A Couple of Smart Bosses

“Neal - how much did you say we need in the Nanotechnology budget?”

Vice President Gore shares a private joke - something about Congress!
Back at the ranch - in Texas!

Science and Technology Policy Program
(Co-Director Dr. Kirstin Matthews)

- Energy and Environment (w/ Amy Jaffe)
- Health and Medicine (w/ Vivian Ho & TMC)
- Space (w/ George Abbey, former Dir. JSC)
- Nuclear Issues/ Non-Proliferation
- The Future of U.S. Science
- Education and Women in Science
- International Cooperation in S&T
- Science and the Public
- Role of Civic Scientists
“Science Policy Tools – Time For An Update?”

Federal Demonstration Partnership
D.C.
January 12, 2012
Neal Lane
OUTLINE

• Order - WWII and the Cold War
• Disorder - Today’s Changing World
• Uncertainty - Possible Futures
• A Way Forward
Order - WWII and the Cold War
**U.S. Science and Engineering**

**Pre-WWII**
U.S. R&D focused on agriculture and industry - with some university involvement

**WWII**
Government mobilized U.S. industry and universities for the war effort

**Early Cold War**
Government-University (GU) partnerships became the norm – physical sciences strong

**Recent decades**
Government-University-Industry (GUI) Partnerships – priority on biomed research

**Vannevar Bush (1945)**
Cold War

- Transistor, 1947
  - Bell Laboratories
- Integrated Circuit, 1958
  - Texas Instruments

WWII

- U.S. Army Radar
- "A-Bomb"
  - Proximity fuse
- U.S. Navy TDC analog computer

Today

- Gordon Moore 1968
  - computer chips
- Feynman 1959
  - vision for nanotechnology

Tomorrow

- nano
- http://www
- MOORE'S LAW

U.S. Science, Engineering, Technology

-A Brief History
Ups and Downs of U.S. Federal R&D Funding

Federal Spending on Defense and Nondefense R&D
Outlays for the conduct of R&D, FY 1949-2006, billions of constant FY 2005 dollars

Presidents
- FDR
- HST
- JFK
- LBJ
- RMN
- JRF
- JC
- RWR
- GHWB
- WJC
- FY01
- GWB
- Obama

Non-defense (85% Res)
Defense (7.2% Res)

Sputnik  Berlin wall falls  9/11
COLD WAR

Source: AAAS, based on OMB Historical Tables in Budget of the United States Government FY 2006. Constant dollar conversions based on GDP deflators. FY 2006 is the President's request.
FEB. '05 © 2005 AAAS
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Outlays for the conduct of R&D, FY 1949-2006, billions of constant FY 2005 dollars

A cold war “linear model”

Security ← Physical Sci. R&D ← Federal $
Currently, 85% of non-defense R&D is Research

**U.S. Science, Engineering, Technology**

-A Brief History

“From the Age of Space to the Age of Medicine”

Trends in Nondefense R&D by Function, FY 1953-2009

outlays for the conduct of R&D, billions of constant FY 2008 dollars

NIH Receives 50% of all Federal Research Funding

Note: Does not show ARRA stimulus funding in FY2009

Source: AAAS, based on OMB Historical Tables in Budget of the United States Government FY 2009. Constant dollar conversions based on GDP deflators. FY 2009 is the President’s request.

Note: Some Energy programs shifted to General Science beginning in FY 1998.

FEB. ‘03 © 2008 AAAS

(Currently, 85% of non-defense R&D is Research)
U.S. Science, Engineering, Technology
-A Brief History
“From the Age of Space to the Age of Medicine”

Trends in Nondefense R&D by Function, FY 1953-2009
outlays for the conduct of R&D, billions of constant FY 2008 dollars

NIH Receives 50% of all Federal Research Funding

A post-cold war “linear model”

Health ← Biomedical R&D ← Federal $
Disorder - Today’s Changing World
Three Realities

Reality #1

- The world needs science and technology at least as much as at any time in recent history – example: ENERGY
Looking Ahead – Challenges to the World.

Rick Smalley’s Top Ten Problems for the Next 50 Years

1. ENERGY (carbon-free)
2. WATER
3. FOOD
4. ENVIRONMENT
5. POVERTY
6. TERRORISM & WAR
7. DISEASE
8. EDUCATION
9. DEMOCRACY
10. POPULATION

“Rice’s Rick Smalley (1943-2005)
Nobel Prize 2005

“The world will need revolutionary new technologies – my candidate is nanotechnology”
World Primary Energy Consumption, 1970-2030

History Projections

Quadrillion Btu

(10^{15}) (1.055 kJ)

History

1970 207
1975 244
1980 284
1985 308
1990 347
1995 365
2000 398
2010 463
2015 511
2020 559
2025 607
2030 654

Projections

1970 207
1975 244
1980 284
1985 308
1990 347
1995 365
2000 398
2005 463
2010 511
2015 559
2020 607
2025 654
2030 702

Sources:

(slide from Ralph Cicerone)
Meanwhile, atmospheric carbon concentrations are rising and the Earth is getting hotter.

- sea level is rising
- ice is melting
- precipitation patterns are changing
- growing seasons are shifting
- species are adapting or dying out

2005 were the hottest years on record; 2007 tied with 1998 for 2nd hottest; 14 hottest all occurred since 1990

http://data.giss.nasa.gov/gistemp/graphs/
The American public is not yet convinced that climate change should be a National priority - why is that?

- Climate science? - complicated and counterintuitive
- Global warming? - seems to have slowed
  - we had a cold, snowy winter in the U.S.
- Threat? - less clear than the economy, jobs, health
- Media? - message is muddled
  - the “blogosphere” is a land of polemics
  - many scientists avoid reporters
- Climate scientists? - some appear arrogant & cavalier
  - “Climategate” mess - cries of hoax
- Skeptics? - well-organized opposition
- Politics? - parties are deeply divided
Climate Science and Policy Are Vulnerable

Figure 1. Mann’s “hockey stick” temperature history for the past 1,000 years, including region of uncertainty (gray area) and time periods of the Medieval Warm Period and Little Ice Age—events that are largely absent in this record. (adapted from the IPCC’s Third Assessment Report).
The American public knows surprising little about energy (and climate change)

According to “Public Agenda” polling 2009 – (Dan Yankelovich and Jean Johnson):

• 40% of Americans can’t name a fossil fuel
• 60% of Americans can’t name a renewable energy source
• over 50% of Americans believe nuclear energy causes global warming
• nearly 1/3 believe solar energy causes global warming – about the same % of Americans that don’t see global warming as a serious problem
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Plenty of disorder!
Three Realities

Reality #1

• The world needs science and technology at least as much as at any time in recent history – example: ENERGY

Reality #2

• The world is “flatter” because of technology, and the U.S. faces economic uncertainties – example: CHINA
Challenges to Competitiveness

Tom Friedman’s Flat World

Ten forces are leveling the playing field for commerce – most have to do with technology and innovation. Those nations that expect to lead will need to invest in science and technology and training scientists and engineers.

The prospects for the U.S. don’t look good!

The World is Flat by Tom Friedman (Farrar, Strauss & Giroux, NY, 2005)
Challenges to Competitiveness

Is the U.S. losing its edge in S&T - perhaps facing a “gathering storm”? 

“Rising Above the Gathering Storm”
National Academies NRC Report 2006

“Is America Falling Off the Flat Earth?”
National Academies Press 2007 (Norm Augustine)

“Rising Above the Gathering Storm Revisited – Rapidly Approaching Category 5”
National Academies NRC Report 2010

Norm Augustine
U.S. Funds ~ 35% of World’s R&D – but decreasing!

U.S. Employs ~ 25% of World’s S&E Researchers – but decreasing!

Shares of Total World R&D, 2007*

Total World R&D = U.S.$ 962 billion**

- U.S., $344
- China, $87
- Japan, $139
- Others (EU, Other)
- France, $41
- U.K., $36
- Germany, $67
- Korea, $36
- All Other, $114

* World = OECD members plus Argentina, China, Romania, Russia, Singapore, Slovenia, South Africa, Taiwan. 2007 or most recent year available.

** Calculated using purchasing power parities.

Shares of World* S&E Researchers, 2006

Total World * S&E Researchers (FTEs) = 5.8 million **

- China, 21%
- Japan, 12%
- Korea, 3%
- EU-27, 38%
- U.S., 25%

* World = OECD members plus Argentina, China, Romania, Russia, Singapore, Slovenia, South Africa, Taiwan. Does not include India.

** Calculated using full-time equivalents.

Source: OECD, Main Science and Technology Indicators, 2008. 2007 data or latest year available.

AUGUST ’08 © 2008 AAAS
U.S. R&D Likely to be Overtaken by Asia

R&D expenditures for United States, EU, and Asia: 1996–2007

SOURCE: National Science Board, Science and Engineering Indicators 2010
U.S. R&D Funding (% of GDP) - Total
Federal R&D continues downward!

U.S. GDP (1953-2010)

Source: NSF, Division of Science Resources Statistics. 2007 data are estimates. Includes defense and nondefense R&D.

AUGUST '08 © 2008 AAAS
U.S. R&D Funding (% of GDP) - Total
Federal R&D continues downward!

And the U.S. has no national strategy – more disorder!

Source: NSF, Division of Science Resources Statistics.
2007 data are estimates. Includes defense and nondefense R&D.
AUGUST '08 © 2008 AAAS
Three Realities

Reality #1
• The world needs science and technology at least as much as at any time in recent history – example: ENERGY

Reality #2
• The world is “flatter” because of technology, and the U.S. faces economic uncertainties – example: CHINA

Reality #3
• The U.S. public and political leadership are polarized and unable to make progress on important issues. And the American people are defenseless against organized attacks on science.
There are many ways to influence federal policy -- from the inside

President

- WH Staff
- WH Executive Offices (OSTP, OMB, NSC, ...)

Congress

- House and Senate Committees & Subcommittees & Staff

“Cabinet” (Department Secretaries)

Office Management and Budget

Federal Departments & Independent Agencies

Federal Agencies: NSF, DOE, NASA, EPA, HHS (NIH), USDA, DoEd, et.al.

House - 435 voting (242 R+192 D+1)

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**Congress**
- House and Senate Committees & Subcommittees & Staff
- Cabinet (Department Secretaries)
- Media
- Lobbyists
- Big Money
- Special Interests
- Consumers
- TEA Parties
- Scientific Societies
- Universities

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**Big Money**
- Scientific Societies
- Universities

**Industry**
- Media
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- Lobbyists
- Scientific Societies
- Universities

**University**
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**Special Interests**
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**Scientific Societies**
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There are many ways to influence federal policy -- from the outside

Finding policy signal in the noise. It’s not perfect disorder – but close!
Policy Held Up While We Rant!

“Slash the budget – but not medicare or social security or…..!”

Another kind of “tea party”
Uncertainty - Possible Futures
Uncertainty – Possible Futures?

• **U.S. Leadership in Science and Technology**
  - Research and discovery ?
  - Engineering, technology, innovation ?
  - Quality of S&E workforce ?

• **U.S. Federal Policies on S&T**
  - Integrity of science in policy making ?
  - Funding of basic research – all fields ?
  - International cooperation (e.g., visas and export controls) ?

• **U.S. Public’s Attitudes and Understanding**
  - Understanding of science and its value?
  - Trust in scientists ?
  - Support for K-12 science and math education ?

• **The U.S. position in the world**
  - An exporter of technology, goods, services ?
  - An exporter of ideas and ideals ?
Uncertainty – Possible Futures?

• U.S. Leadership in Science and Technology
  • Research and discovery?

Progress requires a change in S&T policy making:

• A long-range strategic vision
• Multi-year commitments and implementation
• Stability in research funding
• Coordination among federal agencies
• Policy based on scientific evidence
• Stronger non-partisan political voice for S&T
• Much more public engagement by scientists
A Way Forward
"At such a difficult moment, there are those who say we cannot afford to invest in science. That support for research is somehow a luxury at a moment defined by necessities. I fundamentally disagree. Science is more essential for our prosperity, our security, our health, our environment, and our quality of life than it has ever been..."
A Way Forward—Obama’s Policies

- Basic Research - double funding!
- NSF graduate fellowships - triple!
- R&E (R&D) tax credit - make permanent!
- Renewables & efficiency - $150 billion/10yr!
- Create ARPA-E (Energy)!
- Earth observations - upgrade systems!
- STEM education - improve all levels!
- NASA - on sustainable trajectory!
- Stem cell research - allow more lines!
- Policy decisions - science based!
However ... following the 2010 Congressional elections, Congress does not agree with most of these priorities - especially those that cost money.

Most members of Congress agree on the importance of S&T and the government’s role in funding research, but science and R&D just get lost in political squabbles over other matters.

Congress has no mechanism to focus on S&T or R&D - no committee, no office, no staff....
Research is a small part of Federal spending – and it is getting squeezed!

Total Federal Spending in FY2011

- **$ 3.6 trillion**
  - **DEF.**
    - $ 82 billion
  - **NON-DEF.**
    - $ 63 billion
  - **Research**: $ 60 billion
  - **Development**: $ 79 billion

X = non-discretionary

National **Debt** ~ $15 trillion & **FY2011 Deficit** ~ $1 trillion

[Image of the Capitol Building and American Association for the Advancement of Science logo]
Research Funding Tracks Total Spending

R&D and Discretionary Outlays (Nondefense), 1962-2010
in billions of constant FY 2005 dollars

Total non-defense (blk)  Total non-defense R&D (red)

Apollo

Nondefense discretionary (left scale)

Nondefense R&D (right scale)
A Way Forward - Obama's S&T Policymakers

John Holdren - Ass’t to President and Dir. OSTP
Eric Lander - Co-Chair (with John Holdren) of PCAST
Steve Chu - Secretary of Energy
Steve Koonin - Undersecretary of Energy for Science
Jane Lubchenco - Administrator of NOAA (DOC)
Marcia McNutt - Director USGS (DOC)
Francis Collins - Director of NIH (HHS)
Harold Varmus - Director of National Cancer Institute
Bill Colglazier - Science Advisor to Secretary of State
Charles Bolden - Administrator of NASA
President Obama has an outstanding S&T team and an office -OSTP-that does focus on S&T and R&D. But he and they need a lot of help.

And the U.S. will have future administrations that will be less progressive in their views about policy and S&T in particular.

We need to do business differently!
One way scientists can help

Former Congressman George Brown (D-CA) had some advice for us – to be “civic scientists”

“to become more involved with the political process and the needs of the broader society — in other words, be more effective citizens.”
A Few Examples of Civic Scientists
- Recent Years!

Francis Collins
Mich/HGP/NIH

Walter Massey
NSF/Morehouse

Arden Bement
Purdue/NSF

Harold Varmus
U.Cal/NIH/NCI

Bruce Alberts
Cal/NAS/‘Science’

Steve Chu
Cal/Sec. Energy

Subra Suresh
MIT/NSF

Rita Colwell
Md/NSF

Elias Zerhouni
NIH/JHU

Bill Foster
D-Ill

Shirley Jackson
RPI, NRC

Jack Gibbons
ORNL/OTA/OSTP

John Holdren
Harvard/OSTP

Rush Holt
D-NJ

Vern Ehlers
R-Mich

Allan Bromley
Yale, OSTP

Jack Marburger
SUNY/BNL/OSTP
Another idea - to help get a stronger political voice for S&T
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- Office Management and Budget

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Lobbyists

Special Interests

Media

universities

scientific societies

Industry

Consumers

TEA PARTIES

Big Money

Media

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Industry

universities

scientific societies
There are many ways to influence federal policy -- from the outside ... room for one more?

President

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Congress

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universities

Industry

scientific societies

scientific societies

scientific societies
One Idea: We may need a new independent organization - supported by Government, Universities and Industry - to carry out policy analysis, develop “rational” options, and inform the public.

President

Congress

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WH Executive Offices (OSTP, OMB, NSC ....)

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GUI S&T Policy Organization

scientific societies

scientific societies

scientific societies

scientific societies
Non-government non-partisan organization
Endowed funding from three sectors G,U,I
Governing Board with G,U,I representation
Congressional Charter
Director and small professional staff
MISSION

Develop non-partisan policy options on S&T matters of national importance that are consistent with scientific evidence; provide public access to all relevant information; and contribute to the public understanding of S&T.
MISSION

Develop non-partisan policy options on S&T matters of national importance that are consistent with scientific evidence; provide public access to all relevant information; and contribute to the public understanding of S&T.
Can the National Academies do this?

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GUI S&T Policy Organization

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**Pros:**
- Reputation for objectivity is without peer
- Supported by both parties and all sectors
- Mature infrastructure – NRC

**Cons:**
- Different mission and Congressional Charter
- Would need larger endowment
- Shared governance (GUI)
- Possible political repercussions & neg. feedback
Sec. 3. And be it further enacted, That the National Academy of Sciences shall hold an annual meeting at such place in the United States as may be designated, and the Academy shall, whenever called upon by any department of the Government, investigate, examine, experiment, and report upon any subject of science or art, the actual expense of such investigations, examinations, experiments, and reports to be paid from appropriations which may be made for the purpose, but the Academy shall receive no compensation whatever for any services to the Government of the United States.
Can the National Academies do this?

NRC BY EXECUTIVE ORDER
President Woodrow Wilson’s Executive Order No. 2859 of
11 May 1918

"[A] National Research Council, the purpose of which shall be to bring into cooperation government, educational, industrial, and other research organizations with the object of encouraging the investigation of natural phenomena, and increased use of scientific research in the development of American industries, the employment of scientific methods in strengthening the national defense, and such other applications of science as will promote the national security and welfare."
The Future?

Why are my grandkids smiling?
You can always count
On the Americans to do
The right thing.
You can always count
On the Americans to do
The right thing.

After they’ve exhausted
All the other possibilities.

Slides stolen from Chuck Vest
President NAE
THANK YOU!