GPRA Performance Reporting: Views from an S&T Bureau

Paul Doremus
Strategic Planning & Economic Analysis Group
National Institute of Standards and Technology

American Association for Budget and Program Analysis
Fall Symposium

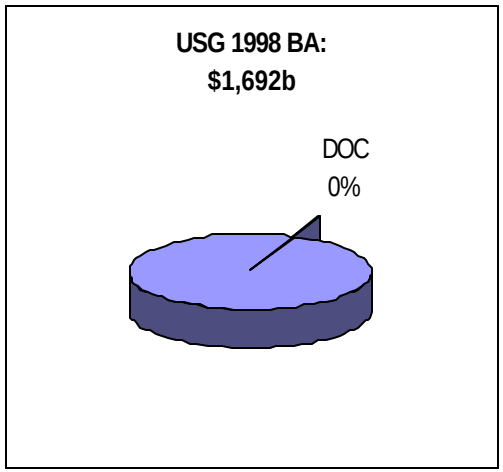
15 November 1999

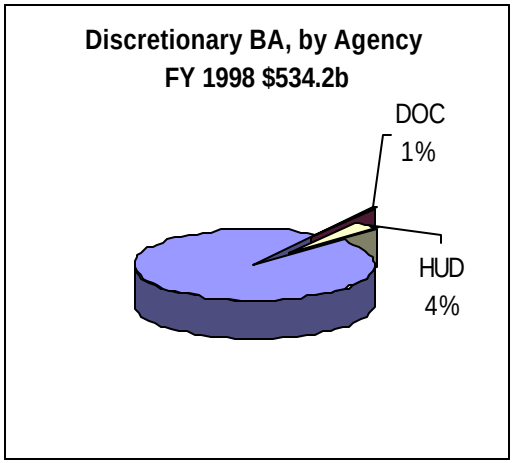
Two observations

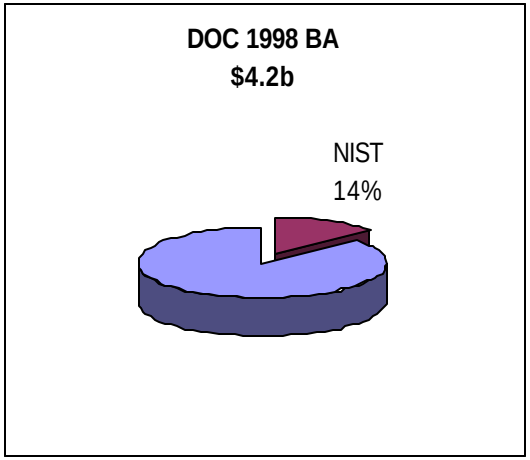
- Mission matters
  - Discrete services provided in large volumes
  - Distributed services and/or intangible outputs
    - Issues in measuring the generation and dissemination of knowledge
    - Need for multiple measurement methods
- Size matters
  - Lots of filters in the information pipeline
  - What is the optimal level of resolution for GPRA?

NIST

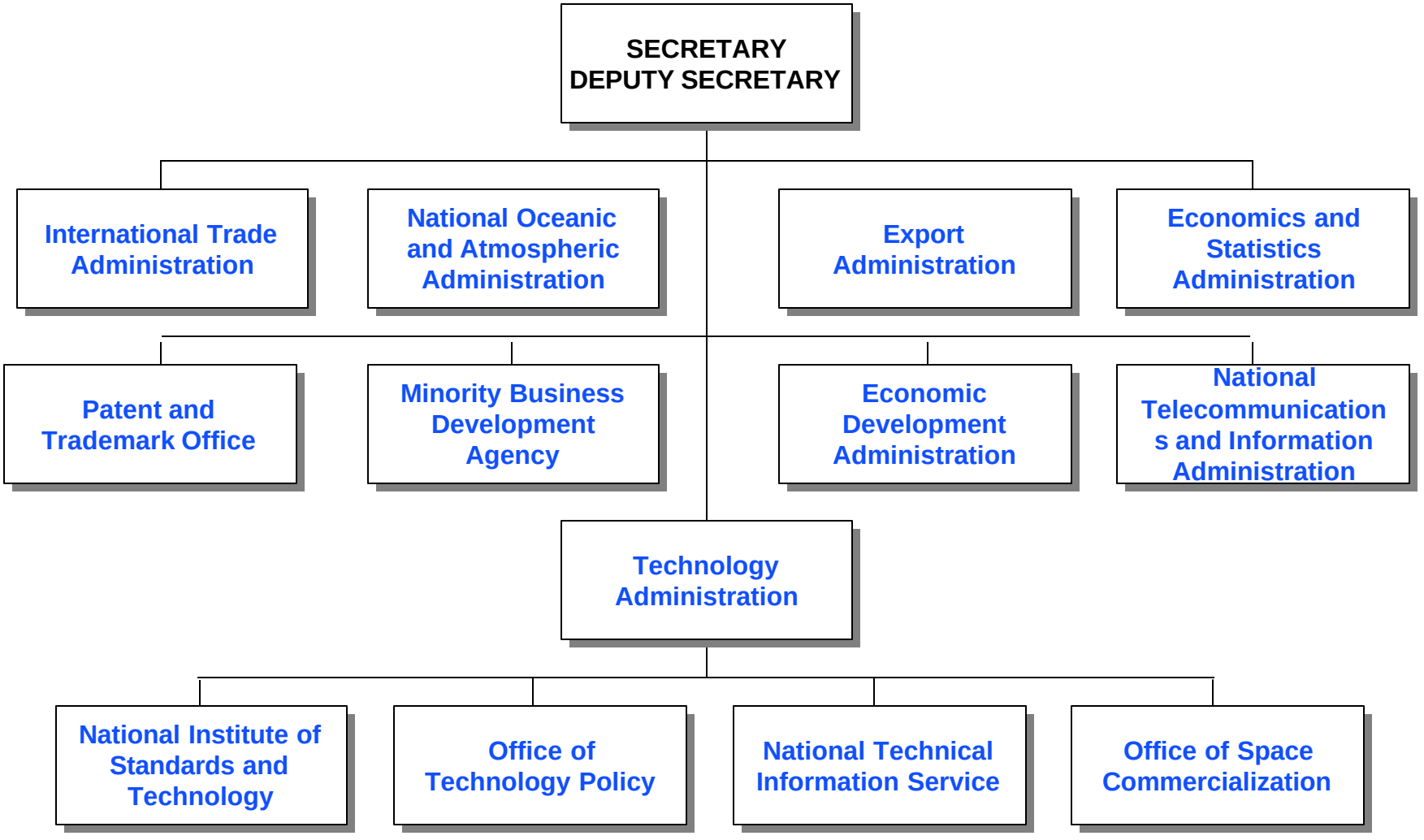
Size: No small issue







Department of Commerce



National Institute of Standards and Technology

NIST strengthens the economy and improves the quality of life by working with industry to develop and apply technology, measurements, and standards

Helping America Measure Up

- **3300 employees**
- **$760 million annual budget**
- **1200 industrial partners**
- **2000 field agents**
- **1550 guest researchers**
- **$1.4 billion co-funding of industry R&D**
- **national measurement standards**

NIST

NIST programs include

Advanced Technology Program

Unique co-funding partnership between NIST and private industry to accelerate the development of high-risk, enabling technologies with broadbenefits for the entire economy and for society.

Measurements and Standards Laboratories

Nation's ultimate reference point for measurements, standards, and technology research to support industry, science, health, safety, and the environment.

Manufacturing Extension Partnership

Nationwide network of locally managed extension centers offering technical assistance and best business practices to the Nation's 380,000 smaller manufacturers. Centers in all 50 state, DC, and Puerto Rico.

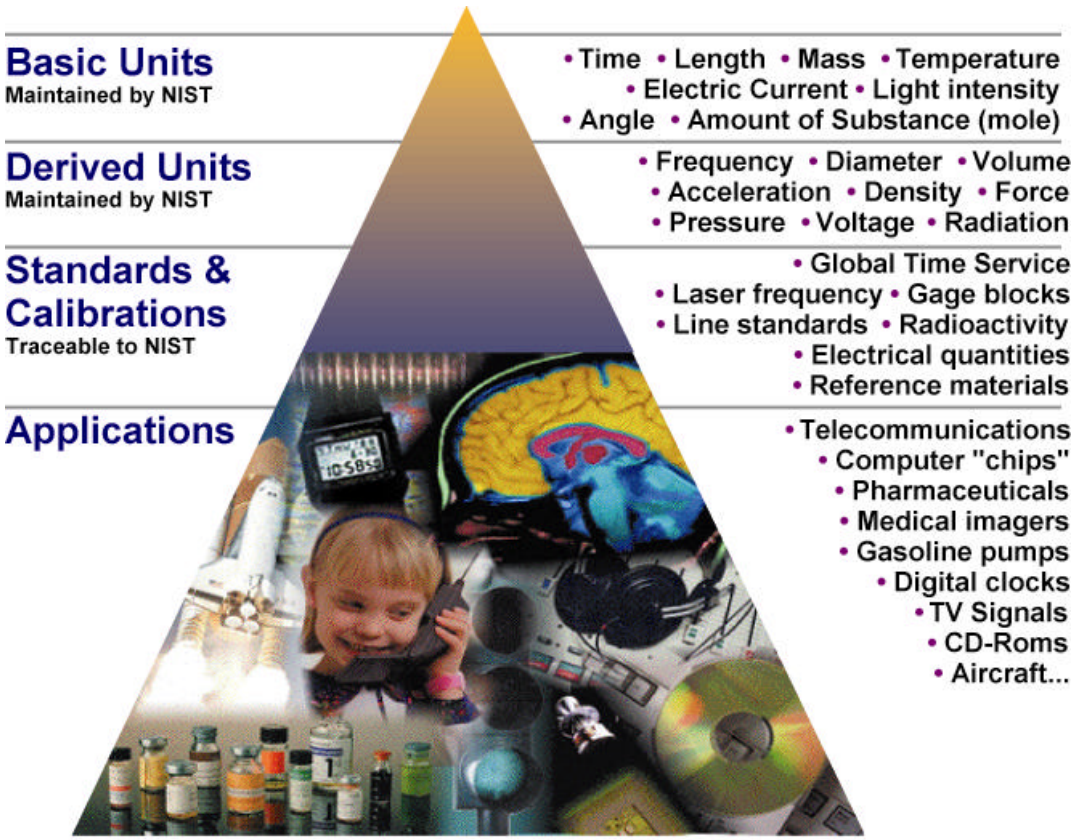
Baldrige National Quality Program

Outreach program to promote business performance excellence and quality achievement by U.S. companies. Annual Baldrige awards in manufacturing, service, small business, education, and health care.

NIST

The mission drives the measures

Goal: Provide technical leadership for the Nation's measurement and standards infrastructure, and assure the availability of essential reference data and measurement capabilities.



LEVERAGE

Approx. $500 M/yr NIST investment (0.7% of federal R&D)

Undergirds ~$10 B/yr of private sector investment in measurements and standards

Impacts U.S. economy - quality and productivity of R&D; reduced transaction costs; greater economic efficiency; higher quality health and safety

NIST

The measurement challenge

The measurement challenge: Developing quantifiable, verifiable, cost-effective outcome measures that accurately and comprehensively capture the impact of measurement and standards research over long time periods.

Alternative Refrigerants Research:
Data and Modeling Technologies for Reducing Use of Chloroflurocarbons

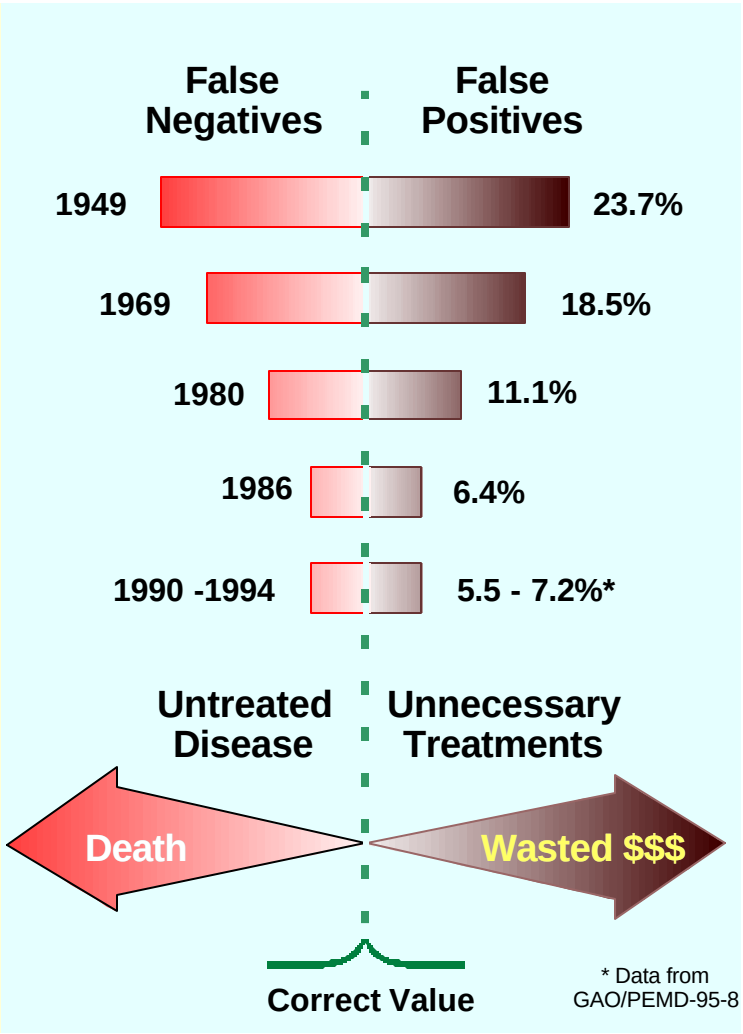
Early 1980s	Mid 1980s	Mid to late 1980s	1990s
Research project initiated: characterizing chemical properties of non-CFC refrigerants	*Near term output*: comprehensive and reliable data and analytical models. *Initial outcome*: Accelerates industrial R&D; reduces R&D costs	*Extended outcome*: R&D efficiency gains to refrigerant manufacturers	*Extended outcome*: Heating and cooling equipment manufacturers benefit from downstream R&D efficiencies

Impacts are project specific

NIST Contributions to National Reference System for Cholesterol

- **1967 - SRM 911 Pure Cholesterol**
- **1980 - Definitive Method for Serum Cholesterol**
- **1981 - SRM 909 Cholesterol in Human Serum**
- **1988 - SRMs 1951 & 1952 Cholesterol in Serum**
- **1996-7 - Values for HDL & LDL Cholesterol**

Measurement Improvement 1969 - Present May Save *$100M/year* in Treatment Costs



Overview of NIST MSL performance measures

- **External Review**: NRC Board on Assessment (expert peer-review panels for each lab); direct feedback from industry clients; additional guidance from VCAT
- **Output Metrics**: Tracking and analysis of core products and services--SRMs, SRDs, calibrations and tests, staff technical publications, etc.
- **Outcome Assessment**: Microeconomic impact assessments provide quantitative and qualitative estimates of long-term outcomes from individual projects.
- **Benchmarking**: Comparisons with other National Measurement Institutes to assess “best in world” status

NIST

NIST approach to GPRA reporting

	Responsibility Segment			
	MSL	**ATP**	**MEP**	**BNQP**
Strategic goal	*Provide technical leadership for the Nation's measurement and standards infrastructure, and assure the availability of essential reference data and measurement capabilities.*	*Accelerate technological innovation and the development of new technologies that underpin future economic growth.*	*Improve the technological capability, productivity, and competitiveness of small manufacturers.*	*Assist U.S. businesses and other organizations in continuously improving their productivity and efficiency by adopting performance and quality management practices.*
Quality &/or outcome metrics	NRC peer review Economic impact studies Benchmarking	Economic impact studies	Increased sales Labor and material savings Capital investment Inventory savings	Economic impact studies
Illustrative output metrics	SRMs available SRD titles available Calibrations and tests Technical publications	Cumulative number of technologies under commercialization Cumulative number of publications Cumulative number of patents filed		Number of business applications per year to MBNQA and Baldrige-based State programs Number of BNQP Baldrige *Criteria* mailed by BNQP and Baldrige-based State programs

Strengths & weaknesses of measurement methods

	Scope & Purpose	Strengths	Limitations
Peer Review	Assess technical quality within operating units. Provides essential data for quality control, laboratory management & planning.	Broad and highly detailed review by external technical experts. Balanced panels with expertise matching each operating unit. NRC independence, high technical capability, and internal quality controls. Review process well established in corporate culture.	Intrinsic features of peer review: panel judgments are not quantifiable; observations and findings are highly contextual and detailed; assessments are not comparable (e.g. no cumulative performance ranking).
Quanti-tative Output Metrics	Diverse output indicators that represent key functions. Important to track for internal management & resource planning.	Direct counts of activities and outputs generate highly reliable quantitative data. Robust data collection systems. Data are cumulative and allow trend analysis for each indicator.	Provide no information about quality or impact; trends require contextual interpretation; indicators not uniformly relevant to all OUs; indicators as a whole do not comprehensively represent NIST output.
Impact Studies of Research Outcomes	Assess down-stream impacts of research projects & infratechnologies. Provides data for evaluating research outcomes & long-term planning.	Provides quantitative and qualitative data re. outcomes. Provides data on impacts over long time periods and across several layers of the supply chain affected by NIST technology. Highly qualified economists and technical specialists conduct detailed analyses using well-developed research methods.	Studies are intermittent and results are not cumulative; elements of user population often are too diffuse to measure; uneven availability and quality of industry data; methodological problems specific to each measure; outcomes are specific to each project (limited comparability); studies are complex and expensive.

NIST

Performance reporting challenges

- Mission requires complex evaluation system
- No “vital few” quantitative measures
- Performance data not synchronized with budget cycle
- Measurement challenges combined with small size lead to information filters at higher reporting levels

Performance reporting: filters

- Peer and/or external review a rich source of performance information… but unwieldy for GPRA reporting
- Impact studies ultimately are illustrative; results are not cumulative, and cover diverse funding periods
- MSL benchmarking data a key metric for top-level performance goal… but difficult to report concisely and/or comprehensively

Laboratory benchmarking data

Quantity	Unit	Range	Capability v. other NMIs	U.S. Economic Sectors Supported
Liquid flowrate	Kilogram/sec	0.1 – 150 g/s - (hydrocarbons).	Best in the world	Aerospace (aircraft engines)
		0.01 – 600 kg/s (water)	State of the art	Potable water, electric power generation
Air speed	Meter/sec.	0.15 – 10 m/s	Best in the world	Environmental monitoring
		4.0 – 67 m/s	Best in the world	Weather observations
Length (iodine stabilized laser wavelength)	Meter	Not Applicable	State of the art	Primary method to realize the unit (below are specific application areas)
SEM Magnification SRMs	Meter	0.5 μm – 50 μm	Best in the world	Semiconductors, mass storage industry, instrument manufacturers
Length stds. for calibrating coordinate meas. Machines	Meter	0.05m –1m	State of the art	Discrete parts, aerospace, heavy equip-ment, optical components, automotive
Surface Finish	Meter	0 μm – 50 μm	State of the art	Discrete parts, optical components
IC Photomask Linewidth	Meter	0.5 μm – 30 μm	Best in the world	Semiconductors
IC Photomask Pitch	Meter	2 μm – 70 μm	State of the art	Semiconductors
Linescales	Meter	2 μm – 1 m	Best in the world	Semiconductors
Gage Blocks (Interferometric)	Meter	1 mm – 100 mm	State of the art	Discrete parts, aerospace, heavy equipment, automotive
Mass	Kilogram	1 mg – 1 g	Best in the world	Transducer manufacturing, aerospace, automotive, buildings, nuclear utilities, weighing industry, equity-in-trade
		1 kg	State of the art	
		10 kg – 10^4 kg	Not state of the art	
Force	Newton	4.4 N – 4.5 MN	Best in the world	Transducer manuf., aerospace, automotive, buildings, nuclear utilities
		4.5 MN – 50 MN	State of the art	
Acceleration	Meter/sec^2	9.8 m/s^2 (5 Hz – 20 kHz)	State of the art	
Acoustic pressure	Pascal	50 Hz – 20 kHz	State of the art	
Ultrasonic power	Watts	10 mW – 1 W	Best in the world	Healthcare

Key: “Best in the world” = only NMI at this level of practice; “State of the art” = one or more NMIs also at this level; “Not state of the art” = below other NMIs

The result: Output metrics

- Capture partial reporting year outputs
- Quantity of products and services is not always the issue
  - Strategy for SRM and calibrations: focus on points of greatest leverage in measurement supply chain
  - Publications: goal is constant level of high quality output

So in the end...

- ... just how informative will the FY 1999 Annual Performance Report be for an S&T bureau?
  - Performance measurement and evaluation are central to how NIST operates
  - GPRA provides additional motivation as well as a communication channel
  - But how useful will the APR be for our stakeholders?