematic problem

Urgent Need to Fill the Intellectual Pipeline

- Engineering and scientific intellectual capital
  - Need to attract more US students to STEM programs
  - Need to continue to attract the best foreign scholars
- Success requires collaboration at all levels
  - Business, education and government policy leaders
  - Advance the development of educational systems



Interesting Comparisons

- Total 2004 U.S. trade deficit: $666B
  - 2004 with China: $162B (advanced technology: $36B)
  - Marshall plan: $90B total over 4 yrs (today's dollars)
- B.S. Engineering Graduates

	1994	2004
U.S.	73,000	65,000
China	60,000	325,000

- Total 4 year cost for 65,000 B.S. engineers ~ $13B
  - One week's trade deficit pays for all U.S. graduates!

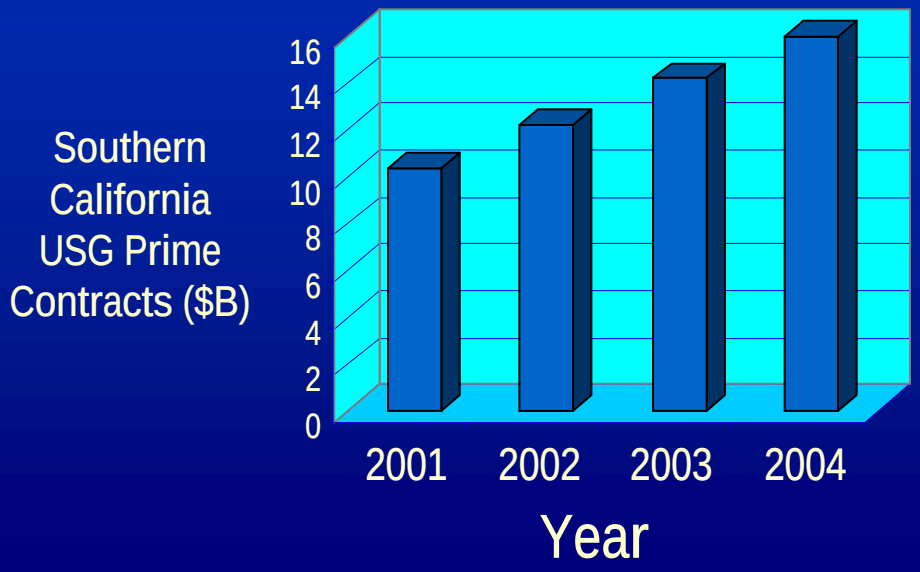
Aerospace Engineering Pipeline Constricted

- Aerospace industry faces shortage of engineers
  - Feb 2004: 50-year low in aerospace employment
  - Now increasing, but talent pipeline is not sufficient
- Aerospace science and engineering positions
  - 9% of funded positions going unfilled
  - 27% eligible for retirement by 2008
  - Lack of qualified candidates

- Collaboration again required to solve the problem
  - Government, industry and universities must work together

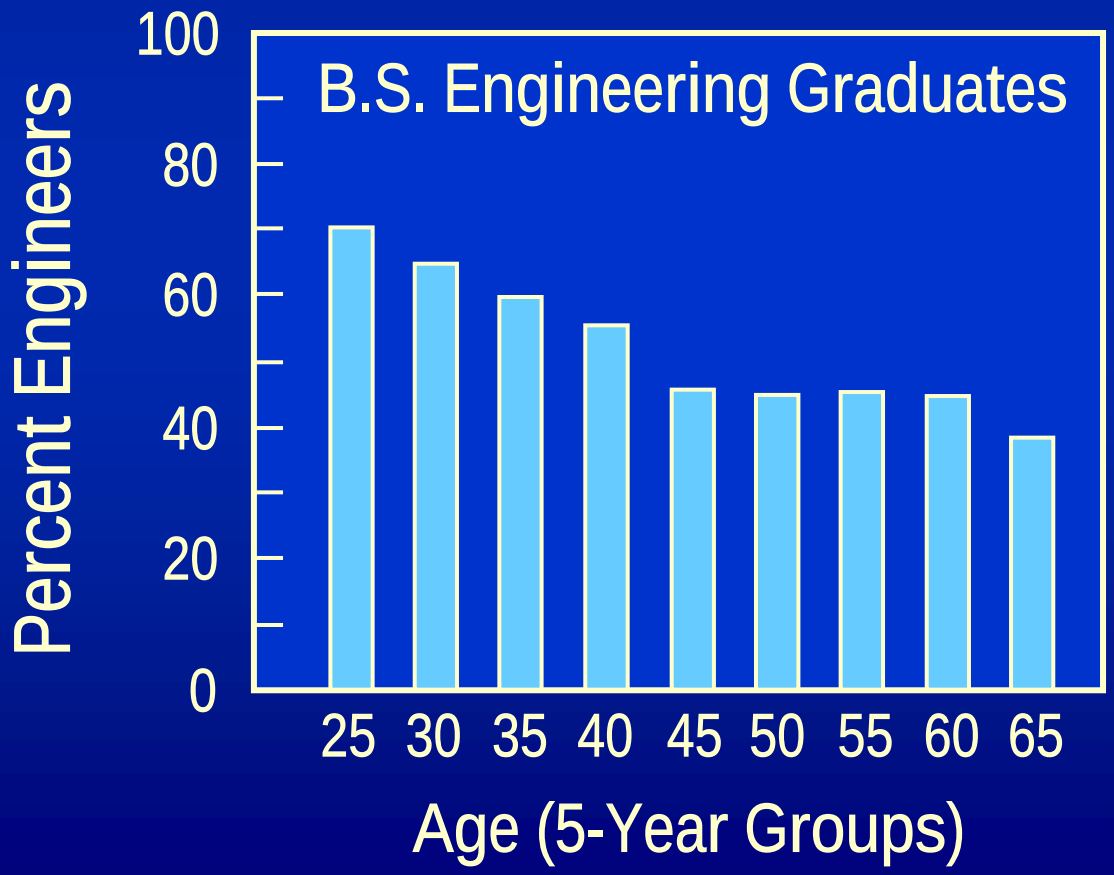
Aerospace Economy in Southern California

- Manufacturing employment in So. Calif. ~ 1,000,000
- Aerospace employment in So. Calif. ~ 200,000
- Business areas with highest 2004 growth rates in Southern California
  - Aerospace
  - International Trade
  - Tourism



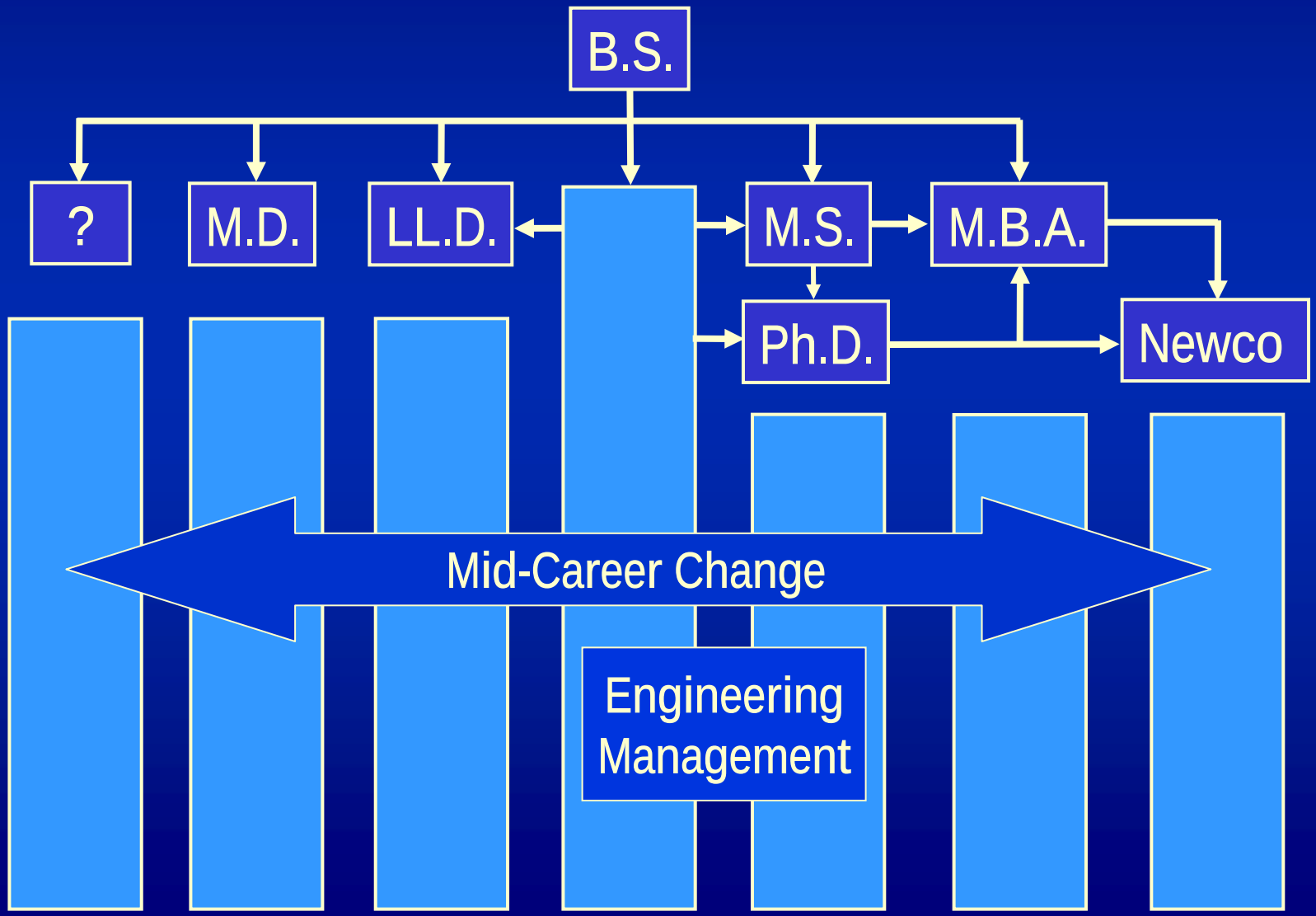
The Future for Engineering Graduates

- Most graduates will not be “engineers” in 25 years



NSF 1995

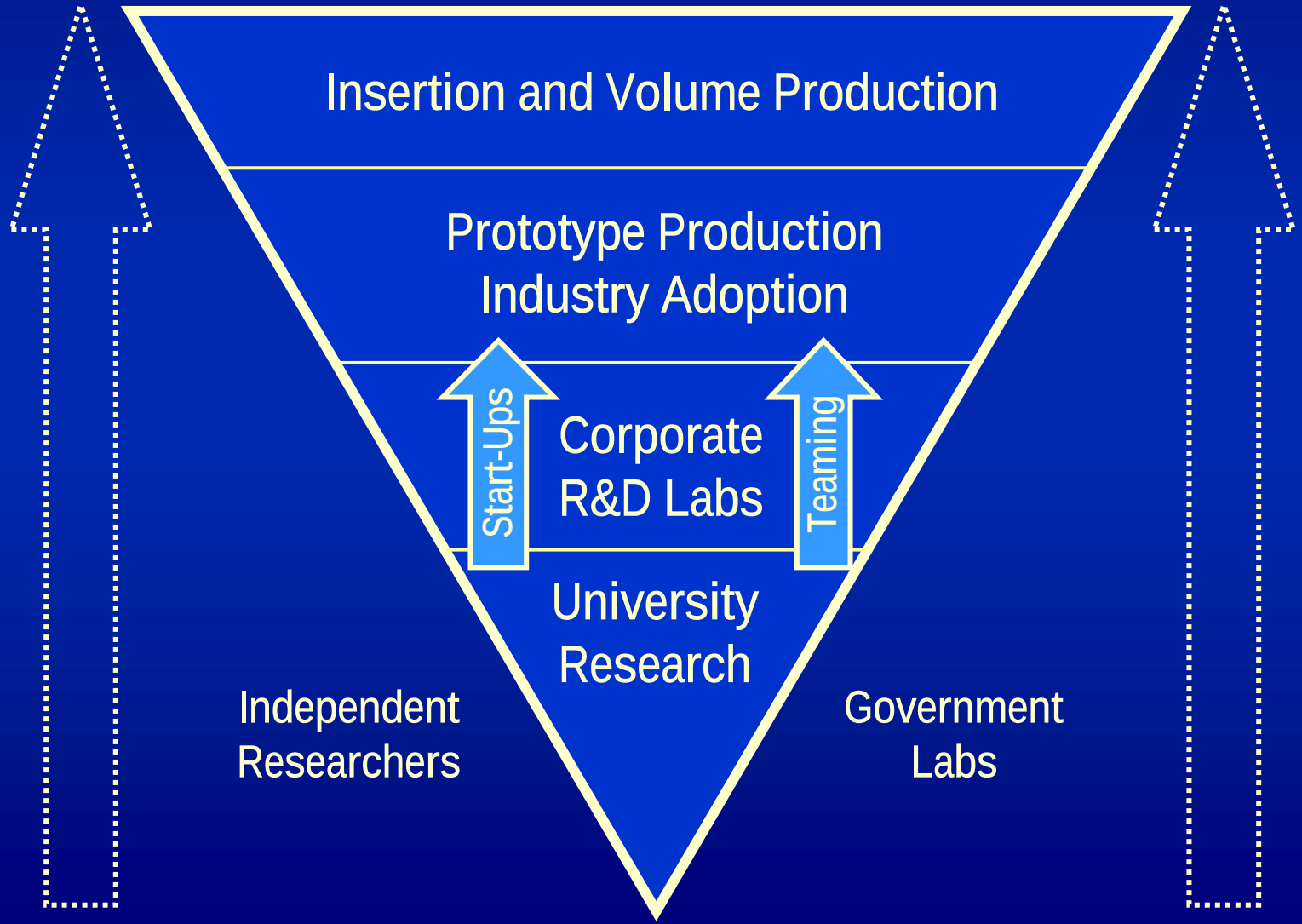
Engineering Career Options



University Research is Key to the Future

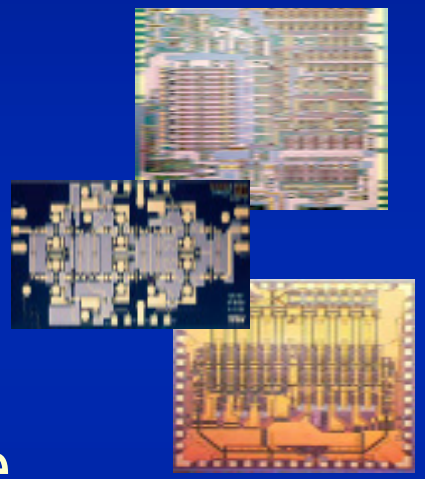
- Corporate R&D labs downsized
  - Most now seen as corporate profit centers
  - Short-term focus with reduced investment
  - Off-shore, global shift in R&D funding
- Government labs focused on DoD
  - Government and defense applications
- University research critical to future success
  - More important than ever for basic R&D
  - Key to future U.S. technology development

University Research Key to the Future



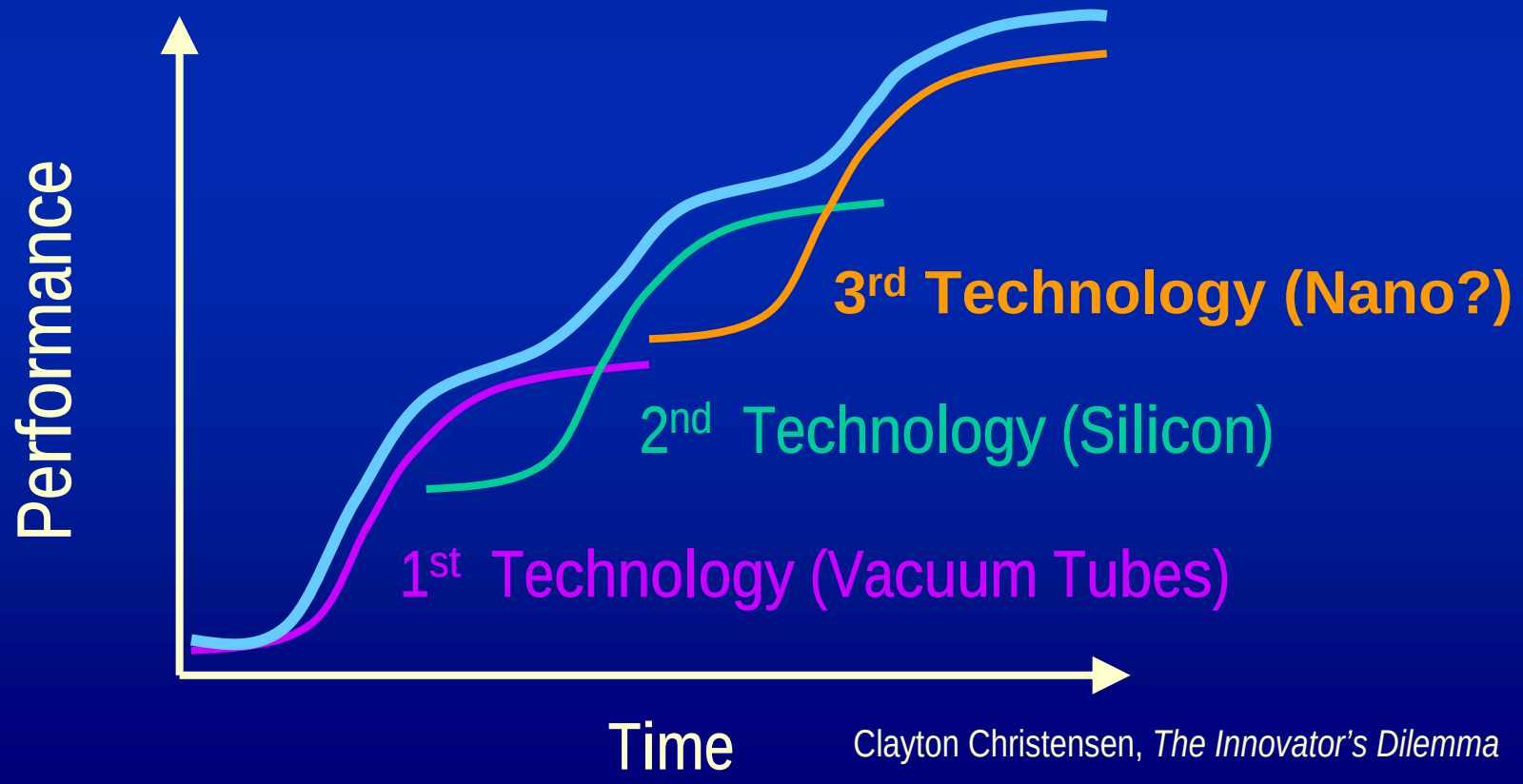
University – Industry Collaboration Goals

- Enable fundamental research
  - Cost-effective tool to achieve innovation
  - IP issues must be resolved up front
- Improve duplex communication
  - Collaboration strengthens ties
  - Enhance technology insertion perspective
- Strengthen university-industry relations
  - Next generation of engineering leadership
  - Professors provide ideal external expertise



Potential for Future Recovery

- Technology s-curve provides creative opportunity
  - Massive investment in new technology required now



Clayton Christensen, *The Innovator's Dilemma*

Engineering Education Requirements

- Continued focus on core skill sets
  - Math and physics remain the critical foundation
- Expanded systems-engineering exposure
  - Integrated approach to engineering solutions
  - Management of global engineering resources
- Communication and teamwork skills
  - A much-discussed and key requirement
- Freedom for creativity
  - At odds with the corporate culture but a critical need!

Conclusion

- Education collaboration required for success
  - Global environment is rapidly changing
  - U.S. government investment support is critical
  - Industry:university:government collaboration required
- Engineering education and university research
  - Focus on basic and emerging engineering needs
  - University research is new technology's forcing function
- Engineering education is the key component
  - Enables innovation which in turn drives U.S. economy