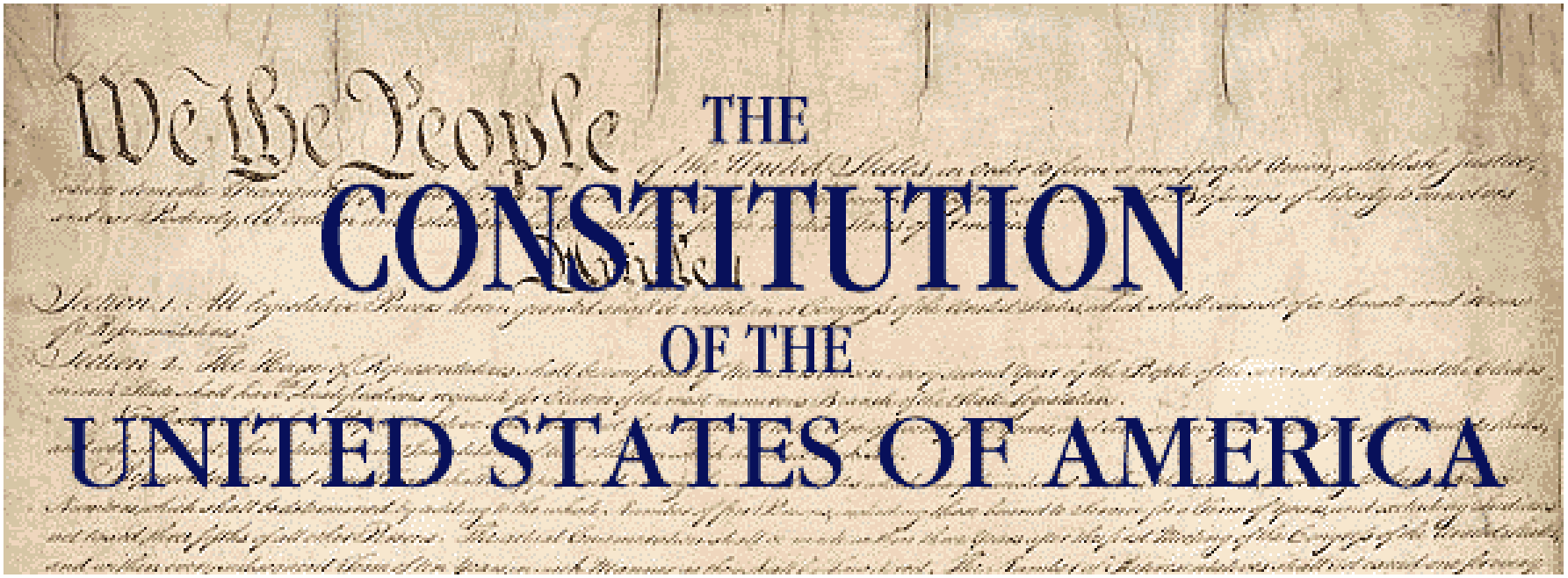
# Nation's Innovation Agenda: ...*NIST Contributions*

**Hratch G. Semerjian**
**Acting Director, NIST**

**IEEE - National Capital Area Awards Banquet**
**April 16, 2005**

# Constitutional authority in 1788




**Article I, Section 8: The Congress shall have the power to …*coin money, regulate the value thereof, and of foreign coin, and fix the standard of weights and measures***

# NIST enables the future…

by strengthening the innovation infrastructure to:

- **advance manufacturing and services**
- **facilitate trade**
- **enhance public safety & security**
- **improve quality of life**

**…and create jobs**

…through effective partnerships with industry, academia, and other government agencies.

# Innovation In The News

"Innovation will be the single most important factor in determining America's success through the 21st century."

**Report of the "National Innovation Initiative", Council on Competitiveness**
December 2004

"We conclude that although the United States still leads the world in research and discovery, our advantage is eroding rapidly as other countries commit significant resources to enhance their own innovative capabilities."

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# Technological Innovation and Growth

Economic studies over several decades have shown that:

1. Technology accounts for *one-half of output (GDP) growth* in all industrialized nations (except Canada).
2. Technology accounts for *three-quarters of productivity growth*.
3. The increase in U.S. productivity growth that began in the mid-1990s is *entirely due to technology investments*.
4. The productivity advantage of the U.S. economy over other OECD countries accounts for *three-quarters of the per capita income gap*.
5. The rate of return to basic science is about *three times* that for applied R&D, which, in turn, has *twice* the return on physical capital.

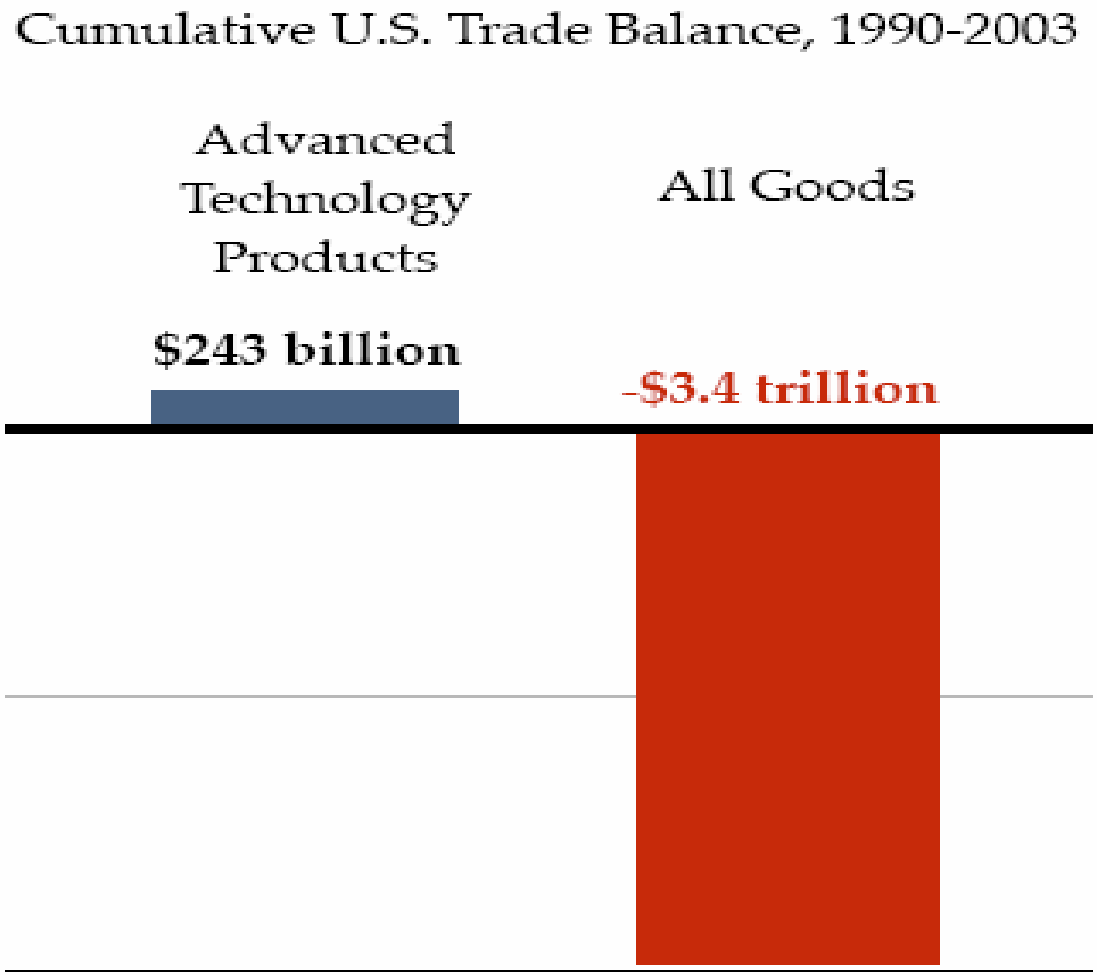
# U.S.…A High-Tech Economy

The most high-tech segments of the U.S. economy...

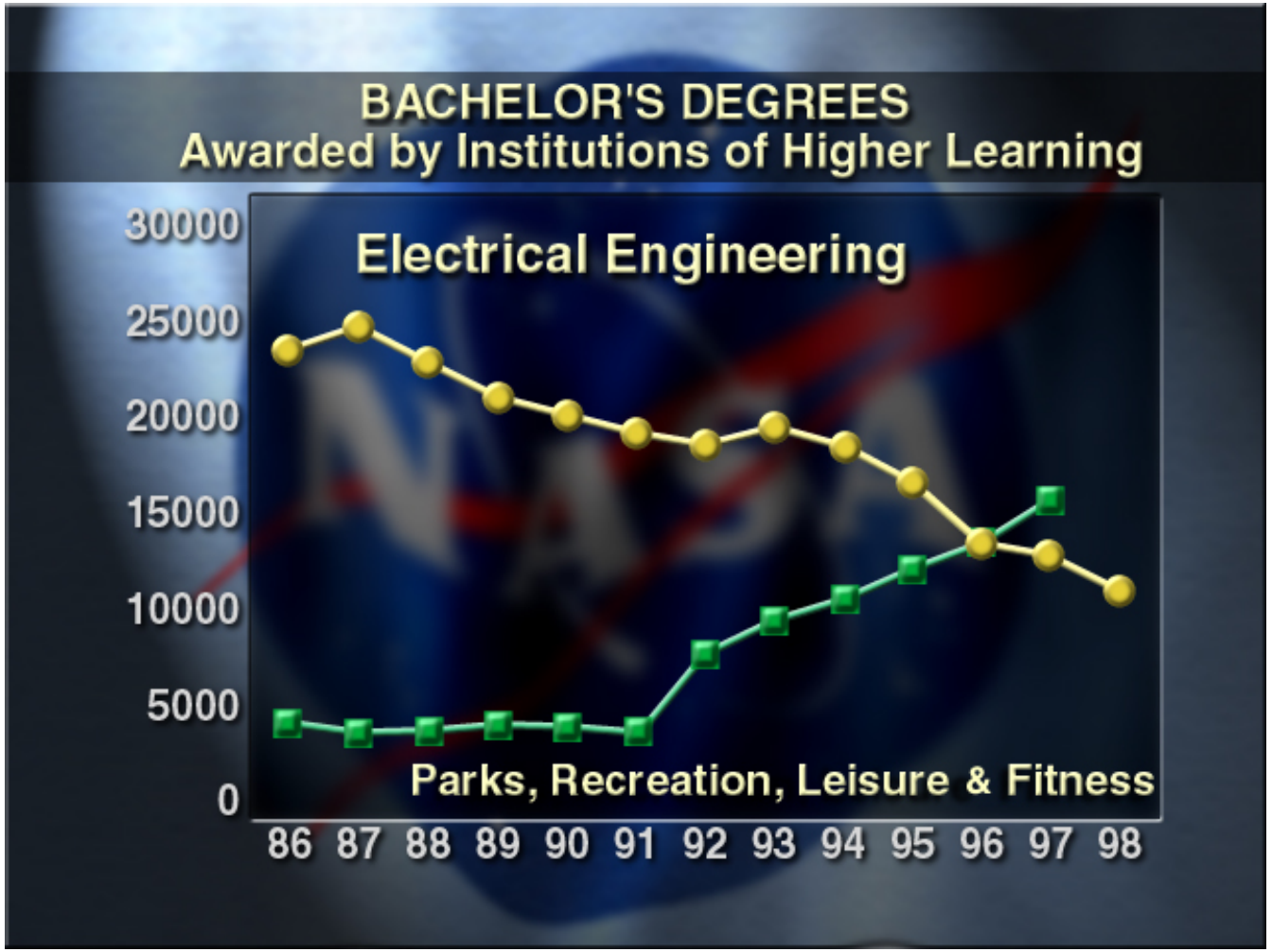
- Electronics
- Pharmaceuticals
- Communication services
- Software and computer-related services

... Account for *7 to 10 percent of our Gross Domestic Product*.

# High-Tech Contribution to Trade Balance

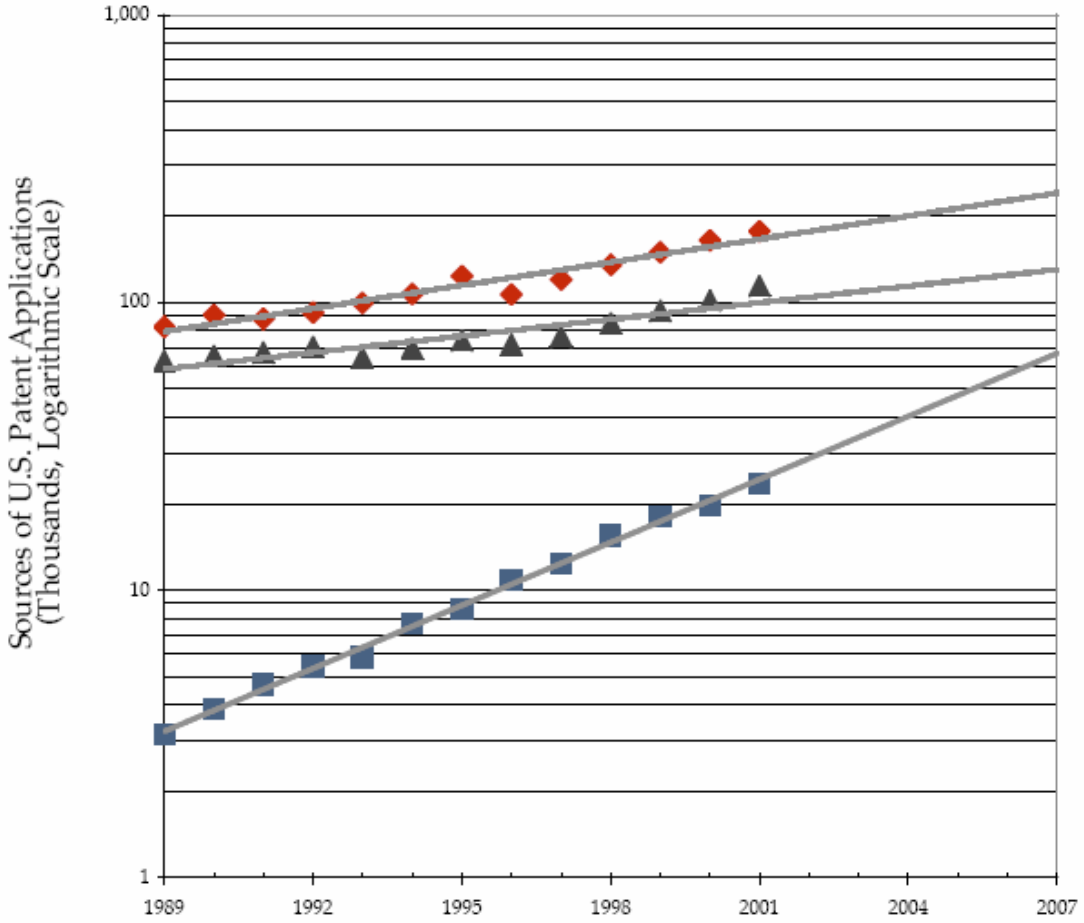


# Students See No Future in Engineering




Slide courtesy of Kathie Olsen, NASA, by way of ASTRA

# U.S. Patent Applications

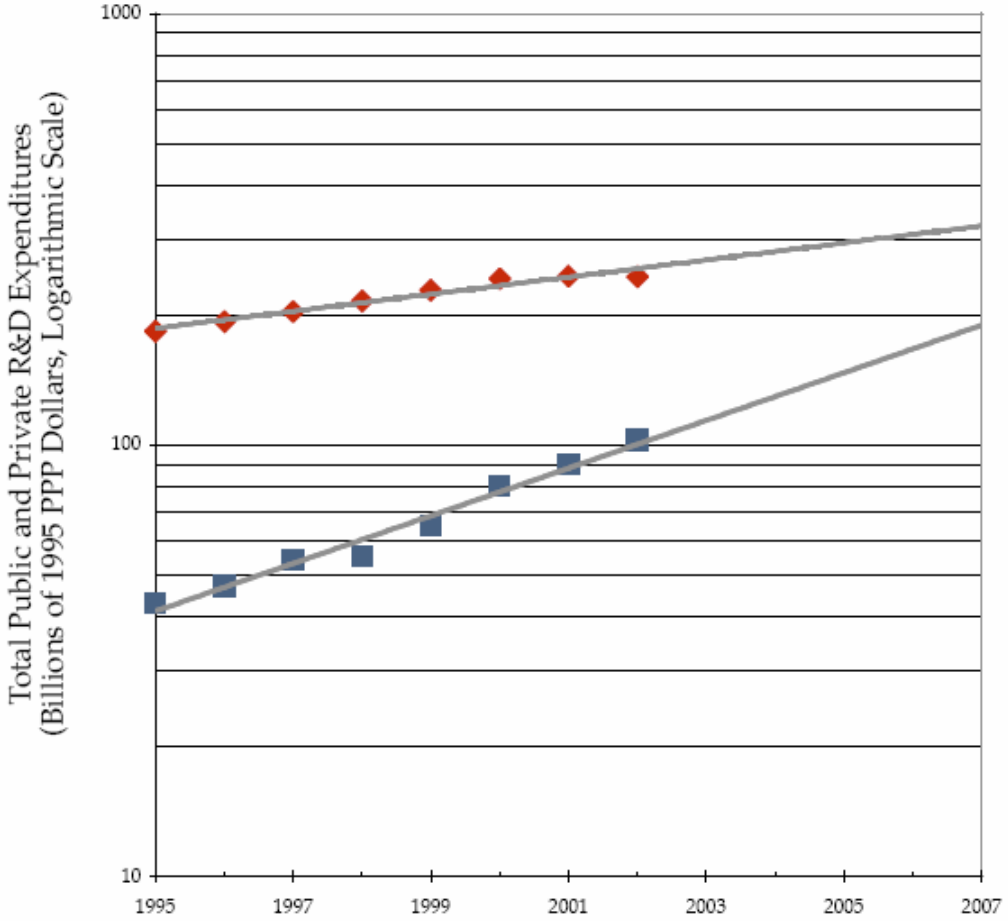



**Other Established Economies:**
Canada, France, Germany, Italy, Japan, Netherlands, Sweden, Switzerland, United Kingdom

**Fastest Growing Economies:**
China, Hong Kong, India, Ireland, Israel, Singapore, South Korea, Taiwan

Source: National Science Foundation, *Science and Engineering Indicators 2004*, Appendix Table 6-11.
Compiled by the APS Office of Public Affairs

# Total R&D Investments




United States

Fastest Growing Economies

**Fastest Growing Economies:**
China, Ireland, Israel, Singapore, South Korea, Taiwan

*(India and Hong Kong data not available)*

Source: Organisation for Economic Cooperation and Development, *Main Science and Technology Indicators*, May 2003.
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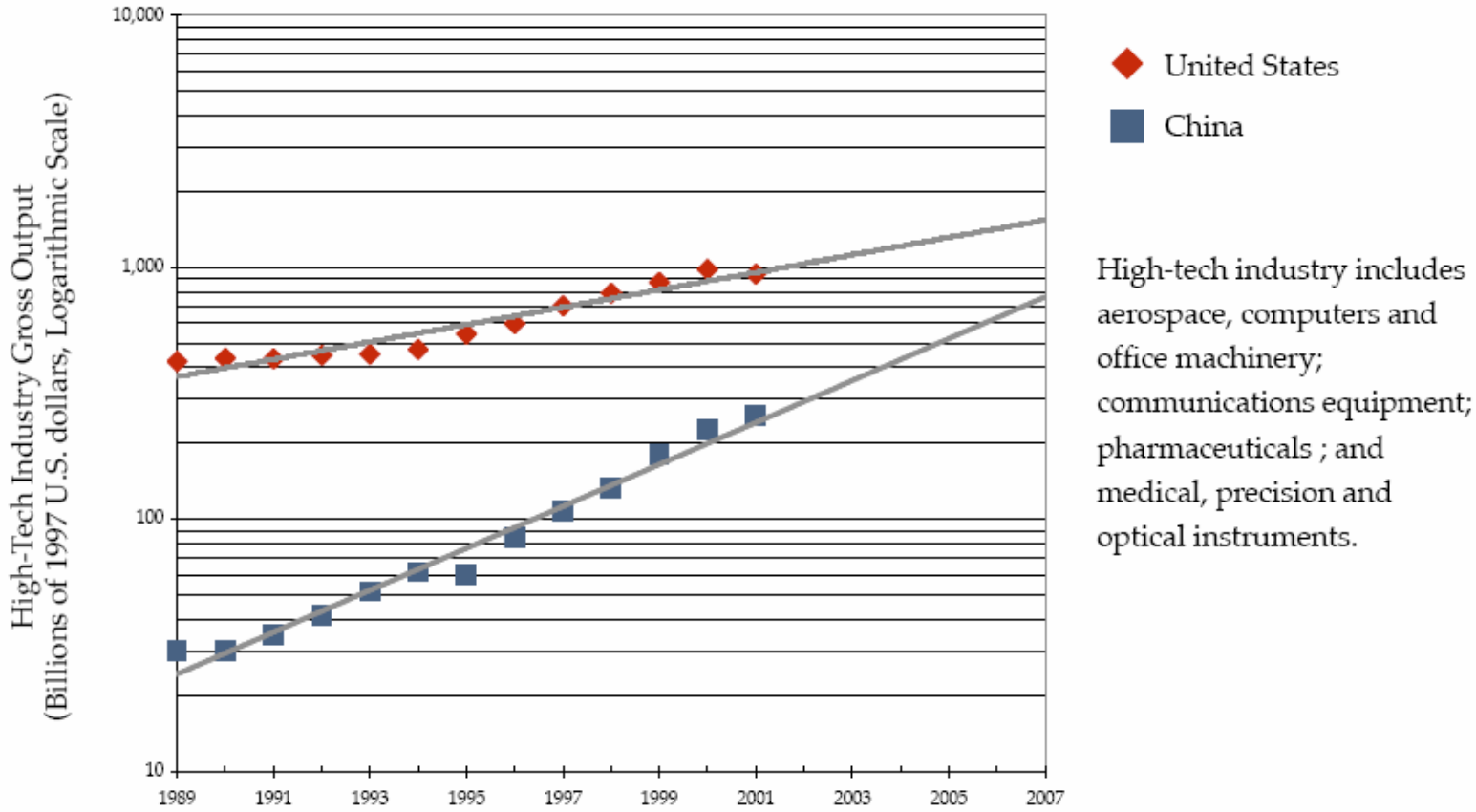
# High-Tech Industrial Output




High-tech industry includes aerospace, computers and office machinery; communications equipment; pharmaceuticals ; and medical, precision and optical instruments.

Source: National Science Foundation, *Science and Engineering Indicators 2004*, Appendix Table 6-1.
Compiled by the APS Office of Public Affairs

# Bottom line: "*Innovate or abdicate*"

**"... we live in a competitive world ... We shouldn't take our preeminence as the world's greatest economy for granted. We've constantly got to make sure the economic environment here is strong. We've got to make sure that we're innovative."**

*President G.W. Bush (April 5, 2004)*

# A National Innovation Policy

- Supporting Innovation through R&D
- Manufacturing
- Measurements and Standards
- Stimulating Private Investment in R&D
- Protecting Intellectual Property

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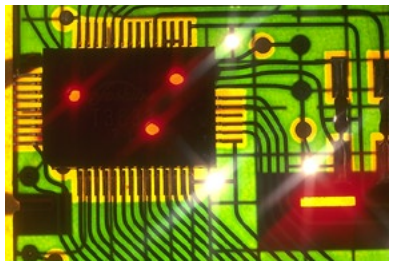
# NIST strengthens the innovation infrastructure to...

## *...advance manufacturing and services*



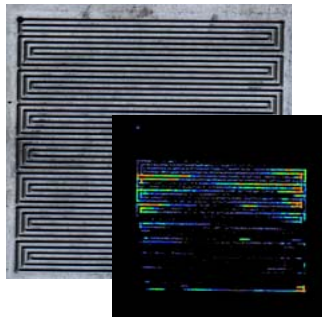
**semiconductor electronics**

**“lean manufacturing” of plastics**

**automobile manufacturing interoperability**

**pharmaceuticals**

**financial services**



**fuel cell technology**

**healthcare**

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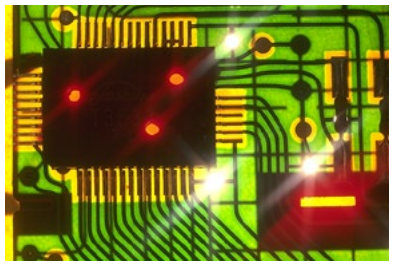

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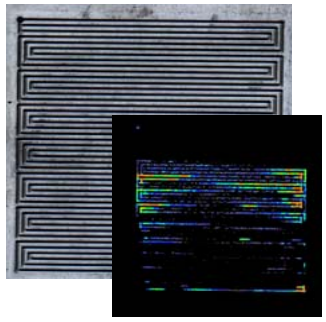

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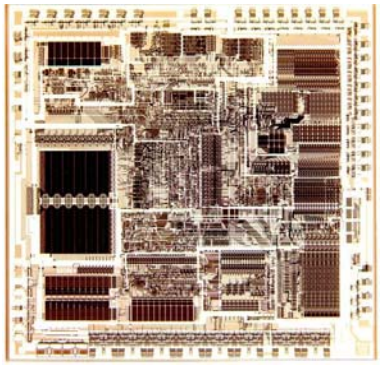
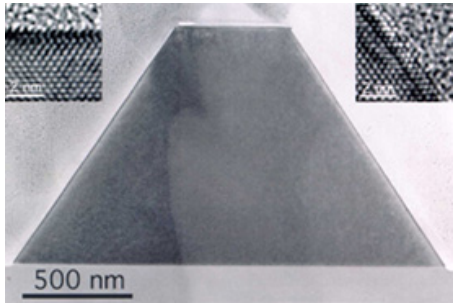
# Advances in... ...electronics

***milli electronics***
**vacuum tubes & discrete transistors**
**1900 - 1960**
*copper, glass, barium, germanium*

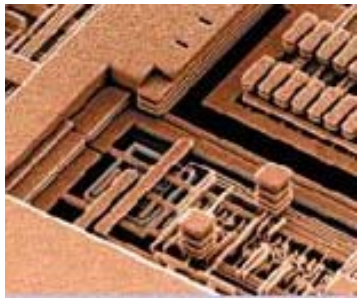
*first neon signs*



***micro electronics***
**integrated circuits**
**1960 - 1990**
*silicon, aluminum*




*single-crystal silicon critical dimension artifact*



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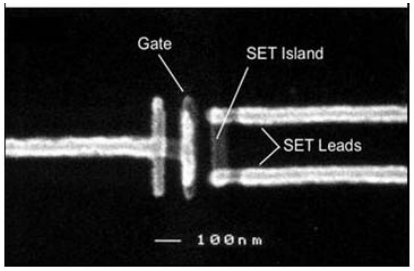


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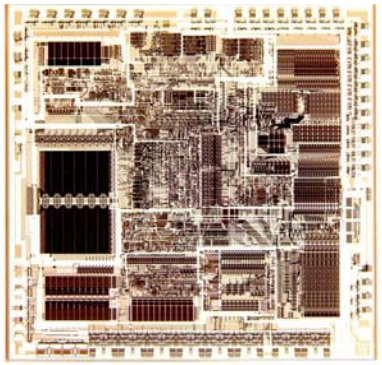

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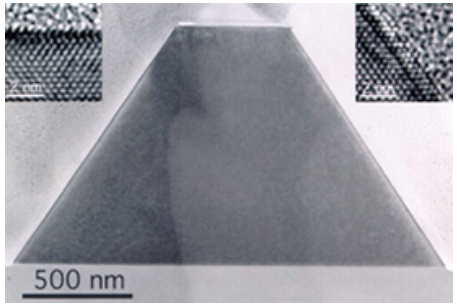


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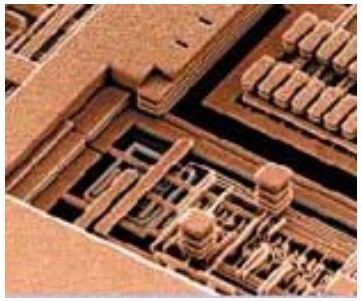

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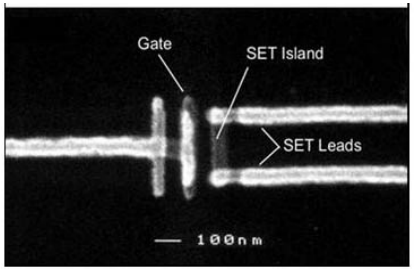


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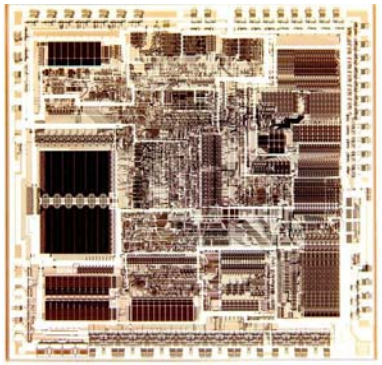

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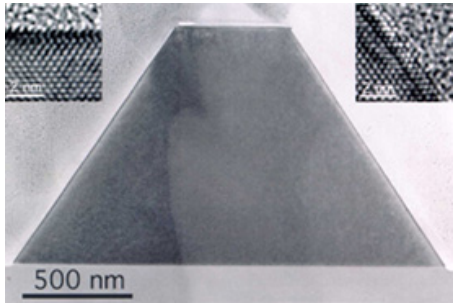


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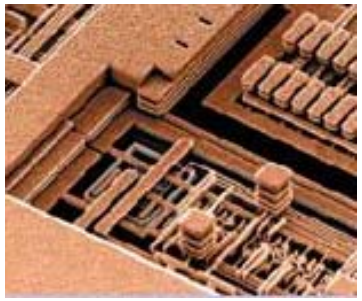

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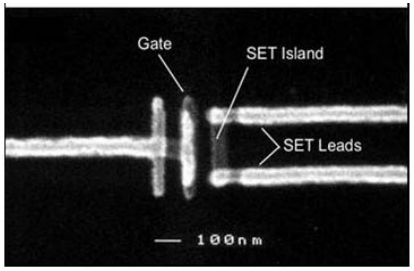


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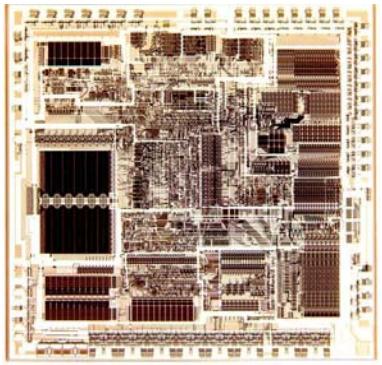

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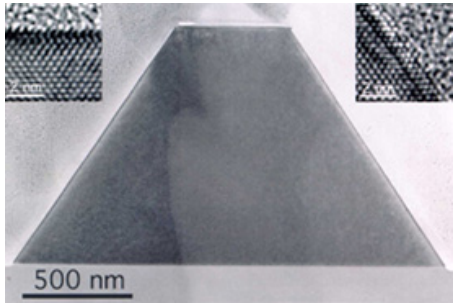


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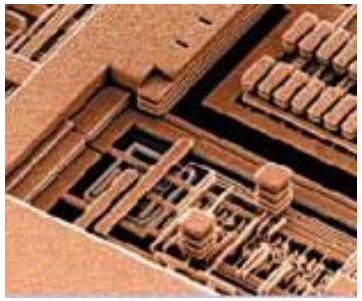

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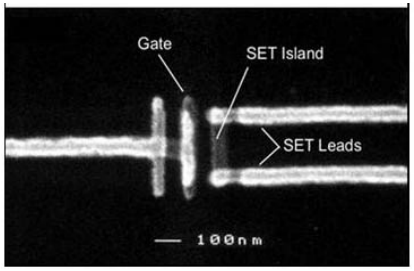
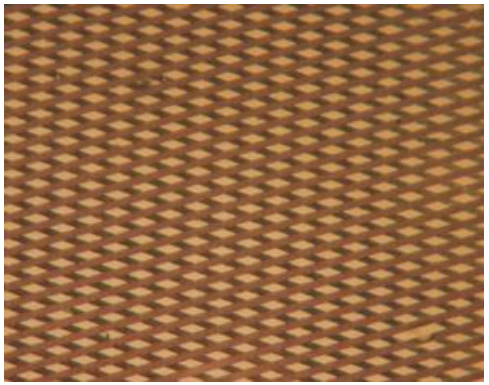



*single electron tunneling device*

# Next : Molecular Electronics ?

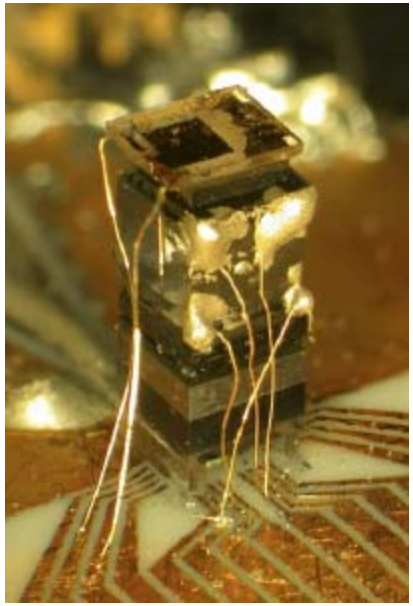
**March, 2003 – HP and NIST make first two laboratory comparison of capacitance-voltage measurements of a molecular-electronic device, a "crossbar"**

**February, 2005 – HP Labs demonstrates "crossbar latch", potential molecular scale replacement for transistors in digital computers**

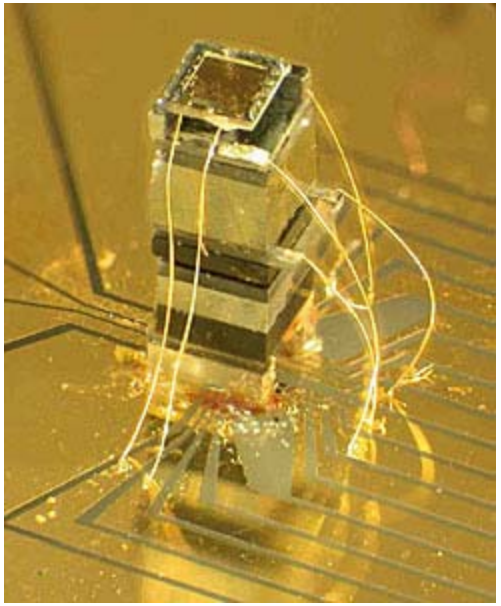



**New Patent on Molecular Electronics Process**

# This just in !

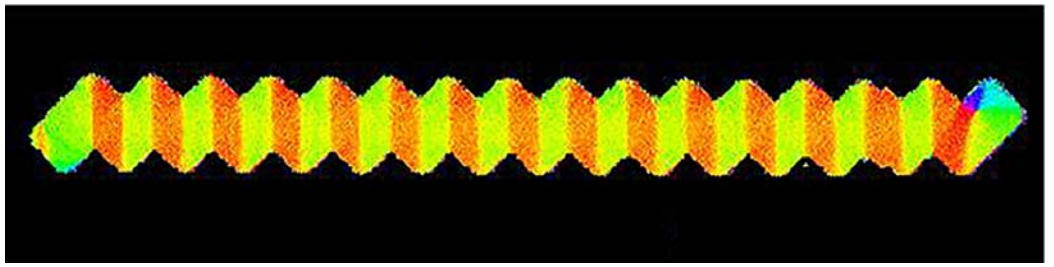


**Chip-scale**
**Atomic clock**



**Chip-scale**

**Magnetometer**



**Zigzag Magnetic Sensor**

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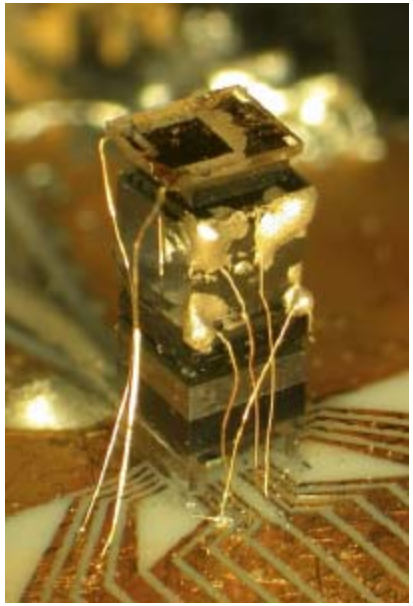

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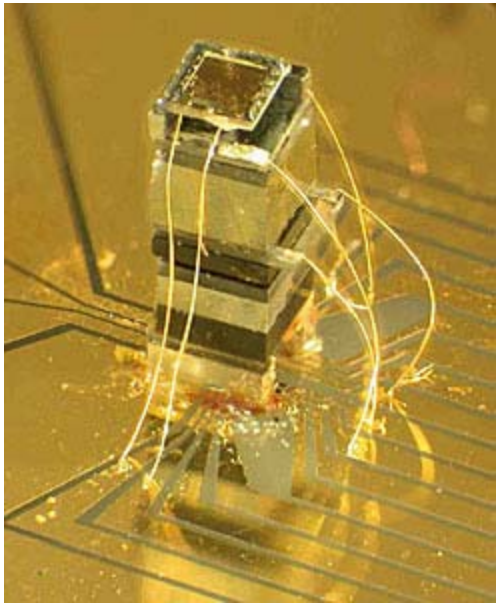

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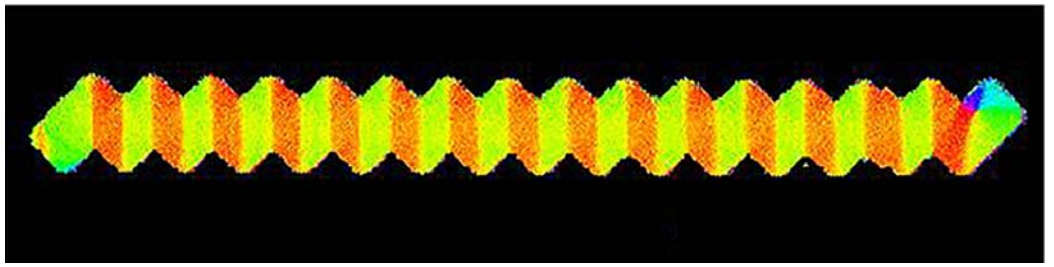

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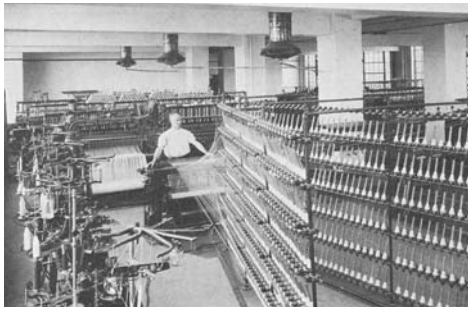
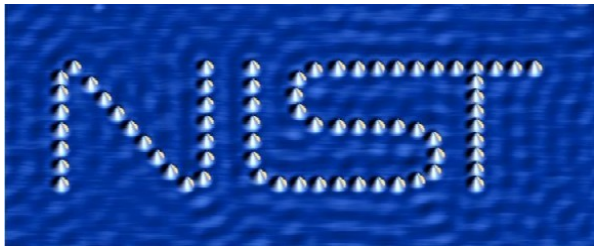
# Advances in... ...manufacturing



**1920**
**experimental cotton mill**

**1983-1995**
**Automated Manufacturing Research Facility**

**2004 simulation technology for manufacturing operations**




**20xx**
**automated and optimized assembly of single atom constructions**

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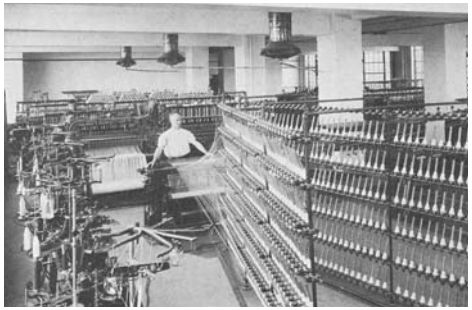

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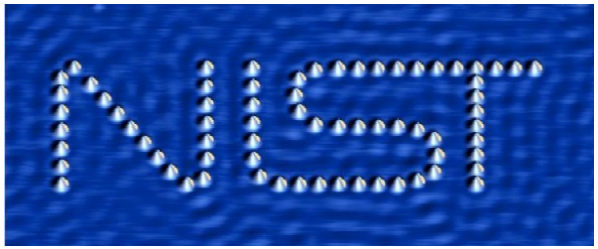


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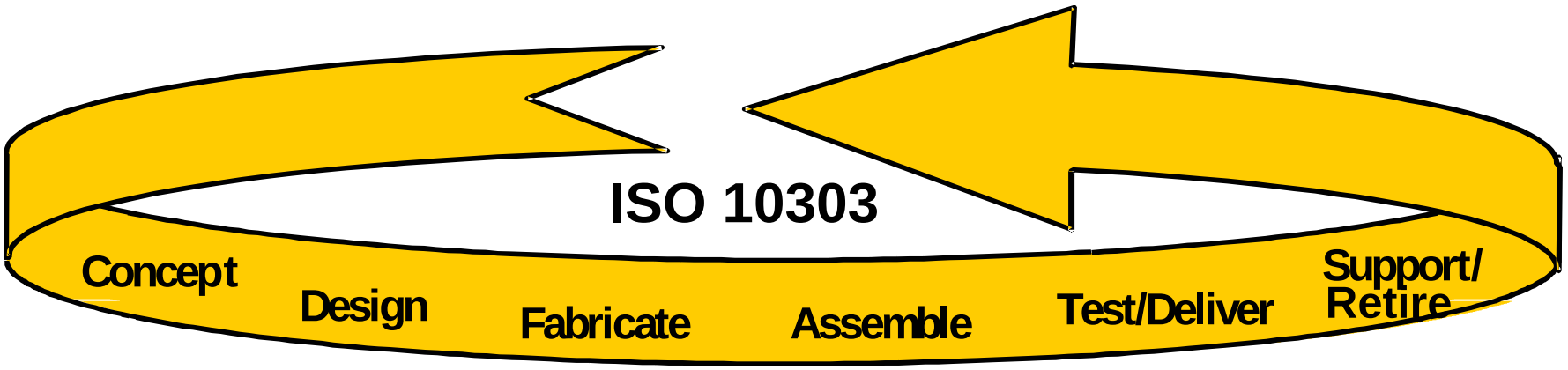
# Product Data Exchange Using STEP (PDES)




**Product Life Cycle**

| As Defined Configurations | As Planned Configurations | As Built Configurations | As Maintained Configurations |
|---|---|---|---|

# Interoperability .... ...of critical importance

**Cost of inadequacies in supply chain infrastructures:**

| | |
|---|---|
| automotive | $ 5 billion |
| electronics | $ 3.9 billion |
| commercial buildings & industrial facilities | $15.8 billion |


NIST GCR 04-867

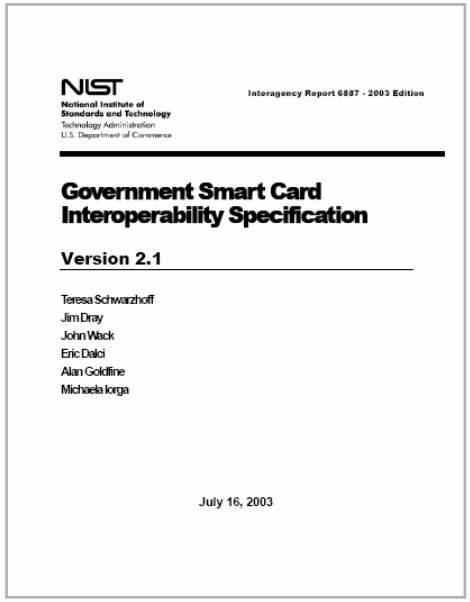
NIST U.S. Department of Commerce Technology Administration National Institute of Standards and Technology — Advanced Technology Program Information Technology and Electronics Office Gaithersburg, Maryland 20899

Cost Analysis of Inadequate Interoperability in the U.S. Capital Facilities Industry

Michael P. Gallaher, Alan C. O'Connor, John L. Dettbarn, Jr., and Linda T. Gilday



**Smart Card Interoperability Specification (GSC-IS)**


NIST National Institute of Standards and Technology Technology Administration U.S. Department of Commerce

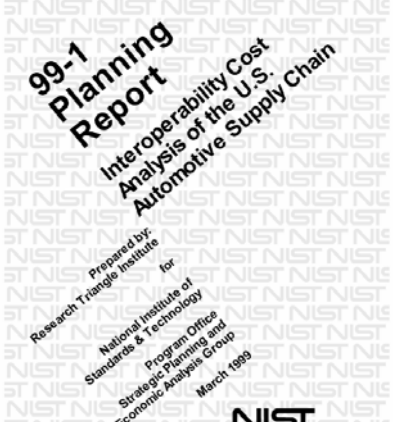
Interagency Report 6887 - 2003 Edition

**Government Smart Card Interoperability Specification**

**Version 2.1**

Teresa Schwarzhoff
Jim Dray
John Wack
Eric Dalci
Alan Goldfine
Michaela Iorga

July 16, 2003


99-1 Planning Report

Interoperability Cost Analysis of the U.S. Automotive Supply Chain

Prepared by: Research Triangle Institute

for

National Institute of Standards & Technology

Program Office Strategic Planning and Economic Analysis Group

March 1999

NIST

**Interoperability testbed for dimensional metrology systems**

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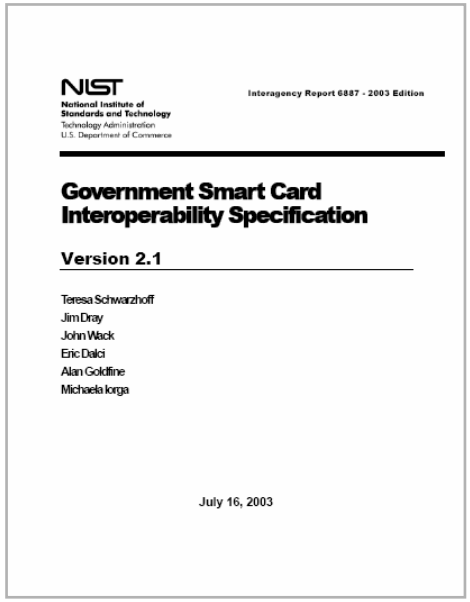
**Smart Card Interoperability Specification (GSC-IS)**


NIST National Institute of Standards and Technology Technology Administration U.S. Department of Commerce

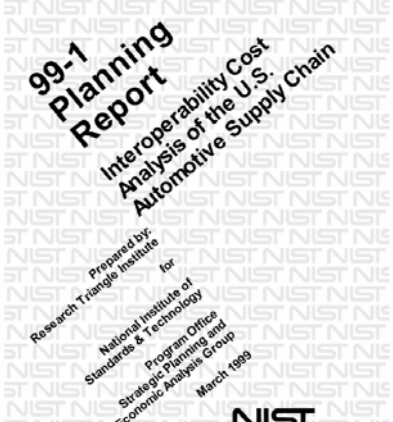
Interagency Report 6887 - 2003 Edition

**Government Smart Card Interoperability Specification**

**Version 2.1**

Teresa Schwarzhoff
Jim Dray
John Wack
Eric Dalci
Alan Goldfine
Michaela Iorga

July 16, 2003


99-1 Planning Report

Interoperability Cost Analysis of the U.S. Automotive Supply Chain

Prepared by: Research Triangle Institute

for

National Institute of Standards & Technology

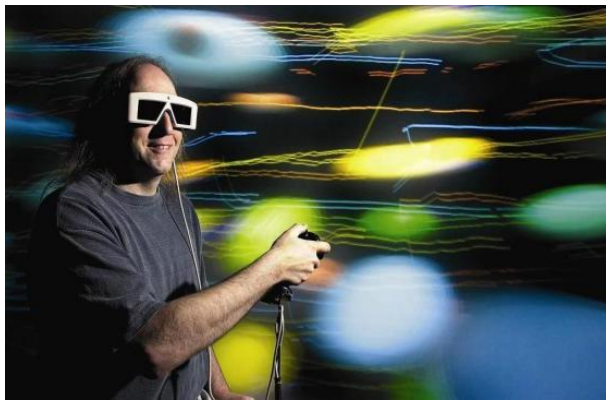
Program Office Strategic Planning and Economic Analysis Group

March 1999

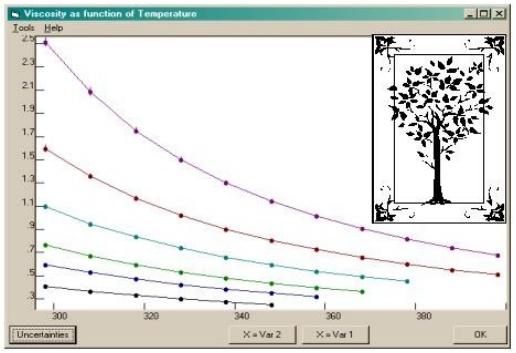
NIST

**Interoperability testbed for dimensional metrology systems**

# Advances in... ... *information technology*



**immersive visualization**



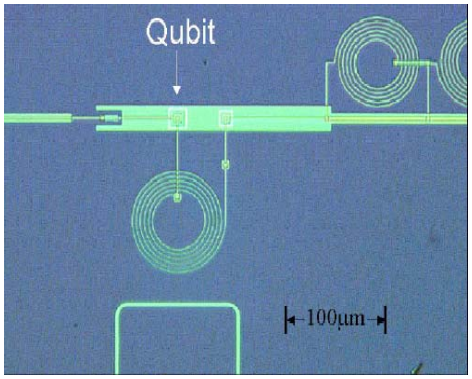

**Guided Data Capture Software**


AES
*A Crypto Algorithm for the Twenty-first Century . . .*

"Working closely with industry"

**128 bit key:** *NIST@100NIST@100*

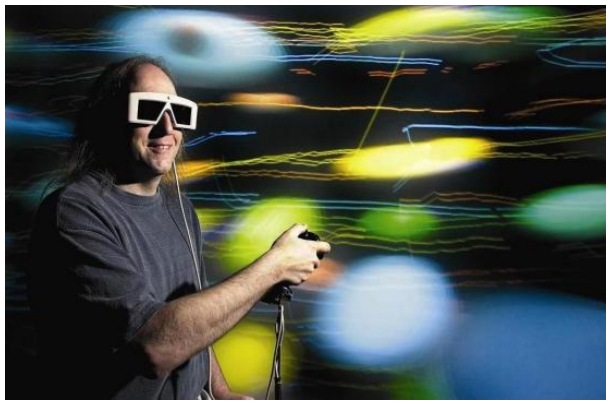
95285ac3f244a6ef4a466b03d7af1275
b8f8e0db1f14c9d33e72d598f12a14fc


**Quantum computing**

NIST **Chemistry WebBook**

# Advances in... ... *information technology*



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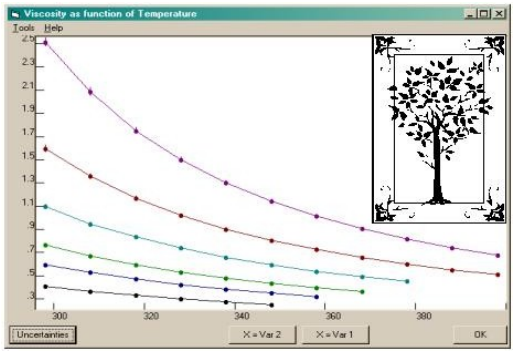


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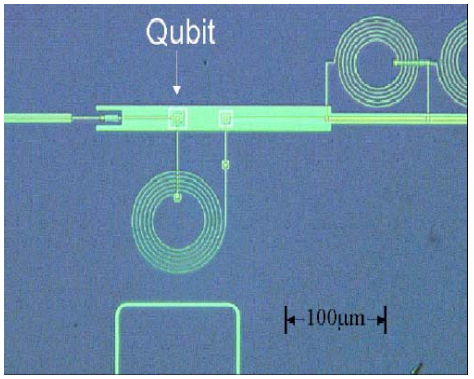


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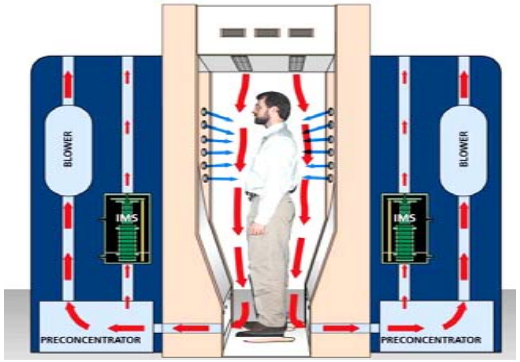
# NIST strengthens the innovation infrastructure to...

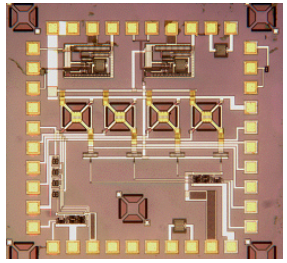
## *...improve public safety and security*

metal detectors

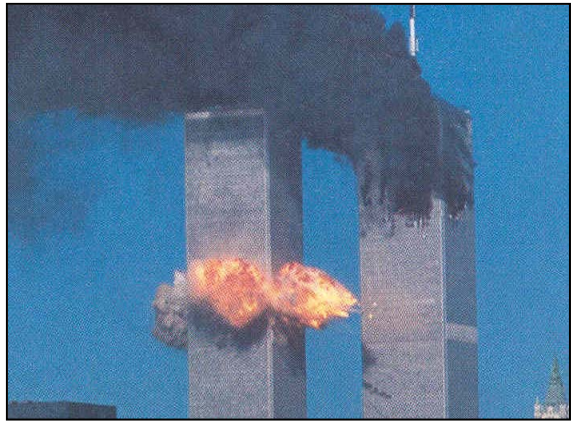
wireless interoperability among first responders




Trace explosives detection portal



novel sensors to detect gases



WTC Investigation

standards for body armor

# Personal Identity Verification (PIV) standards

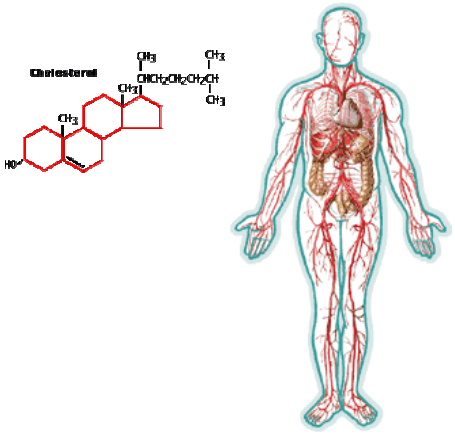
**NIST-developed system for studying the performance of facial recognition software programs**

**Homeland Security Presidential Directive HSPD-12**

***"Policy for a common identification standard for Federal employees and contractors"***

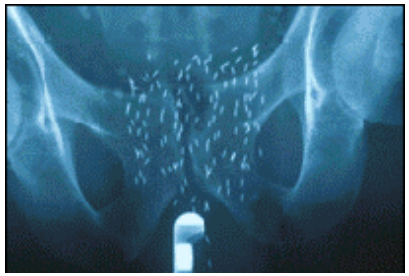
# NIST strengthens the innovation infrastructure to...

## *... improve quality of life*

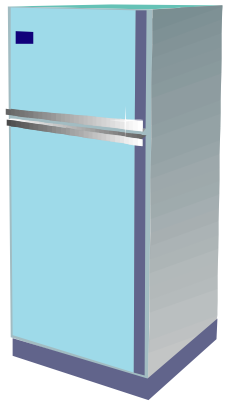



**cholesterol standard reference material**

**drinking water quality**



**prostate and breast-cancer treatment**



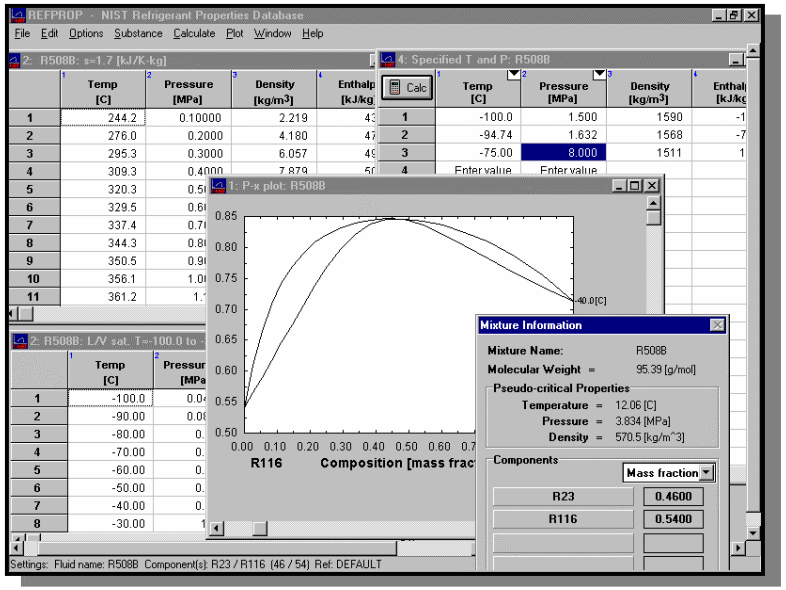
**database and measurements for alternative refrigerants**

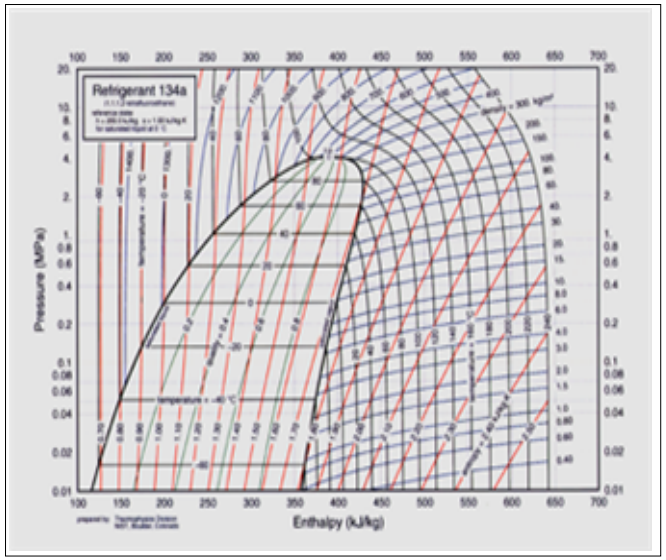
**standards for sulfur in fossil fuels**

# Alternative Refrigerants

***REFPROP database (NIST SRD 23)***

- **Based on experimental data**
- **Models the behavior of refrigerant mixture**
- **Effective form of information dissemination**
- **Key to developing CFC replacements**




- **Facilitated the development of new products that are:**
  - **Energy efficient**
  - **Environmentally safe**
  - **Timely, Economical**

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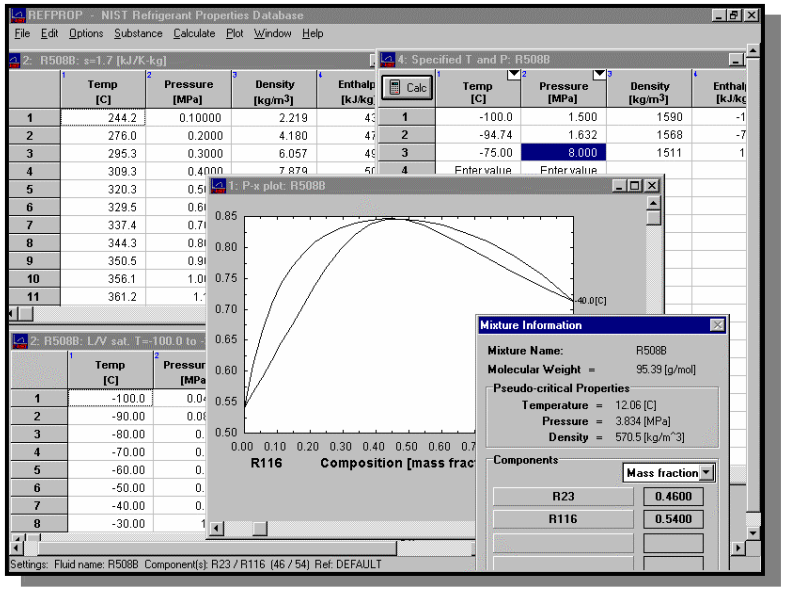


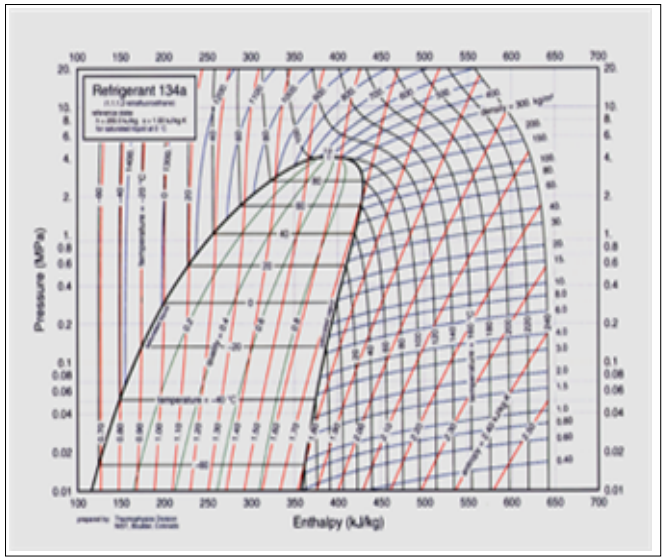


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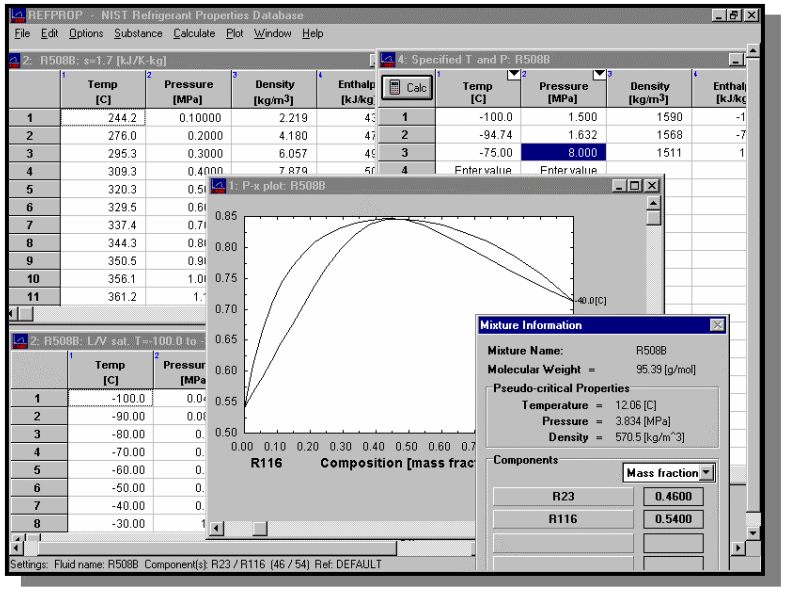
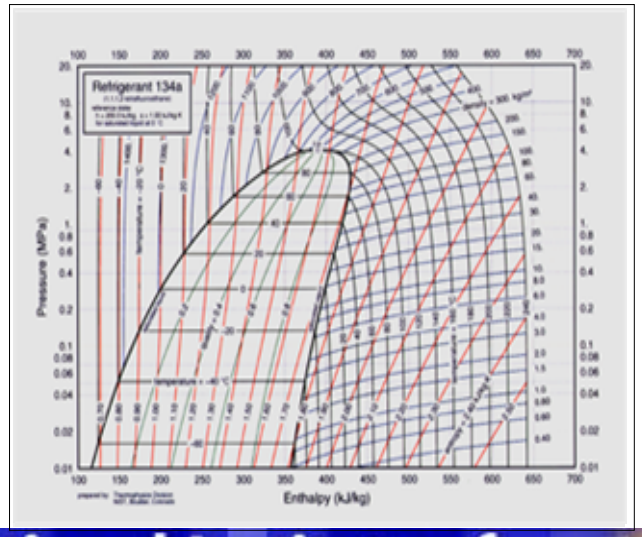



***Internationally adopted***

- **IEA Annex 18**
- **ISO Standard 86**
- **Distributed through ARI, IIR, ASHRAE, etc.**

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# NIST has... ...strong partnerships

**Partnerships with industry, academia, and other government agencies have been an integral part of NIST culture since 1901.**

ILLINOIS

JILA NIST CU

University of Colorado

CARB

UNIVERSITY OF MARYLAND

Hollings Marine Laboratory

Penn
University of Pennsylvania

AdvaMed
Advanced Medical Technology

IEEE

THE UNIVERSITY of WISCONSIN MADISON

AIAG

ASTM INTERNATIONAL
Standards Worldwide

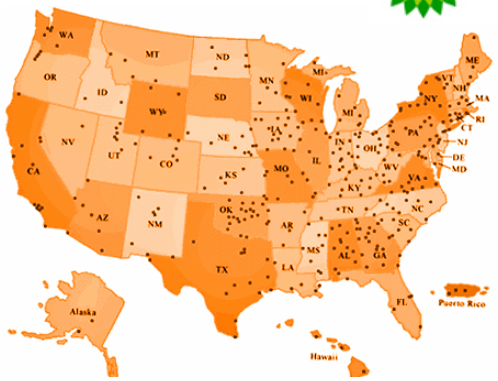
ITRS

INTERNATIONAL TECHNOLOGY ROADMAP FOR SEMICONDUCTORS


USCAR

AMERICAN INDUSTRY / GOVERNMENT EMISSIONS RESEARCH
AIGER
Cooperative Research and Development Agreement

# NIST has... ...strong partnerships



Agilent Technologies

DOW
Living.
Improved daily.

intel

IBM

GM

Ford

Pfizer

bp solar

NCMS
Manufacturing Trust

VLSI Standards Incorporated

100 BEST RESOURCES FOR SMALL BUSINESS
DANIEL KEHRER BizBest

Homeland Security

National Institutes of Health

United States Department of Health & Human Services

NASA

United States Environmental Protection Agency

National Cancer Institute

THE NATIONAL CONFERENCE ON WEIGHTS AND MEASURES

# U.S.M.S. … *A new Undertaking*

- Roadmapping America's measurements needs
- A Private-Public Partnership for the Future
- Respond to needs of Global Trade
- Identify crucial infrastructure needs of USMS customers and stakeholders
- Specify additional actions that need to be taken
- Articulate the consequences of not acting
- Organize workshops for information gathering
- Convene USMS Summit – January 2006

# NIST enables the future…

by strengthening the innovation infrastructure to:

- **advance manufacturing and services**
- **facilitate trade**
- **enhance public safety & security**
- **improve quality of life**

**…and create jobs**

…through effective partnerships with industry, academia, and other government agencies.