Report of the BESAC (Office of Science) Subpanel on Performance Measurement

Ned R. Sauthoff

Presented at the FESAC meeting
February 28, 2002
Gaithersburg, Maryland

Introduction:
The FY2003 Science and Technology Budget

- $112B (of $2.1T total: ~5%) for research spending, an 8% rise
- Emphasis on R&D for anti-terrorism, networking/IT, nanotechnology, and climate-change
- Growing fraction to Defense R&D; emphasis on combating terrorism
- Health-related R&D up 16%, completing the 5-year doubling of NIH; > 1/2 of civilian R&D spending, and ~2/3 of basic research
- Significant focus on “improving management” of R&D

Marburger on S&T Funding Priorities

"I support these science management initiatives because I believe they are essential to reassure the public -- our ultimate sponsors -- that the ever increasing investment in science is being made wisely."

AAAS 2/15/2002

"The simple reason for evaluation is that there is not enough money. Choices have to be made.

OMB/COSEPUP workshop 2/27/02

Marburger on S&T Funding Priorities

"The President's budget makes much of management, and proposes many measures that are not designed particularly to save money so much as to optimize its impact.

I am referring to proposals to transfer programs among agencies, to reward agencies and programs that can document the success of their projects, to find ways of making clear and explicit the basis for investment in one program rather than another."

AAAS 2/15/2002

" . . . I also expect measurable performance objectives and accountability. Where performance does not measure up, I have made clear to my entire leadership team that changes will be made."

(The Secretary of Energy, October 16, 2001.)

The Bottom Line:

***No** accountability,*

***No** performance,*

***No** planning,*

***No** funding increases*

"The wrong question to ask is: How much of an increase in our budget are we getting? The right question is: What are we getting for the money?"
OMB Official, January 2002

A House Science Committee Democratic (Minority) view on R&D metrics in the President's FY2003 R&D budget

"Metrics have become a cloak behind which politics, both Presidential and Congressional, can carry on as before with a new patina of impartiality."

BESAC (Office of Science) Subpanel on Performance Measurement: Charge

1. SC's current methods for performance measurement

2. Appropriateness and comprehensiveness of the methods

3. Effects on science programs

4. SC's integration of performance measures with the budget process as required by the Government Performance and Results Act (GPRA) of 1993

Membership of the BESAC Subpanel

- chair — Dr. John Stringer (EPRI)

- ASCR — Dr. Roscoe C. Giles (Boston University)
- BER — Dr. Eugene W. Bierly (AGU)
- BES — Dr. John H. Richards (Caltech)
- FES — Dr. Ned R. Sauthoff (Princeton University)
- HEP — Dr. Fred Gilman (Carnegie Mellon)
- NS — Dr. John P. Schiffer (Argonne National Lab)

- academia — Dr. Nicholas Vonortas (George Washington University)

BESAC / Office of Science Panel on Performance Measurement: Presenters and Roundtable Participants

William J. Valdez, Director	**Office of Planning and Analysis, DOE Office of Science**
Dr. James F. Decker	**Acting Director, Office of Science, DOE**
Dr. Patricia Dehmer	**Associate Director, Office of Basic Energy Sciences, DOE**
James Powers	**Director, Program Analysis and Evaluation, Office of the Chief Financial Officer, DOE**
Dr. Michael J. Holland	**Program Examiner, OMB**
Robin Nazzaro	**Assistant Director, Natural Resources and Environment, GAO**

1st Roundtable: Effects of Performance Measurement on Science Programs Supported by SC

- Dr. Milton Johnson, Acting Principal Deputy Director, Office of Science, DOE
- Dr. Patricia Dehmer (BES), Dr. Anne Davies (FES), Dr. Ed Oliver (ASCR), Dr. Ari Patrinos (BER), Dr. Alan Schriesheim (ANL), Dr. Robin Staffin (HENP)

2nd Roundtable: Effects of Performance Measurement on Facility Construction and Operation

- Dr. James Turi, Acting Deputy Director for Operations, Office of Science, DOE
- Dr. Patricia Dehmer (BES), Dr. Anne Davies (FES), Dr. Ed Oliver (ASCR), Dr. Ari Patrinos (BER), James A. Rispoli (Engineering & Construction Management), Dr. Robin Staffin (HENP)

3rd Roundtable: Alternative Approaches to Evaluation and Other Agency Experiences

- William J. Valdez, Office of Planning and Analysis, Office of Science, DOE
- Dr. Irwin Feller (Penn State), Dr. Gretchen B. Jordan (Sandia), Dr. Nathaniel Pitts (NSF), Dr. Lana Skirboll (NIH)

Outline of this talk:
Situation Analysis ⇨ Recommendations

- **Government Performance and Results Act (GPRA) [1993]**
- **National Academies' Committee on Science, Engineering and Public Policy (COSEPUP) studies regarding GPRA and research**
- **President's Management Agenda [2001]**
- **President's FY2003 Budget Submission [2002]**
  - for the DOE Office of Science
  - for the Office of Fusion Energy Sciences

➢ **Recommendations to DOE/SC**

➢ **COSEPUP workshop 2/27/02**

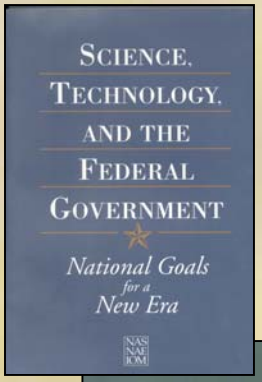
Government Performance and Results Act (GPRA) [1993]

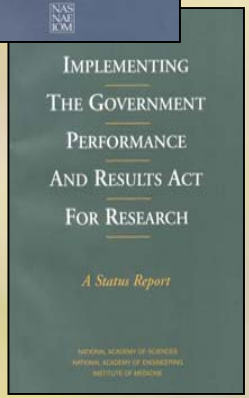
- **Objective: "to provide for the establishment of strategic planning and performance measurement in the Federal Government"**

- **Highlights:**
  - GPRA requires the agency plan to
    - "establish performance goals to define the level of performance to be achieved by a program activity"
    - "express such goals in an objective, quantifiable, and measurable form *unless authorized to be in an alternative form under section (b)*". [italics added]
  - "an agency may aggregate, disaggregate, or consolidate program activities, except that any aggregation or consolidation may not omit or minimize the significance of any program activity constituting a major function or operation for the agency."
  - "No later than March 31, 2000, and no later than March 31 of each year thereafter, the head of each agency shall prepare and submit to the President and the Congress, a report on program performance for the previous fiscal year."

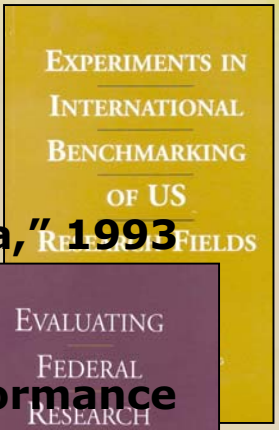
"Government should be run like a business....."

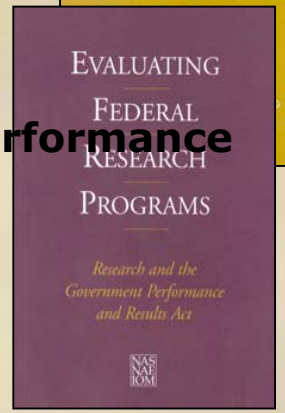
GPRA was developed with the notion that government and private sector/industrial management shared common practices. The primary vehicle for science agency implementation of GPRA has been COSEPUP.





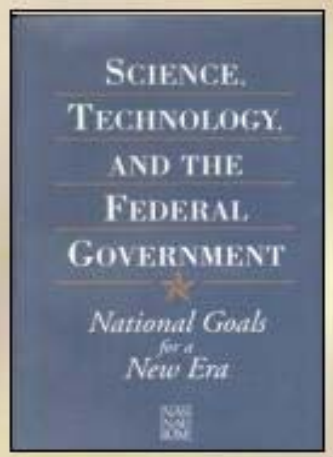
- **"Science, Technology, & The Federal Government: National Goals for a New Era," 1993**
- **"Evaluating Federal Research Programs: Research and the Government Performance and Results Act," 1999**
- **"Experiments in International Benchmarking of US Research Fields," 2000**
- **"Implementing the Government Performance and Results Act for Research: A Status Report," 2001**





Our challenge is to meld public and private sector practices into something that works for the Office of Science.

Goals for Federally Funded Science

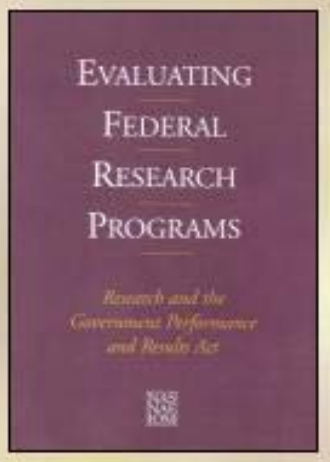


SCIENCE, TECHNOLOGY, AND THE FEDERAL GOVERNMENT: National Goals for a New Era (COSEPUP, 1993)

Summary of Science Goals:

- **The first goal is that the U.S. should be among the world leaders in all major areas of science.**
- **The second goal is that the U.S. should maintain clear leadership in some major areas of science. The decision to select a field for leadership would be based on national objectives and other criteria external to the field of research.**
- **The comparative performance of U.S. research in a major field would be assessed by independent panels of experts from within and outside the field.**

Evaluation Criteria for Federally Funded Science



EVALUATING FEDERAL RESEARCH PROGRAMS: Research and the Government Performance and Results Act (COSEPUP, 1999)

Among the Six Conclusions:

- **Both applied research and basic research programs can be evaluated meaningfully on a regular basis.**
- **The most effective means of evaluating federally funded research programs is expert review, which includes quality review, relevance review, and benchmarking.**
- **Agencies must evaluate their research programs by using measurements that match the character of the research.**
- **The development of effective methods for evaluating and reporting performance requires the participation of the scientific and engineering community.**

Examples of International Benchmarking from other fields

- **COSEPUP prototyped international benchmarking in several fields:**
  - Materials Science and Engineering Research
  - Mathematics Research
  - Immunology Research

- **Some outcomes:**
  - "Virtual Congress" and other methods for assessing international standing
  - Some lessons:
    - in fields that require capital-intensive infrastructure, US has earned and maintained access to leading international facilities (e.g., neutron sources, light sources)
    - in fields that do not require capital-intensive infrastructure, the US exploited discoveries abroad via leading expertise in adjacent fields
      - US exploited high-temperature superconductor discoveries abroad
      - emphasize the flexibility/mobility of leading researchers to move to adjacent emerging areas of recent discovery/opportunity

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET

THE PRESIDENT'S MANAGEMENT AGENDA

FISCAL YEAR 2002

President's Management Agenda [FY2002]: R&D Investment Criteria

Better R&D Investment Criteria are critically important to keeping our nation's economy competitive and for addressing challenges we face in health care, defense, energy production and use, and the environment. As a result, every federal research and development (R&D) dollar must be invested as effectively as possible.

- **THE PROBLEM**
  - Vague goals lead to perpetual programs achieving poor results.
  - The federal government needs to measure whether its R&D investments are effective.
  - We do not link information about performance to our decisions about funding.
  - Many R&D projects have ended up stepping beyond the legitimate purposes of government

- **THE EXPECTED LONG–TERM RESULTS**
  - The Administration expects that these investment criteria will better focus the government's research programs on performance.
  - Applied research programs will be better focused on achieving well-defined practical outcomes.
  - Basic research programs will better target improving the quality and relevance of their research.

President's Management Agenda [FY2002]:
R&D Investment Criteria

THE INITIATIVE

- DOE and OMB are developing performance criteria for applied research and development programs.
  OMB and DOE will use these criteria to guide funding for the 2003 Budget for the Department's Solar and Renewable Energy, Nuclear Energy, Clean Coal, Fossil Energy, and Energy Conservation programs.

- OMB and the Office of Science and Technology Policy will also work with NASA, the National Science Foundation, the Department of Defense, the National Institutes of Health, and DOE to develop separate criteria, to be issued in Spring 2002, for evaluating basic research during formulation of the 2004 Budget.

Applied R&D Criteria/Metrics from OMB

- Is the project a presidential priority?
- Will the project clearly benefit the public in an area where the private sector does not have sufficient market incentive to sufficiently fund the research?
- Is support for applied research the best means to accomplish the federal goal?
- Is the project comprehensive, meaning it includes milestones to measure progress and guidance as to when the research should stop?
- Was the project selected in a competitive manner based on its merits?
- If the project was previously funded, did it deliver results on time and in a cost-effective manner?

GPRA & the SC Budget Process

Fy2003 Budget Changes

Science Corporate Context

For the past 50 years, U.S. taxpayers have earned an enormous return on their investment in the basic research sponsored by the Department of Energy's Office of Science. The science underlying a multitude of discoveries – ranging from advanced energy and environmental technologies that reduce consumer electricity bills while protecting the environment, to great leaps in our knowledge of how the universe originated – has flowed out of the national laboratories and universities where DOE-sponsored scientists conduct their research. During Fiscal Year 2003, DOE will continue this legacy of discovery through strategic investments in basic research and the major national scientific user facilities that the Office of Science builds and operates on behalf of the Nation.

The events of 2001, particularly the war on terrorism, underscore the continuing need for sustained investments in basic research. DOE's accomplishment of its missions in national security, energy, and environment rely upon advances in basic research that are managed by the Office of Science. This basic research – which encompasses such diverse fields as materials sciences, chemistry, high energy and nuclear physics, plasma science, plant sciences, biology, advanced computation, and environmental studies – is contributing to effective counter measures in the war on terrorism, the Administration's goal of U.S. energy independence, and the overall vitality of the U.S. science and technology enterprise.

Science Goal

Deliver the scientific knowledge and discoveries for DOE's applied missions; advance the frontiers of the physical sciences and areas of the biological, environmental and computational sciences; and provide world-class research facilities and essential scientific human capital to the Nation's overall science enterprise.

Strategic Objectives

The Office of Science business line goal is supported by the following eight strategic objectives. Programs requesting funding to achieve these objectives are identified with each objective below:

SC1: Determine whether the Standard Model accurately predicts the mechanism that breaks the symmetry between natural forces and generates mass for all fundamental particles by 2010 or whether an alternate theory is required, and on the same timescale determine whether the absence of antimatter in the universe can be explained by known physics phenomena. (HEP)

SC2: By 2015, describe the properties of the nucleon and light nuclei in terms of the properties and interactions of the underlying quarks and gluons; by 2010, establish whether a quark-gluon plasma can be created in the laboratory and, if so, characterize its properties; by 2020, characterize the structure and reactions of nuclei at the limits of stability and develop the theoretical models to describe their properties, and characterize using experiments in the laboratory the nuclear processes within stars and supernovae that are needed to provide an understanding of nucleosynthesis. (NP)

Corporate Context: Provides a general context for the Office of Science

Science Goal: Could serve as the Mission Statement for SC in a Strategic Plan.

Strategic Objectives: The high level goals for the Office of Science.

OFFICE OF SCIENCE U.S. DEPARTMENT of ENERGY

President's FY2003 Budget [2/2002]
Corporate Context for Science (SC) Programs

- **Corporate Context … is provided to facilitate the integration of the FY 2003 budget and performance measures.**

- **The Department's Strategic Plan published in September 2000 is no longer relevant**
  - The Department has initiated the development of a new Strategic Plan due for publication in September 2002

- **Science (SC) Goal:**
  - deliver the scientific knowledge and discoveries for DOE's applied missions;
  - advance the frontiers of the physical sciences and areas of the biological, environmental and computational sciences; and
  - provide world-class research facilities and essential scientific human capital to the Nation's overall science enterprise.

President's FY2003 Budget [2/2002]
Strategic Objectives for the DOE Office of Science
(1 of 4)

- **SC1: Determine whether the Standard Model accurately predicts the mechanism that breaks the symmetry between natural forces and generates mass for all fundamental particles by 2010 or whether an alternate theory is required, and on the same timescale determine whether the absence of antimatter in the universe can be explained by known physics phenomena. (HEP)**

- **SC2: By 2015, describe the properties of the nucleon and light nuclei in terms of the properties and interactions of the underlying quarks and gluons; by 2010, establish whether a quark-gluon plasma can be created in the laboratory and, if so, characterize its properties; by 2020, characterize the structure and reactions of nuclei at the limits of stability and develop the theoretical models to describe their properties, and characterize using experiments in the laboratory the nuclear processes within stars and supernovae that are needed to provide an understanding of nucleosynthesis. (NP)**

President's FY2003 Budget [2/2002]
Strategic Objectives for the DOE Office of Science
(2 of 4)

- **SC3: By 2010, develop the basis for biotechnology solutions for clean energy, carbon sequestration, environmental cleanup, and bioterrorism detection and defeat by characterizing the multiprotein complexes that carry out biology in cells and by determining how microbial communities work as a system; and determine the sensitivity of climate to different levels of greenhouse gases and aerosols in the atmosphere and the potential resulting consequences of climate change associated with these levels by resolving or reducing key uncertainties in model predictions of both climate change that would result from each level and the associated consequences. (BER)**

- **SC4: Provide leading scientific research programs in materials sciences and engineering, chemical sciences, biosciences, and geosciences that underpin DOE missions and spur major advances in national security, environmental quality, and the production of safe, secure, efficient, and environmentally responsible systems of energy supply; as part of these programs, by 2010, establish a suite of Nanoscale Science Research Centers and a robust nanoscience research program, allowing the atom-by-atom design of revolutionary new materials for DOE mission applications; and restore U.S. preeminence in neutron scattering research and facilities. (BES)**

President's FY2003 Budget [2/2002]
Strategic Objectives for the DOE Office of Science
(3 of 4)

- **SC5: Enable advances and discoveries in DOE science through world-class research in the distributed operation of high performance, scientific computing and network facilities; and to deliver, in 2006, a suite of specialized software tools for DOE scientific simulations that take full advantage of terascale computers and high speed networks. (ASCR)**

- **SC6: Advance the fundamental understanding of plasma, the fourth state of matter, and enhance predictive capabilities, through the comparison of well-diagnosed experiments, theory and simulation; for MFE, resolve outstanding scientific issues and establish reduced-cost paths to more attractive fusion energy systems by investigating a broad range of innovative magnetic confinement configurations; advance understanding and innovation in high-performance plasmas, optimizing for projected power-plant requirements; develop enabling technologies to advance fusion science, pursue innovative technologies and materials to improve the vision for fusion energy; and apply systems analysis to optimize fusion development; for IFE, leveraging from the ICF program sponsored by the National Nuclear Security Agency's Office of Defense Programs, advance the fundamental understanding and predictability of high energy density plasmas for IFE. (FES)**

President's FY2003 Budget [2/2002]
Strategic Objectives for the DOE Office of Science
(4 of 4)

- **SC7: Provide major advanced scientific user facilities where scientific excellence is validated by external review; average operational downtime does not exceed 10% of schedule; construction and upgrades are within 10% of schedule and budget; and facility technology research and development programs meet their goals. (Crosscutting all major programs.)**

- **SC8: Ensure efficient SC program management of research and construction projects through a reengineering effort of SC processes by FY 2003 that will support world class science through systematic improvements in SC's laboratory physical infrastructure, security, and ES&H. (Covers the following accounts: Energy Research Analysis, Science Laboratories Infrastructure, Science Program Direction, Science Education, Field Operations, Safeguards and Security, Technical Information)**

GPRA & the SC Budget Process

Fy2003 Budget Changes

High Energy Physics

Strategic Objectives

SC1: Answer two key questions about the fundamental nature of matter and energy. Determine whether the Standard Model accurately predicts the mechanisms that breaks the symmetry between natural forces and generates mass for all fundamental particles by 2010 or whether an alternate theory is required, and on the same timescale determine whether the absence of antimatter in the universe can be explained by known physics phenomena.

SC7: Provide major advanced scientific user facilities where scientific excellence is validated by external review; average operational downtime does not exceed 10% of schedule; construction and upgrades are within 10% of schedule and budget; and facility technology research and development programs meet their goals.

Progress toward accomplishing these Strategic Objectives will be measured by Program Strategic Performance Goals, Indicators and Annual Targets, as follows:

Program Strategic Performance Goals

SC1-1: Exploit U.S. leadership at the energy frontier by conducting an experimental research program that will establish the foundations for a new understanding of the physical universe. (Research and Technology subprogram and HEP Facilities subprogram).

Performance Indicator

Amount of data delivered and analyzed; Number of significant scientific discoveries.

Performance Standards

As discussed in Corporate Context/Executive Summary.

Annual Performance Results and Targets

FY 2001 Results	FY 2002 Targets	FY 2003 Targets
Completed first phase of upgrades to enable the Tevatron at Fermilab to run with much higher luminosity. Began commissioning of phase-one accelerator upgrades.	Deliver integrated luminosity as planned (80 pb-1) to CDF and D-Zero at the Tevatron. Begin implementation of second phase of accelerator upgrades: install four performance improvements to existing systems.(SC1-1)	Deliver integrated luminosity as planned (250 pb-1) to CDF and D-Zero at the Tevatron. Complete and install two new accelerator systems. Design new device to improve yield in antiproton target. (SC1-1)
Completed and commissioned upgrades of the CDF and D-Zero detectors at the Tevatron facility at Fermilab.	Collect data and begin analysis. (SC1-1)	Take data with high efficiency; record over 60% of available data and continue analysis. (SC1-1)

Strategic Objectives: Meant to be 5-10 years in outlook.

Program Strategic Performance Goals (PSPG): Meant to be 3-5 years in outlook. Will be tracked by CFO using PBViews in FY 2002.

Performance Indicator: Overall measure for the PSPG and Targets.

Performance Standards: The same for all SC.

Targets: Annual milestones, will also be tracked by PBViews starting in FY 2002. SC Program manager annual accountability is linked to these Targets.

This structure, when combined with the Corporate Context, will serve as a foundation For SC's Strategic Plan.

OFFICE OF SCIENCE U.S. DEPARTMENT OF ENERGY

President's FY2003 Budget [2/2002]
Fusion Energy Sciences: Strategic Objectives

- **SC6: Advance the fundamental understanding of plasma, the fourth state of matter, and enhance predictive capabilities, through the comparison of well-diagnosed experiments, theory and simulation; for Magnetic Fusion Energy (MFE), resolve outstanding scientific issues and establish reduced-cost paths to more attractive fusion energy systems by investigating a broad range of innovative magnetic confinement configurations ; advance understanding and innovation in high-performance plasmas, optimizing for projected power-plant requirements; develop enabling technologies to advance fusion science, pursue innovative technologies and materials to improve the vision for fusion energy; and apply systems analysis to optimize fusion development; for Inertial Fusion Energy (IFE), leveraging from the Inertial Confinement Fusion (ICF) program sponsored by the National Nuclear Security Agency's (NNSA) Office of Defense Programs, advance the fundamental understanding and predictability of high energy density plasmas for IFE.**

- **SC7: Provided major advanced scientific user facilities where scientific excellence is validated by external review; average operational downtime does not exceed 10% of schedule; construction and upgrades are within 10% of schedule and budget; and facility technology research and development programs meet their goals.**

President's FY2003 Budget [2/2002]
Program Strategic Performance Goals: SC6-1

- **SC6-1: Develop the basis for a reliable capability to predict the behavior of magnetically confined plasma and use the advances in the Tokamak concept to enable the start of the burning plasma physics phase of the U.S. fusion sciences program. (Science subprogram)**
  - Performance Indicator:
    - The range of parameter space over which theoretical modeling and experiments agree.

- **SC6-2: Develop the cutting edge technologies that enable FES research facilities to achieve their scientific goals and investigate innovations needed to create attractive visions of designs and technologies for fusion energy systems. (Enabling R&D subprogram)**
  - Performance Indicator
    - Percentage of milestones met for installing components developed by the Enabling R&D program on existing experimental devices.

President's FY2003 Budget [2/2002]
Program Strategic Performance Goal SC6-1:
FY2001 Results

- Improved nonlinear magnetohydrodynamics codes to be capable of computing the effect of realistic resistive walls and plasma rotation on advanced tokamak pressure limits.
  (met goal)

- Evaluated first physics results from the innovative Electric Tokamak at UCLA, to study fast plasma rotation and associated radial electric fields due to radiofrequencydrive, in order to enhance plasma pressure in sustained, stable plasmas. (Exploratory Concept-Electric Tokamak)
  (met goal)

President's FY2003 Budget [2/2002]
Program Strategic Performance Goal SC6-1: Targets

- **FY 2002 Targets**
  - Use recently upgraded plasma microwave heating system and new sensors on DIII-D to study feedback stabilization of disruptive plasma oscillations.
  - Successfully demonstrate innovative techniques for initiating and maintaining current in a spherical torus.
- **FY 2003 Targets**
  - Complete installation of internal coils for feedback control of plasma instabilities on DIII-D, and conduct a first set of experiments demonstrating the effectiveness of these coils in controlling plasma instabilities, and compare with theoretical predictions.
  - Produce high temperature plasmas with 5 Megawatts of Ion Cyclotron Radio Frequency (ICRF) power for pulse lengths of 0.5 seconds in Alcator C-Mod. Study the stability and confinement properties of these plasmas, which would have collisionalities in the same range as that expected for the burning plasma regime.

President's FY2003 Budget [2/2002]
Program Strategic Performance Goals: SC6-2

- **Develop the cutting edge technologies that enable FES research facilities to achieve their scientific goals and investigate innovations needed to create attractive visions of designs and technologies for fusion energy systems. (Enabling R&D subprogram)**

- **Performance Indicator**
  - Percentage of milestones met for installing components developed by the Enabling R&D program on existing experimental devices.

President's FY2003 Budget [2/2002]
Program Strategic Performance Goal SC6-2: Results and Targets

- **FY 2001 Results**
  - Completed the DOE-Japan Atomic Energy Research Institute collaboration on fusion plasma chamber exhaust processing in the Tritium Systems Test Assembly (TSTA) facility at LANL. (met goal)
  - Initiated a new U.S.-Japan collaborative program for research on enabling technologies, materials, and engineering science for an attractive fusion energy source. (met goal)

- **FY 2002 Targets**
  - Complete design and fabrication of the High-Power Prototype advanced ion-cyclotron radio frequency antenna that will be used at the Joint European Torus (JET).
  - Complete measurements and analysis of thermal creep of Vanadium Alloy (V-4Cr-4Ti) in vacuum and lithium environments, determine controlling creep mechanisms and access operating temperature limits.

- **FY 2003 Targets**
  - Complete testing of the High- Power Prototype advanced ioncyclotron radio frequency antenna that will be used at the Joint European Torus.
  - Complete preliminary experimental and modeling investigations of nano-scale thermodynamic, mechanical, and creep-rupture properties of nanocomposited ferritic steels.

President's FY2003 Budget [2/2002]
Program Strategic Performance Goals: SC7-6

- **Manage all FES facility operations and construction to the highest standards of overall performance, using merit evaluation and independent peer review. (Facility Operations subprogram)**

- **Performance Indicator**
  - Percent on time/on budget, percent unscheduled downtime.

President's FY2003 Budget [2/2002]
Program Strategic Performance Goal SC7-6:
Results and Targets

- **FY 2001 Results**
  - Kept deviations in cost and schedule for upgrades and construction of scientific user facilities within 10 percent of approved baselines; achieved planned cost and schedule performance for dismantling, packaging, and offsite shipping of the Tokamak Fusion Test Reactor (TFTR) systems [Met Goal]
  - Kept deviations in weeks of operation for each major facility within 10 percent of the approved plan. [Met Goal]

- **FY 2002 Targets**
  - Keep deviations in cost and schedule for upgrades and construction of scientific user facilities within 10 percent of approved baselines; successfully complete within cost and in a safe manner all TFTR decontamination and decommissioning activities.
  - Keep deviations in weeks of operation for each major facility within 10 percent of the approved plan.

- **FY 2003 Targets**
  - Keep deviations in cost and schedule for upgrades and construction of scientific user facilities within 10 percent of approved baselines; complete the National Compact Stellarator Experiment (NCSX) Conceptual Design and begin the Preliminary Design.
  - Keep deviations in weeks of operation for each major facility within 10 percent of the approved plan.

GPRA and FY2003 Budget Submission

- **The Subpanel was told that it is recognized by most of the participants that the FY2003 Budget Submission did not meet several of the GPRA requirements**
  - for example, that the program descriptions should give a comprehensive description of the program.

- **The Subpanel members from the Office of Science Advisory Committees considered that the set of these for the parts of the programs with which they are familiar distorted the aims and accomplishments of SC research programs.**
  - With PSPGs that are only representative and not at all comprehensive, the Office's programs are portrayed as significantly less than they truly are.
  - The Subpanel was concerned that this could even be detrimental to programs where their mis-portrayal could lead to unfortunate misunderstandings.

- **The Budget Submission fails as an effective communication tool, which is one of its most important roles.**

BESAC Subpanel Recommendation #1

The Subpanel recommends that the Office of Science completes its Strategic Plan as soon as possible.

- a key part of the GPRA process
- particularly important in relation to developing criteria for basic research
  - the five-year scope allows for longer-term planning
  - the review on a three-year basis allows for the introduction of new discoveries into the research planning
- gives basis against which “relevance” can be measured
- development should involve stakeholders

BESAC Subpanel Recommendation #2

The Subpanel recommends that the general principles of the performance assessment methods that have been used by the Office of Science in the past should continue to be followed.

- The success of the Office of Science in maintaining a very effective program of world-class research and the development of a significant number of world-class facilities has been recognized by independent reviews in the recent past.

Office of Science Categories of Activities

The Office of Science's research program can be described in terms of five distinct categories:

- Research projects at Universities and within the National Laboratories.
- Operation of the National Laboratories for which the Office of Science is responsible….
- Construction of the Large User Facilities, including the new Computer Facilities.
- Operation of the Large User Facilities.
- Operation of the Distributed Facilities.

Review of University Research

- **SC's "Merit Review System" guidelines, published in the Federal Register, and 10 CFR 605 set forth the policy and procedures applicable to the award and administration of grants and cooperative agreements by SC.**

  http://www.er.doe.gov/production/grants/merit.html
  http://www.er.doe.gov/production/grants/605index.html

- **3 independent reviewers for initiation of an award and for award renewals (generally every 3-4 years). Mail review, site visits, panel reviews all acceptable.**

- **Evaluation criteria:**

  (1) Scientific and/or technical merit or the educational benefits of the project;
  (2) Appropriateness of the proposed method or approach;
  (3) Competency of applicant's personnel and adequacy of proposed resources;
  (4) Reasonableness and appropriateness of the proposed budget; and
  (5) Other appropriate factors, established and set forth by SC in a notice of availability or in a specific solicitation.

- **Selection of applications for award is based upon the findings of the technical evaluations, the importance and relevance of the proposed application to SC's mission, and funding availability.**

Review of DOE Laboratory Research

- Laboratory programs are merit reviewed in a manner similar to that of university programs but using procedures appropriate to laboratories, e.g., site visits for multiple-PI activities. All lab programs are reviewed regularly using methods that match the character of the laboratory programs.
- Example -- Basic Energy Sciences.
  http://www.er.doe.gov/production/bes/labreview.html

  The document "Merit Review Procedures for Basic Energy Sciences Projects at the Department of Energy Laboratories" sets forth the procedures for merit review of research projects funded at these institutions. Mail review and visiting committees are used depending on the size of the program.
- Example – HEP and NP.
  Single-purpose labs are reviewed annually by visiting committees. HEPAP and NSAC review lab programs on a rotating basis.

Review of Scientific User Facilities

Charge to the BESAC subpanel for the review of the BES synchrotron radiation light sources

1. What has been the scientific impact of synchrotron radiation based research during the past decade, and what is it expected to be during the next decade?

2. What is the scientific and technological demand for synchrotron radiation? From what fields and sectors? Who are the newcomers? How has the demand changed since the 1984 Seitz-Eastman report, and how might it change in the future? Please provide quantitative information whenever possible, e.g., how has structural biology or geosciences or environmental sciences or x-ray microscopy changed during the past decade at the various light sources?

3. What is the user demand at each of the DOE synchrotron light sources? What is the distribution of users? Are there special needs served (e.g., scientific, industrial, geographical) at the different light sources, and, if so, are these needs growing or declining?

4. What is the expected future capability of each synchrotron light source over time? How do the capabilities complement one another?

5. What does each light source see as its own vision of the future? How do the visions complement each other? How well do the visions accommodate potential changes found in item 2?

6. In a constant budget scenario, what is the appropriate level of research and development (R&D) funding for efforts related to continuously improving current facility operations such as accelerator R&D, the design of insertion devices, the design of advanced instrumentation, etc.? How should these funds be apportioned between the facilities themselves and the user community including the broader accelerator R&D community? What is the priority between support for such R&D and direct support for users?

7. In a constant budget scenario, what level of investment should DOE/ BES make in R&D for 4th generation synchrotron sources and how should this effort be distributed among the facilities and other research sectors?

8. In a constant budget scenario, is the level of DOE/BES support of synchrotron radiation related research for users and user-controlled beamlines appropriate and, if not, how should it be changed?

9. If additional funds were available to DOE/BES, should they be invested in items 6, 7, and 8 and, if so, what should the priority be among them?

10. What would be the consequences of the shutdown of one or more of the four DOE/BES synchrotron light sources?

Review of Scientific User Facilities, Con't.

Biological and Environmental Research (BER)

- The EMSL was reviewed in November 2001 to assess scientific impact, operations, user access, user satisfaction, laboratory management, ES&H, and cyber (and other) security activities.
- The Joint Genome Institute Production Genomics Facility was reviewed in July 2000 to assess technical, cost, schedule, and management issues. A key element of this review was to evaluate progress in correcting deficiencies identified at a similar review held in November 1998.
- Each structural biology facility is reviewed every 4-5 years by groups that include experts in the facility's technology and experts in the applications of the technology. The results are evaluated by BER program managers in consultation with managers in DOE-BES, DOE-NNSA [for LANSCE] and in other agencies, including NIH, NSF and NIST.

Fusion Energy Sciences (FES)

- The major scientific user facilities are DIII-D at General Atomics, Alcator C-Mod at MIT, and National Spherical Torus Experiment at Princeton. Each is reviewed by peers in conjunction with contract or grant renewal every 5 years. OFES is arranging for similar reviews at mid-term.
- Each facility submits an annual work proposal that is reviewed in a community-wide meeting and by OFES staff.
- Each facility has its own Program Advisory Committee providing advice on the basis of technical review.
- Each facility sponsors an annual planning meeting in which previous results are reviewed and new ideas for research are proposed by the community.

Review of Scientific User Facilities, Con't.

High-Energy Physics (HEP)

- Annual reviews are conducted at HEP's five major facilities: Stanford Linear Accelerator Center (SLAC), Fermilab, Argonne National Laboratory (ANL), Brookhaven National Laboratory (BNL), and Lawrence Berkeley National Laboratory (LBNL).
- HEP Program Managers attend Program Advisory Committee (PAC) meetings to assess the quality of research, relevance and effectiveness of user facility research programs.
- The High Energy Physics Advisory Panel (HEPAP) periodically reviews research activities and capabilities in the High Energy Physics program.
- HEPAP is charged periodically to review research activities and capabilities of the HEP program.

Nuclear Physics (NP)

- Annual reviews are conducted at NP's two major facilities RHIC and TJNAF.
- Annual on-site Program Manager Reviews are conducted at NP's smaller user facilities.
- NP Program Managers attend Program Advisory Committee (PAC) meetings to assess the research quality, relevance and effectiveness of user facility research programs.
- Focused bottoms-up operation reviews are conducted periodically.
- NSAC is charged periodically to review research activities and capabilities in the Nuclear Physics program.

GAO Findings on SC Merit Review

- **Following the GAO report "*Federal Research -- Peer Review Practices at Federal Science Agencies Vary*" (GAO/RCED-99-99), the House Committee on Science requested a follow-up study at DOE, which included an audit of the peer review procedures of BES.**

- **GAO randomly sampled 100 BES research projects from a database of 1,298 projects funded in FY 1998. The sample included 75 grants and 25 projects funded at 9 DOE laboratories.**

- **The resulting report, "*Federal Research: DOE Is Providing Independent Review of the Scientific Merit of Its Research*" (GAO/RCED-00-109, April 2000) found:**

  "On the basis of our review of available documentation from program and project files for fiscal years 1998 and 1999, the Office of Basic Energy Sciences ... [followed] the merit review procedures they have established...[and] are performing merit reviews on projects or programs, are selecting reviewers with the requisite knowledge of the research, are requiring those reviewers to apply appropriate criteria in making their evaluations, and are using the merit review evaluations in making award decisions" (page 15).

- **Both GAO reports are available at:**
  http://www.sc.doe.gov/production/bes/peerreview.html

Review of Construction Projects

- SC's Construction Management Support Division conducts independent technical, cost, schedule, and management peer reviews of SC construction projects and large experimental equipment. These reviews are known as "Lehman Reviews" after the Division Director, Dan Lehman.
- Lehman Reviews are widely known in DOE, other agencies, and abroad. Dan Lehman has briefed OMB and other agencies on the process, which is now being adopted by other parts of DOE.
- A primary responsibility is conducting reviews of major projects, which are held typically twice yearly and may include 30-40 independent technical experts, who are divided into 6-8 subpanels during the review to investigate all aspects of the project.
- Reviews can result in modifications to the project, work stoppage, and management changes.

Summary of Review Mechanisms

- Scientific peer review of research and facility operations by mail, site visits, and panels as appropriate
- Detailed reporting of statistics for facility operations
- Construction project management reviews
- Infrastructure maintenance reviews
- Annual evaluation of M&O contractors
- Committees of Visitors to assess program management
- Advisory Committee subpanels for programmatic, facility, laboratory, and relevance reviews
- Occasionally, NRC, COSEPUP, The Washington Advisory Group, JASON, etc.

BESAC Subpanel Recommendation #3

The Subpanel recommends that the Office of Science's performance measurement criteria be aligned with those that have been developed by the National Academies' Committee on Science, Engineering, and Public Policy (COSEPUP), and with their ongoing studies on the development of criteria for Basic Research, to allow a common basis for the different Federal Agencies that support basic research programs.

- Quality
- Relevance
- Leadership

SC's Corporate Measures

SC has reviewed COSEPUP guidance and adopted an approach that is consistent, but tailored to SC's needs and combines quantitative and qualitative measures.

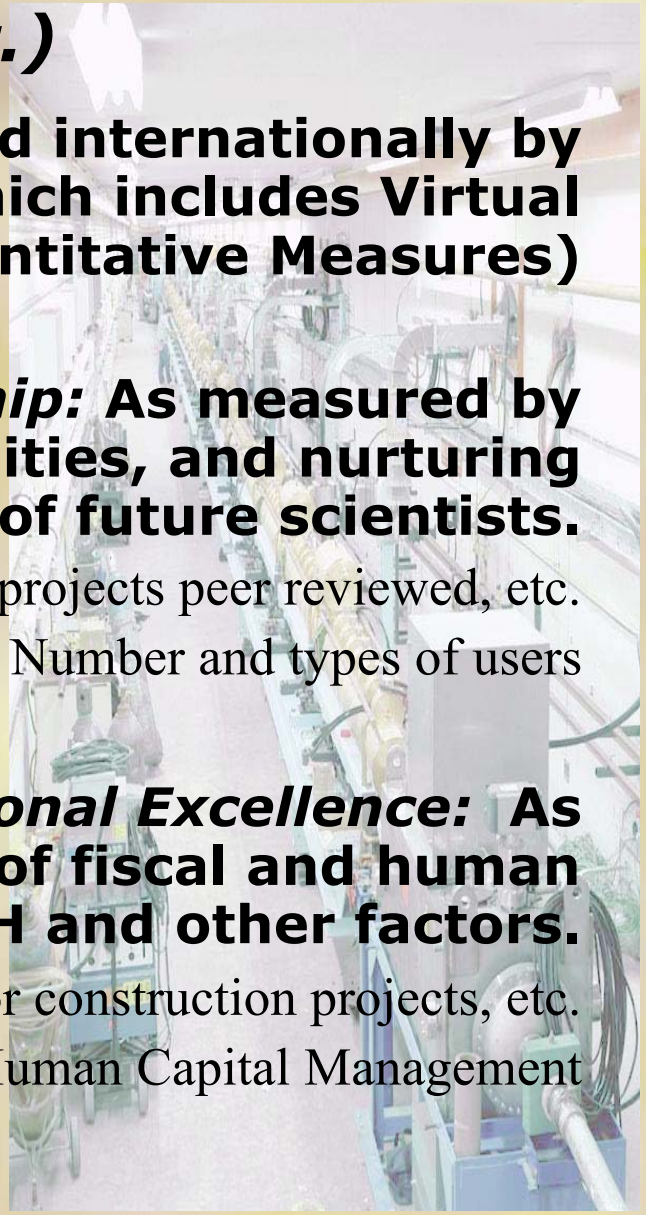
- ***Excellence:* As measured by external peer review, advisory committees, GAO, NAS, etc.**
  - A mix of quantitative measures are also being considered (citations, case studies, conference papers)
- ***Relevance:* As measured by external review.**
  - A mix of quantitative measures is being considered.

SC's Corporate Measures (cont.)

- ***Science Leadership:*** **As measured internationally by Rolling Program Reviews (which includes Virtual Congress, Quantitative Measures)**

- ***Science Infrastructure Stewardship:*** **As measured by our management of labs/facilities, and nurturing of future scientists.**
  - Percentage of projects peer reviewed, etc.
  - Number and types of users

- ***Management & Operational Excellence:*** **As measured by our use of fiscal and human resources, ES&H and other factors.**
  - On time/on budget for construction projects, etc.
  - Human Capital Management



Some Lessons Learned:

COSEPUP's studies and SC's experience indicate the following:

- Basic research programs should be evaluated on their Quality, Relevance, & Leadership.
- Great care should be taken to measure the right things.
- 80%-90% of GPRA's requirements are already being met by SC.
- The 10%-20% not being met by SC – principally outcome measures and linkages to annual budgets – is very difficult to accomplish.

"Our report takes two strong positions. First, the useful outcomes of basic research cannot be measured directly on an annual basis…. Second, that does not mean that there are no meaningful measures of of performance of basic research while the research is in progress…." COSEPUP, 1999

Quality

- **COSEPUP has stated clearly in their reports that peer review is still the most effective means of evaluation of quality.**

- **The Office of Science's methods of peer review are defined in two public documents:**
  - the Office of Science Merit Review System, published in March, 1991
  - Regulation 10 CFR 605, a more formal specification of the requirements for awarding research contracts

- **The peer review methods of the Office of Science have themselves been reviewed by external bodies several times**
  - these have always indicated that the methods are appropriate and effective.

➢ **The Subpanel believes that the methods currently being used by the Office to measure quality are appropriate and adequate, and that they should continue to be used.**

Relevance

- has traditionally been interpreted in terms of the relevance of the research to progress in the appropriate scientific discipline
- in a mission-oriented agency it must also mean relevance to the mission of the agency
- the President's Management Agenda indicates that this must, in turn, relate to the Administration's goals

➢ the Subpanel believes that the Office needs to review its procedures in the light of these broader definitions of relevance, using the COSEPUP analyses as guidelines.

Leadership

- **means leadership in the global context**
  - discussed by COSEPUP in terms of benchmarking

- **The Office of Science is very conscious of this metric, for example in its decisions relating to the justifications for new large user facilities and for upgrading the existing facilities**

➢ **the Subpanel believes that the new criteria may require wider assessment of the status of U.S. fields of research in the global context**
  - the COSEPUP-guidelines may provide methods of assessment

("leadership as a goal" is an issue with OMB)

BESAC Subpanel Recommendation #5

The Subpanel recommends that criteria to assess the "world leadership" element in the assessment of the Office of Science's research should be developed.

- Separate recommendation to emphasize its importance

Measure All the Right Things
Quality (), Relevance (), Leadership (), Management ()

Experiments in International Benchmarking of US Research Fields
NAS, NAE, IOM Committee on Science, Engineering, and Public Policy (COSEPUP), 2000

International Benchmarking of US Materials Science and Engineering Research*

Summary and Conclusions

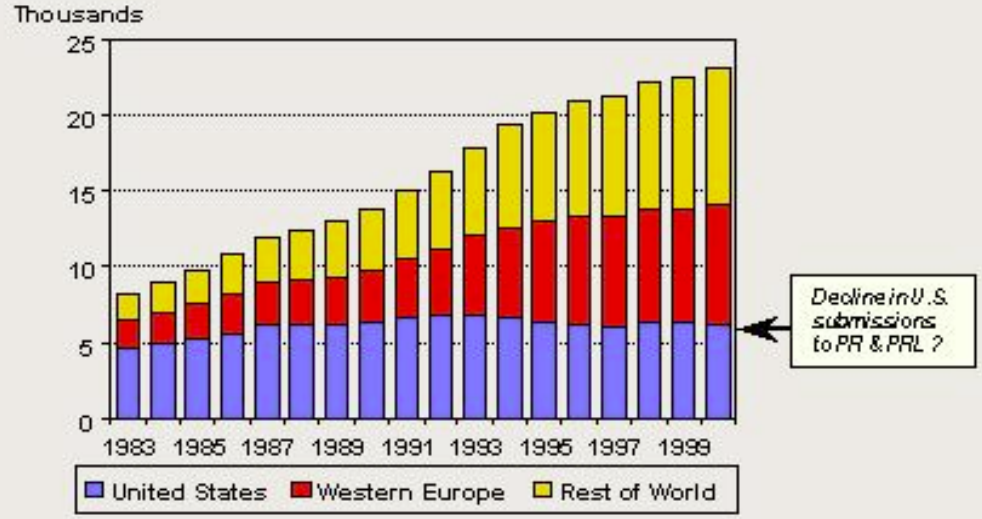
The United States is among the world's leaders in all subfields, and it is the leader in some.

The US is currently among world leaders in all of the subfields of materials science and engineering, and currently it enjoys a clear lead in biomaterials. The US is expected to maintain its lead in metals and electronic-photonic materials because of their large US industrial base. ...

Erosion of US leadership is expected in the subfields of composites, catalysts, polymers, and biomaterials bec... of the high priority being given to these subfields by other countries. Cur... and processing relative to Europe and Japan is especially highlighted in t...

* Subfields assessed: biomaterials, ceramics, composites, magnetic mat... and optical-photon materials, superconducting materials, polymers, and...

Submissions to APS journals



Source: American Physical Society - *APS News August/September 2000* - Letter to the Editor - Editor-in-Chief Martin Blume Replies

BESAC Subpanel Recommendation #4

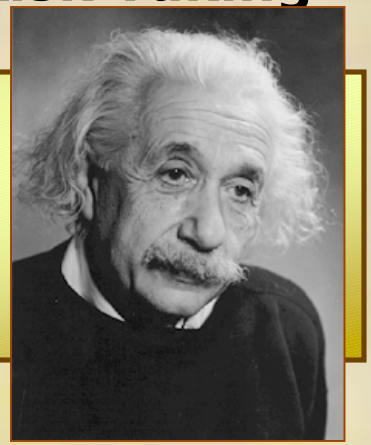
- **The Subpanel recommends that the discussions between the Office of Science and the Office of Management and Budget as to appropriate criteria for the assessment of the progress of basic science programs be continued, to allow the development of appropriate metrics.**
  - Objectives must be comprehensive, not merely representative
  - Must take into account the considerable qualitative component in measuring the quality of basic research, and the intrinsically longer time scales involved
    (request approval from OMB, as allowed by GPRA)
    - "do no harm"
  - Discussions should include considerations of the extent to which methods of assessment from other federal research agencies might be appropriate

Principles for GPRA Implementation

- Simple, Elegant & Defensible Approach
- A Balanced Portfolio of Performance Measures
- Open & Participatory Process
- Respect for Practitioners -- "Do No Harm"
- Emphasis on the Future, Informed by the Past
- Supportive of Science Excellence & Appropriate Risk Taking

"Not everything that can be counted counts, and not everything that counts can be counted."

Albert Einstein



BESAC Subpanel Recommendation #6

The Subpanel recommends that work-force issues, including the development of succession plans for the research staffs, and the education and training of a technically sophisticated personnel reservoir for the future of the nation, be incorporated into the GPRA goals of the Office of Science.

- Major COSEPUP recommendation
- The DOE should describe in their strategic and performance plans the goal of developing and maintaining adequate human resources in fields critical to their mission.

COSEPUP workshop on OMB Proposed Criteria for Federal Agency Basic Research Programs (2/27/02)

- **EOP and OMB leadership:**
  - John Marburger (OSTP)
  - Mitch Daniels (OMB)
  - Marcus Peacock (OMB)
  - Michael Holland (OMB)
  - David Trinkle (OMB)

- **Some other agency leadership:**
  - Arden Bement (NIST)
  - Joseph Bordogna (NSF)
  - Patricia Dehmer (DOE)
  - Ruth Kirschstein (NIH)

- **Congressional committees**
  - David Goldston (HSC)

Investment criteria/performance metrics (retrospective and prospective)

COSEPUP

- Quality
  - Peer-review
- Relevance
  - To agency mission
  - To field
- Leadership benchmarking

OMB proposal

- Quality (3-5 years)
  - Competitive, merit-based peer-review
  - Breadth of competing pool
  - Plans for regular reviews and for results feeding into decisions
  - Leadership benchmarking
- Relevance (3-5 years)
  - Long-range plans and agency mission
- Performance
  - Outputs/outcomes (1-3 years?)
  - Human resource development

Issues/concerns with the OMB proposal

- **The continuum/cycles between basic and applied research (OMB Circular A-11?)**
  - Need a more sophisticated taxonomy of research
  - Make the criteria/metrics similar, with variable weightings?
- **Should "Leadership" be a highest-level metric, separate from quality?**
- **Development of Human Resources as a criterion/metric**
- **At what level to apply the criteria and metrics**
  - Agency, program, portfolio, …? Not individual investigators!
  - Multi-agency programs and initiatives (nanotechnology, IT, climate change, …)
    - via integrated advisory committees? HEPAP (DOE/NSF), NASA/NSF, …
- **Inter-agency sharing of best-practices**
  - NSF: extramural research, information management, research performers?
  - DOE: scientific user facilities, construction of user facilities, research performers?
- **Pace of design and implementation -- is one year too fast?**

Final thoughts…

- **GPRA and The President's Management Agenda are here to stay…**
  - Evaluations will be used in investment decisions…
  - GPRA plans/reports can do good, but must do not harm…
  - GPRA can be an opportunity to jointly plan, to communicate, and to demonstrate value to decision-makers
- **A Strategic Plan, including stakeholder involvement, is essential**
- **GPRA program goals must be comprehensive**