SCIENCE, TECHNOLOGY & ENGINEERING

Evaluation of Science, Technology, and Engineering Programs at Sandia National Laboratories

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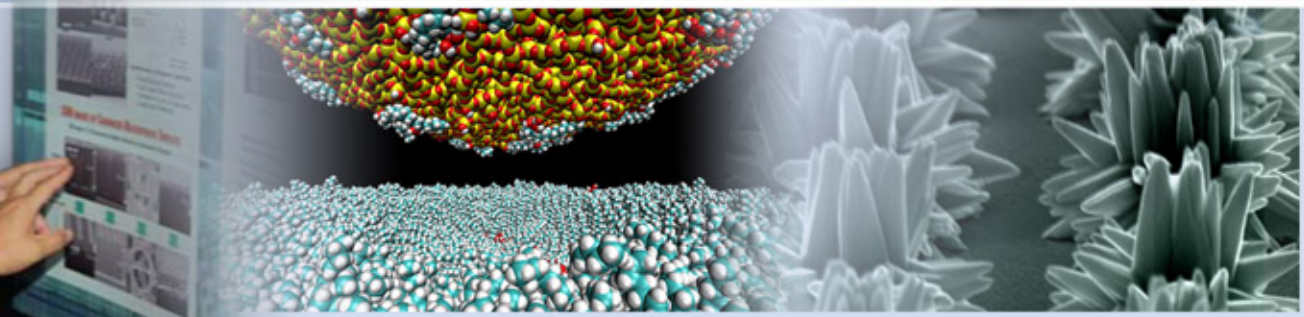


Sandia National Laboratories

Outline

- **ST&E at Sandia**
- **Corporate and DOE performance management systems**
- **DOE evaluation criteria and weights**
- **Sandia Objectives/Milestones and Risk Assessment**
- **New ST&E Metrics – Scorecard and process**
- **Summary**

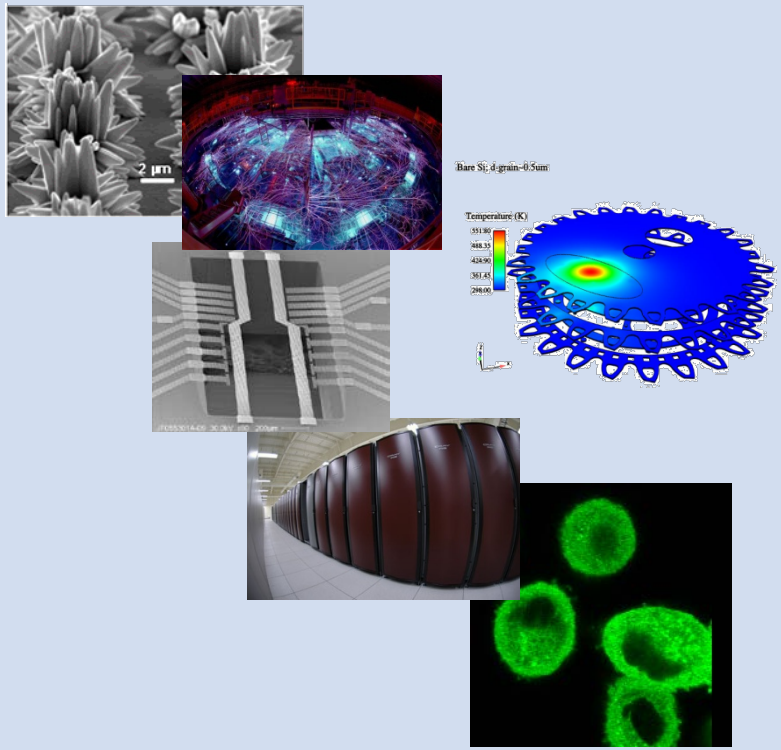
Unique national science & engineering facilities

~ 25,000 scientists & engineers

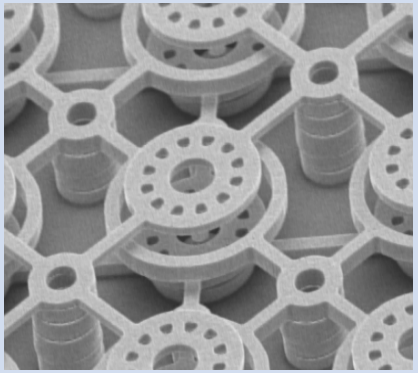
Sandia's ST&E Strategy

Create, integrate and apply capabilities needed to address national security challenges through strategic investments in six research foundations

- Materials Science and Technology
- Pulsed Power Sciences
- Engineering Sciences
- Microelectronics & Microsystems
- Computer and Information Sciences
- Bioscience and Technology



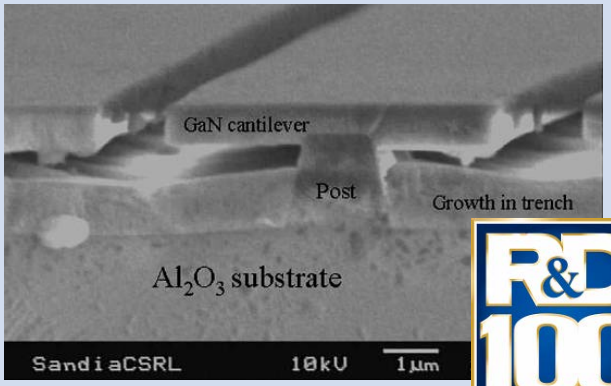
The Relationship Between Science and Sandia's Mission Has a Dual Nature

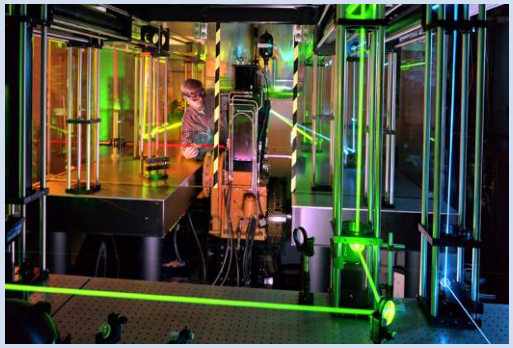


Science underpins and enables technology for Sandia's missions,

AND

Facilities and equipment for mission needs enable world-class science that pushes the frontiers of knowledge

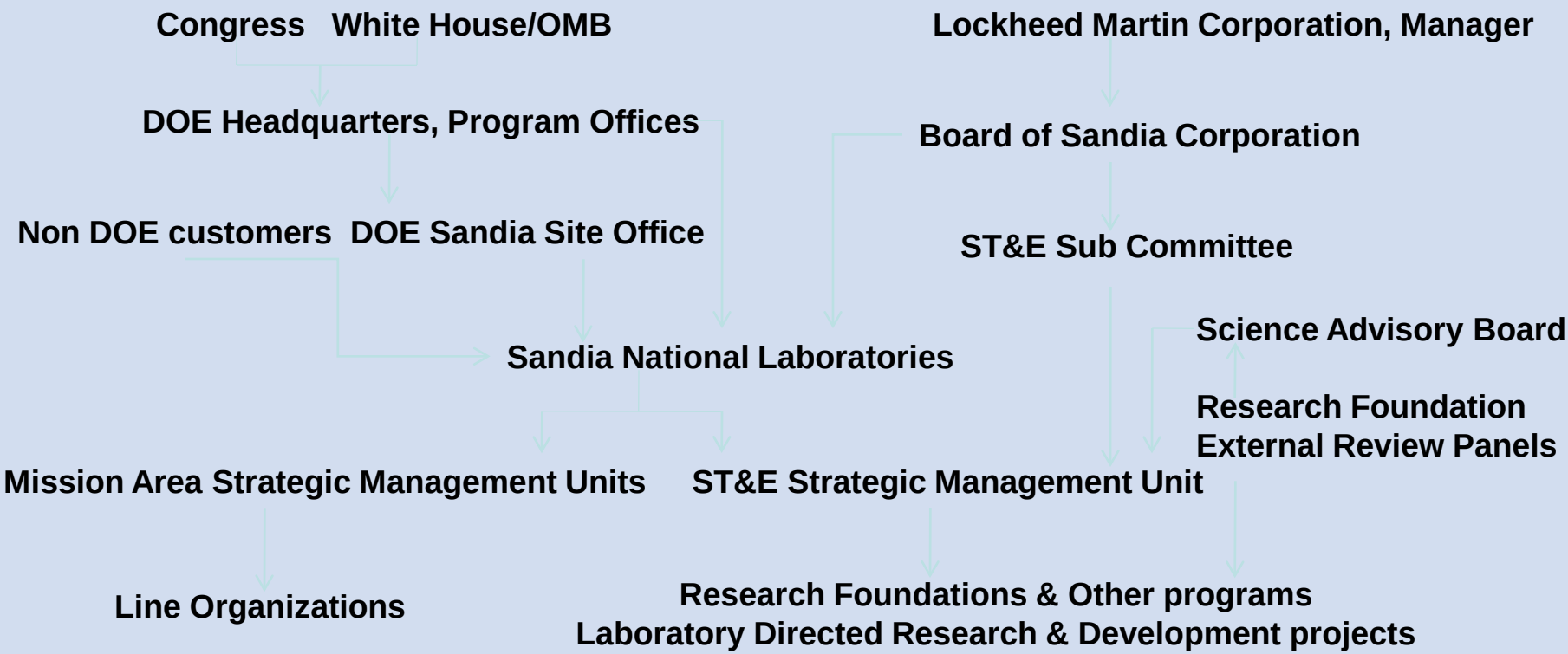




Two Corporate Objectives drive the implementation of ST&E strategy

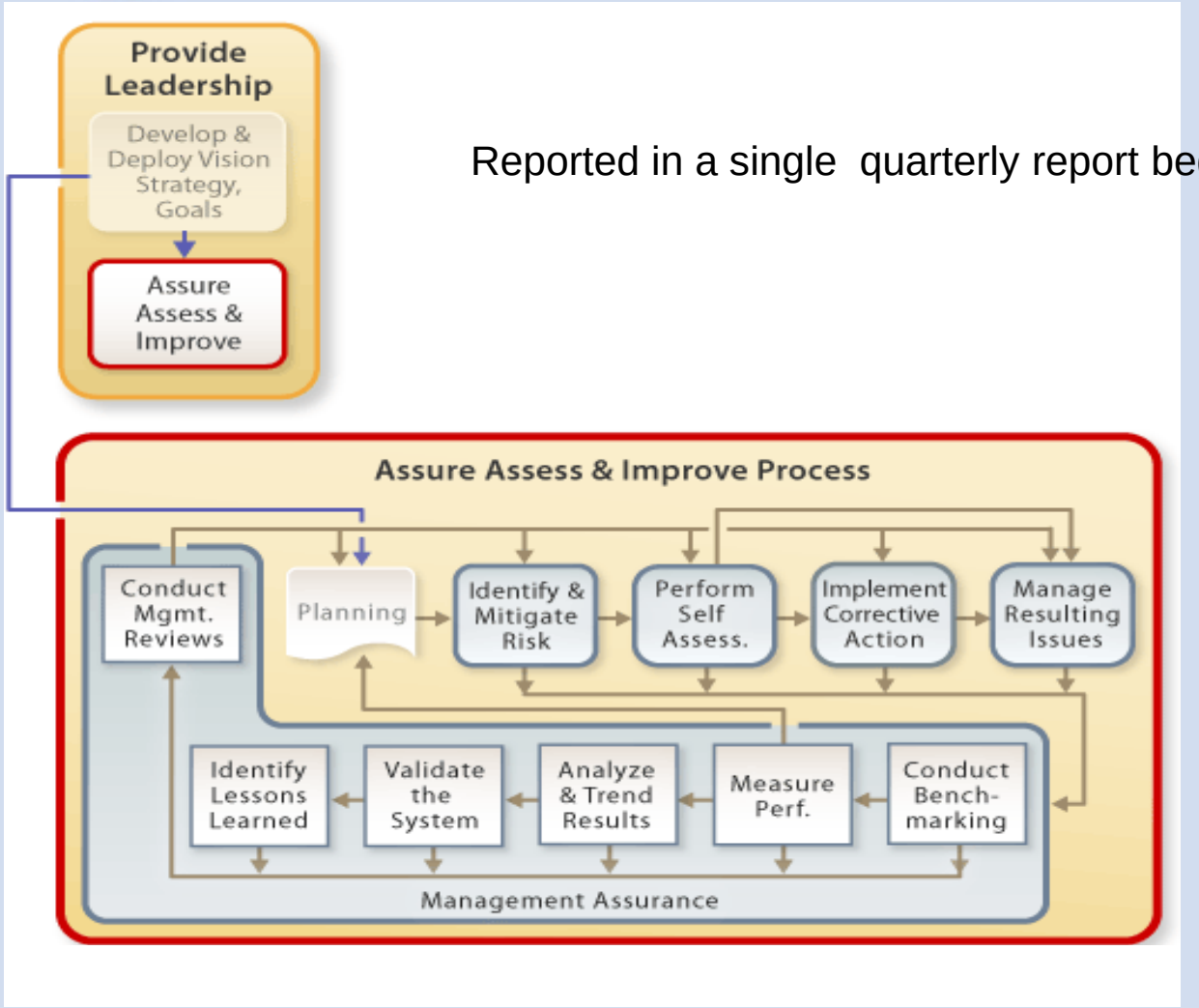
1) Create Breakthrough Results through Science & Engineering
   - Description: Nurture a vibrant, innovative core (people and facilities) that is on the forefront of science & engineering. This is about the seed corn of discovery that keeps us out in front to create breakthrough results.
2) Drive the Future
   - Description: We will drive the future by working jointly with the mission SMGs, SMUs and the ACG to apply the creative, vibrant ST&E core to develop innovative approaches to national security challenges now and in the future.

The organizational structure of assessment is complex



Evaluation Fits Within Sandia's Integrated Laboratory Management System

Assess Assure & Improve Process fits routine work better than most S&T



Reported in a single quarterly report beginning 2008.

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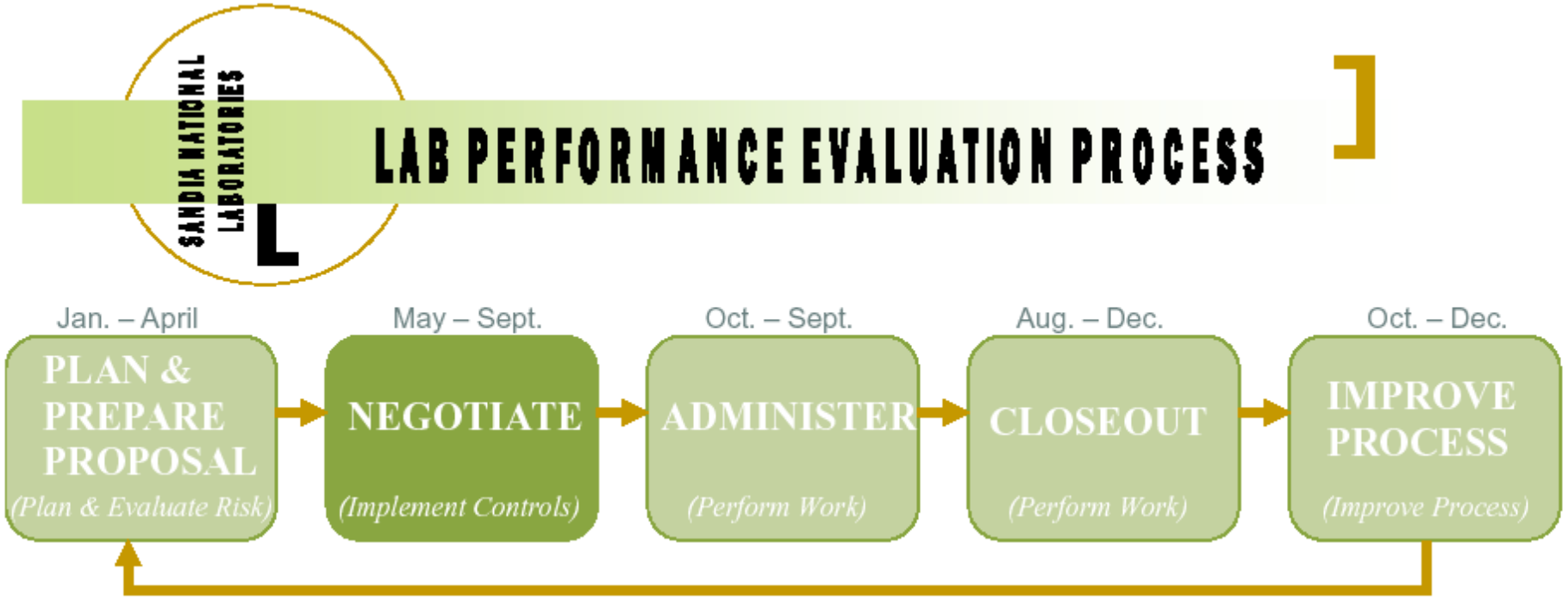
In addition there is the Annual DOE Performance Management Process



Performance Evaluation Plan

Includes the ST&E corporate objectives and milestones

Performance Evaluation Assessment Reports (Sandia)

Performance Evaluation Report (DOE)

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Performance Evaluation Criteria for S&T (includes external review panels & program reviews)

Evaluation criteria defined by OMB, modified by DOE

Criteria	Weight
1) Programmatic performance, management and planning	30-40*
2) Quality of science, technology and engineering	50
3) Performance in the technical development and operations of major facilities	0-10
4) Relevance to national needs and agency Mission	10
	100%

* Ranges are provided to accommodate areas that do not have any “Operations” activities. In these cases, the “Operations” criterion will be assigned zero weight and the remaining criteria will be adjusted upward as indicated.

Programmatic performance, management, and planning should consider:

- Achievement of broad programmatic goals, including development and maintenance of program/project plans;
- Establishing and meeting scientific/technical milestones, schedules and budgets; managing program/project resources; establishing and implementing program/project management systems, including performance measurement systems;
- Implementing agreed-to changes to program/project baselines;
- Satisfying programmatic/project sponsors;
- Planning for the orderly completion or continuation of programs/projects; documentation of the results of programs/projects in scientific and technical reports; and
- Providing, to the Office of Scientific and Technical Information, Energy Science and Technology Center, copies of software that is developed in Sandia Programs.

Quality of science, technology and engineering should consider:

- Subjective indicators of excellence such as impact on the scientific community;
- Scientific, technological, and engineering developments and accomplishments;
- Research accomplishments; innovation; and sustained achievements.
- Development of new technologies that advance research capabilities and reduce costs, as indicated by new scientific and technology programs that emerge from research related to DOE/NNSA's programs,

Performance in the technical development and operation of major facilities should consider

- Success in meeting scientific and technical objectives, technical performance specifications, and user availability

goals.

- Quality of user science performed, extent of user participation and user satisfaction,
- Operational reliability and efficiency, and
- Effectiveness of planning for future improvements, recognizing that DOE/NNSA programmatic needs are considered to be primary when balanced against user goals and user satisfaction.

Relevance to national needs and agency missions should consider:

- The impact of Laboratory's research and development on
  - the mission and program needs of the DOE/NNSA,
  - needs of other agencies' funded programs, and
  - other scientific and technical needs
- The attainment of National goals as related to areas where science and technology are factors

Sandia Objectives/Goals/ Milestones Process

- Part of a corporate process, with objectives and goals for 2010 (set in 2006) and annual milestones for each goal
- Goals and milestones
  - Are set in consultation with relevant stakeholders, assigned an owner
  - Reflect the strategies by which the SMU expects to effect change
- Currently most milestones are process oriented and self assessment suffices
- ST&E Council rotates discussion of O/G/Ms at the monthly meeting
- Milestones are reported on in the quarterly corporate Management Review

Corporate Risk Management, Self Assessment Process

- Annual corporate process to review, designate major risks
- Risks are proposed by senior managers, down–selected by CTO, assigned owners; Control activities and metrics are defined and tracked quarterly
- Evaluation combines self assessment, external expert review, and some quantitative metrics
- High risks are reported to corporate, with assistance discussed as needed
- Current ST&E risks are around
  - Retaining key capabilities
  - Driving innovation and a “Science Strategy”
  - Compliance with requirements, and keeping that burden as low as feasible

We are currently measuring an integrated, balanced set of metrics that assesses critical success factors from four perspectives.

Critical Success Factors

Perspectives	Nurture core ST&E	Enable the Missions	Provide Optimal Value
Provide Value to the Nation	A measure of science leadership & stewardship	A measure of socio-economic impact	A measure of SMU Innovation
Provide Value to Individual Customers	– Value of science to science and potential users (nuggets) – Citation measure	– Value of ST&E integrated into SMU/ sponsor's product (nuggets) - External investment	- Value of ST&E Collaboration – Internal and External
Technical & Operational Excellence	-Publications (Quality and Quantity) - Patents	- Improved Technology Performance and Cost; - Patents	- ST&E Portfolio Characteristics (source of funds, type of work) - Effectiveness of ST&E Management Initiatives
Capabilities & Learning Environment	- ST&E Capabilities (people, facilities) - Ability to attract & retain the best staff		- Innovativeness of Work Environment

Gathered data can be quantitative or qualitative, objective or subjective.

- Critical success factors and underlying goals are defined by the documented ST&E strategic plan.
- The goals induced by the strategy are interpreted in the framework of the Balanced Scorecard.
- An integrated set of metrics is derived to measure progress and achievement of the underlying goals.

The goal is a Sandia ST&E Scorecard we can "drill down" to see detail as needed.

Value to Nation

- Staff retention & attraction
- Reputation for science-based solutions
- Stakeholder advocacy
- National media mentions

Value to Customer

ST&E Community

- Citations
- Value nuggets

SMU & WFO Customers

- Follow on dollars
- ST&E embedded in products

ST&E/Customer Integration

- $ in Joint work
- External collaborations, partnerships

Today's Products

- Nurture the core
  - Publications
  - "Breakthroughs"
- Enable the Mission
  - Value to readiness level
  - Improved performance/cost

ST&E Portfolio & Processes

- ST&E funding
- Amount of risk/Project duration
- Effectiveness of processes

Capabilities - now and for the future

- People
- Equipment, facilities
- Progress in filling gaps

Research/Work Environment

- Employee attitudes on work environment
- Compliance record, burden

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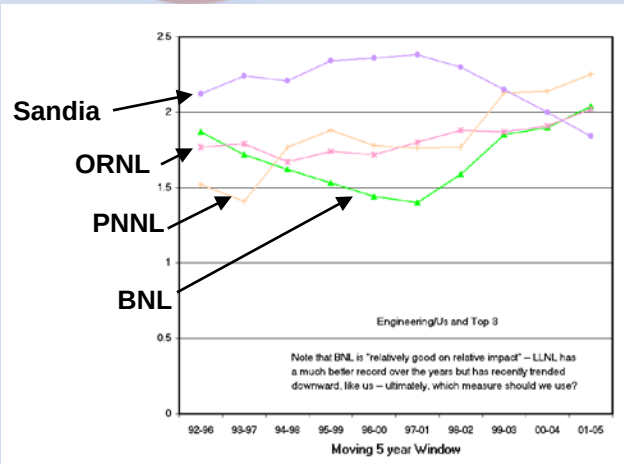
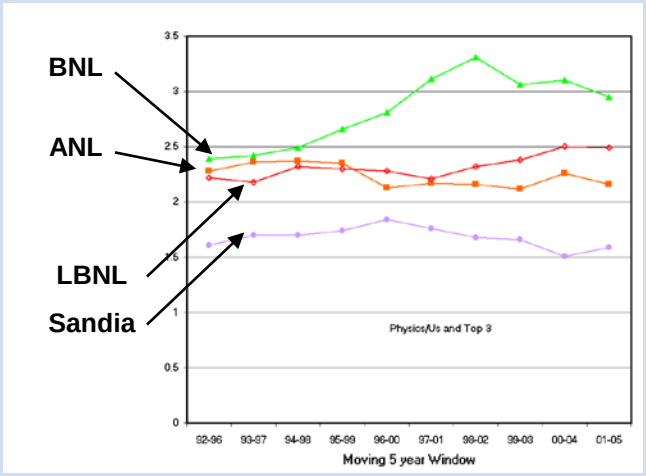
Sandia publication citations are above the world citation impact factor in key disciplines, but cited less than some other Federal labs.

Engineering

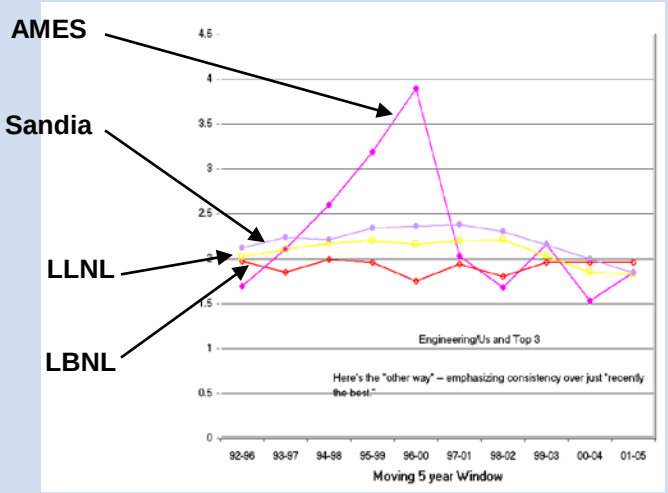


Physics

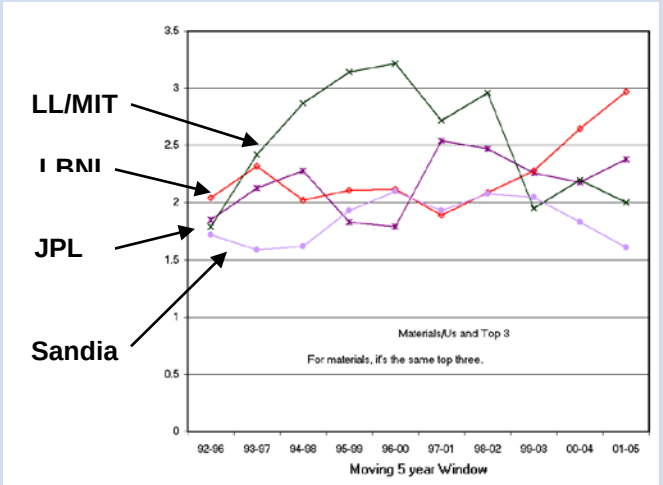


For example, looking at citations...

Engineering – Alternative

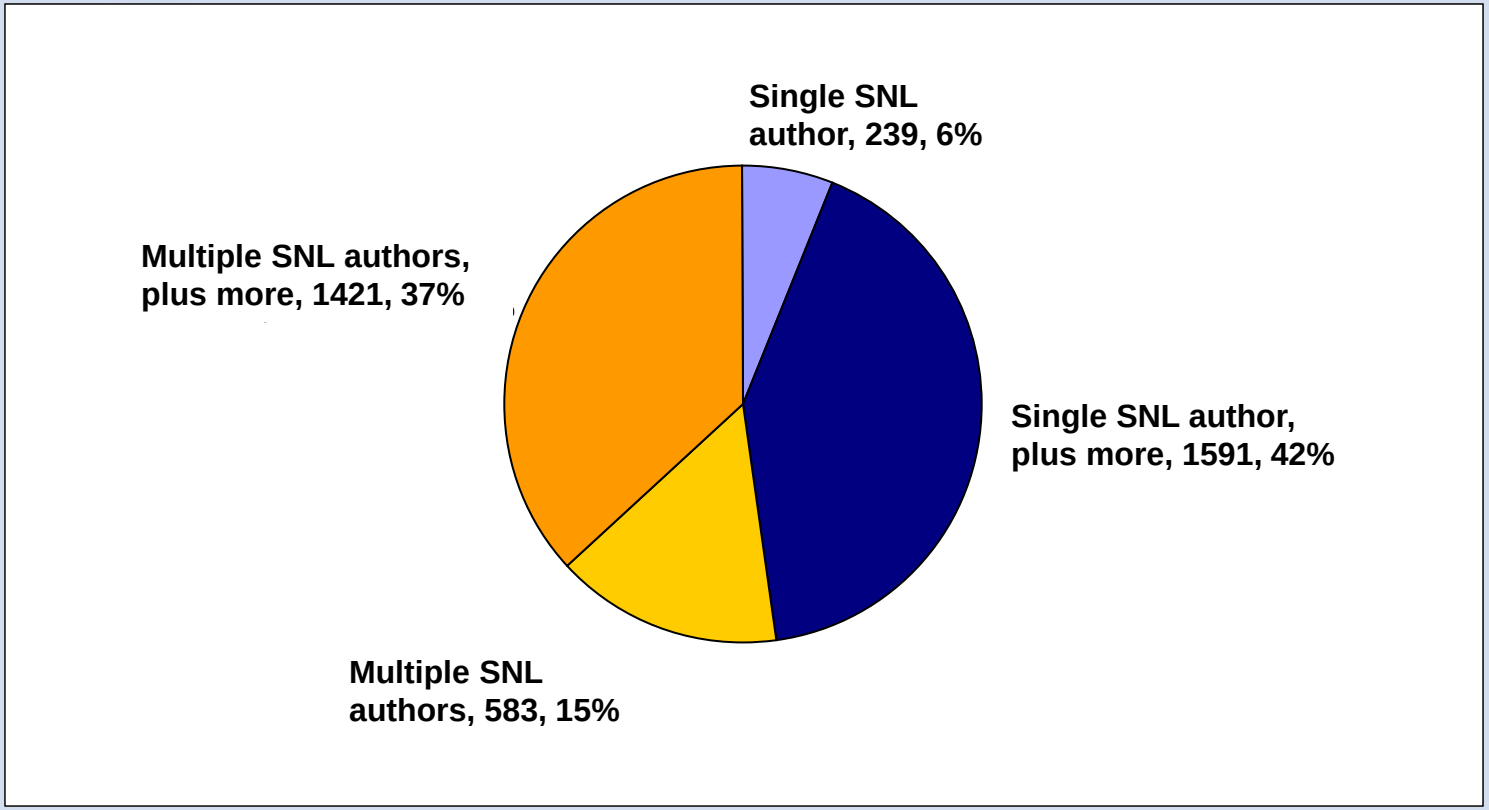


Materials



94% of SMU peer-reviewed publications have at least one co-author.

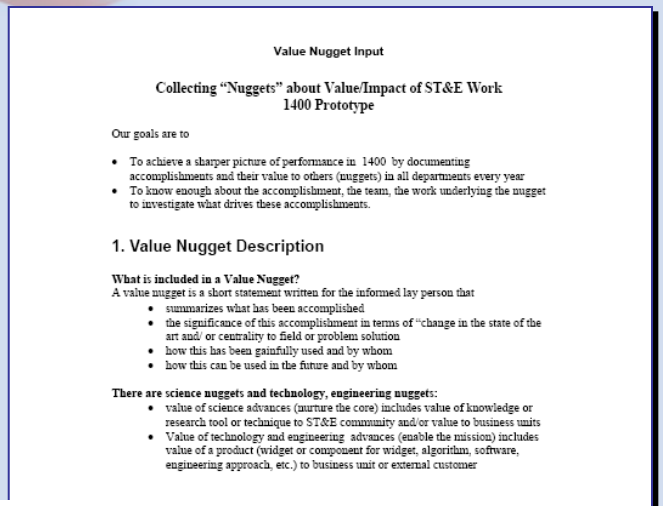
2002-2006, ~3634 publications



- 79% of Sandia peer-reviewed publications have one or more external authors.
- 52% of peer-reviewed Sandia publications have multiple Sandia authors.

We are gathering refined anecdotal information to analyze ST&E impact.

CPA



Value Nugget Input

Collecting "Nuggets" about Value/Impact of ST&E Work
1400 Prototype

Our goals are to

- To achieve a sharper picture of performance in 1400 by documenting accomplishments and their value to others (nuggets) in all departments every year
- To know enough about the accomplishment, the team, the work underlying the nugget to investigate what drives these accomplishments.

1. Value Nugget Description

What is included in a Value Nugget?
A value nugget is a short statement written for the informed lay person that

- summarizes what has been accomplished
- the significance of this accomplishment in terms of "change in the state of the art and/ or centrality to field or problem solution
- how this has been gainfully used and by whom
- how this can be used in the future and by whom

There are science nuggets and technology, engineering nuggets:

- value of science advances (nurture the core) includes value of knowledge or research tool or technique to ST&E community and/or value to business units
- Value of technology and engineering advances (enable the mission) includes value of a product (widget or component for widget, algorithm, software, engineering approach, etc.) to business unit or external customer

Compute Process Allocator
In collaboratiion with researchers from the State University of New York-Stony Brook and the University of Illinois-Urbana, Sandia has developed an innovative solution to resource allocation for parallel processing on supercomputers, the Compute Process Allocator (CPA). In experiments, the optimized node allocation strategy employed by CPA increased throughput by 23 percent, in effect, processing five jobs in the time it normally takes to process four. For its superior strategy and scalability over other allocators, the CPA won a prestigious 2006 R&D 100 Award. The CPA's innovative solution was carried to the commercial sector in 2005 when CPA was licensed to Cray Inc. The breadth of impact has been extended through software licensing to numerous laboratory and research centers that bought XT3 systems from Cray.

- What is included in a Value Nugget?
- A value nugget is a short statement written for the informed lay person that
  - Summarizes what has been accomplished.
  - The significance of this accomplishment in terms of "change in the state of the art and/ or centrality to field or problem solution.
  - How this has been gainfully used and by whom (in particular for NW, ITS and external customers).
  - How this can be used in the future and by whom.
- Possibly collect at the Level 1 (department) management level annually.

Research Environment Survey - a diagnostic tool looking at 42 attributes

Rewards for Research/Work
Salaries
Benefits
Educational/Professional Development
Technical Career Advancement
Recognition for Merit
Respect for People

Value of Managers of Research
Management Integrity
Technical value added
Overall Value-Added Management

Quantity & Quality of Resources
Equipment for research
Lab/ Physical Work Environment
Stability of funding
Quality of Technical Staff
Staffing for Optimal Mix of Skills

Organizational Support for Research
Staff Services
Laboratory Systems & Process
Competencies –range& depth
Competitiveness/Overhead Rates
Reputation for Excellence

Control Via Managers
Project Planning & Execution
Project-Level Measures of Success
Measures of mission success

Autonomy
Autonomy in Decision-Making
Freedom to Explore New Ideas
Resources for Exploring New Ideas

Internal Collaboration/ Integrate Ideas
Internal Communication about research
Collaboration inside the organization
Internal teams with multiple fields
Provide critical thinking for each other

Exploration
Time to Think Creatively
Able to Take Risks with Ideas
Sense of enthusiasm

Agile, Long term Investment
Investing in new program areas
Investment in basic research
Identify new opportunities
Internal Resource Allocation

External Collaboration/ Integration
Collaboration outside the organization
Exchange ideas within the field
Exchange ideas with different fields
External teams with multiple fields

Focus with Clearly Defined Goals
Research Vision
Research Strategies
An integrated R&D portfolio

Example: Case study findings (survey and interviews) Measures of creativity and risk-taking

	S&T MD 2004		CO-LO 2004	
Attribute	Mean	Percent Time True	Mean	Percent Time True
Authority to Make Decisions	4.8	86	3.9	68
Resources/ Freedom to Pursue New Ideas	4.4	78	3.3	57
Sense of Challenge & Enthusiasm	3.8	66	4.3	76
Time to Think & Explore	3.6	62	3.1	52
Commitment to Critical Thinking	3.6	62	3.9	68

Comparing perceptions of a basic research department in a manufacturing division to survey response of a group co-locating basic and applied researchers and developers to speed radical new product development

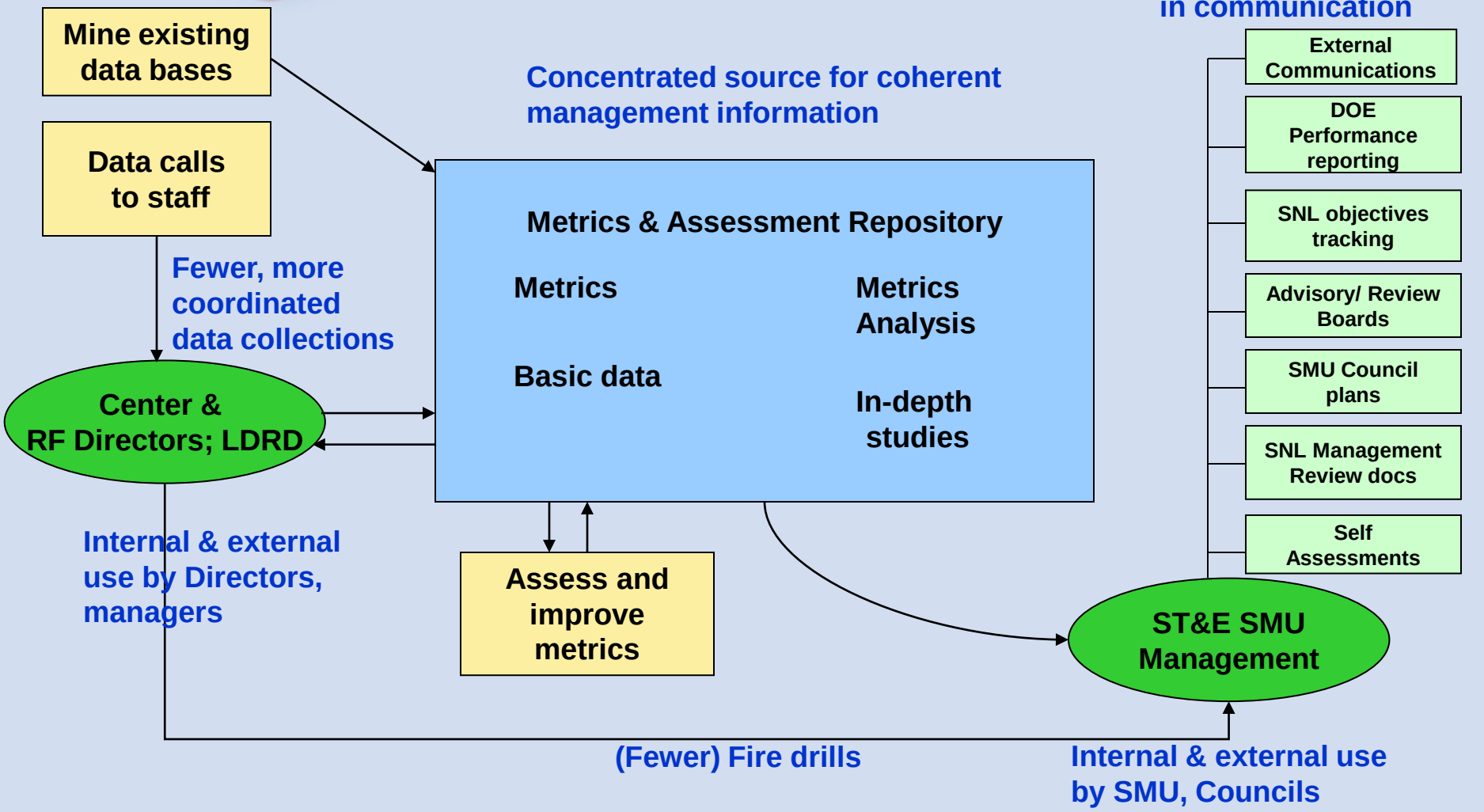
- Autonomy and economic resources are higher in S&T MD (manager gave them time to define and develop their own projects)
- Time to think is higher in S&T MD (more do basic research)
- Challenge is lower (due to constrained choice of problem/approach)
- Critical thinking is lower, but in interviews said they had a great deal; (manager was also a mentor)

The ST&E metrics project is ongoing.

Our future progress requires:

- Complete and improve measurement of the initial set of metrics, both individual metrics and integrated analysis.
- Assist with, and track, the application of metrics data and analysis.
- Work on defining benchmarks.
- Study other issues including (1) prioritized root cause analyses; (2) validity of chosen metrics.
- Document and communicate the results of the metrics project.
- Build a sustainable metrics process.

The ST&E metric project integrates data collection, analysis, and preservation to address complex management action and communication requirements.



Summary

- Accountability requirements at the federal level impact the DOE national laboratories
- ST&E evaluation within a mission laboratory has to push back on assessment that does not recognize inherent uncertainty of the work or is overly time consuming
- ST&E evaluation has purposely coordinated what is being evaluated and on what criteria across various requirements
- Primary methods are self assessment and external expert review.
- Much remains to be done, but the energy around the new ST&E metrics effort is encouraging.