



SCIENCE, TECHNOLOGY & ENGINEERING



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

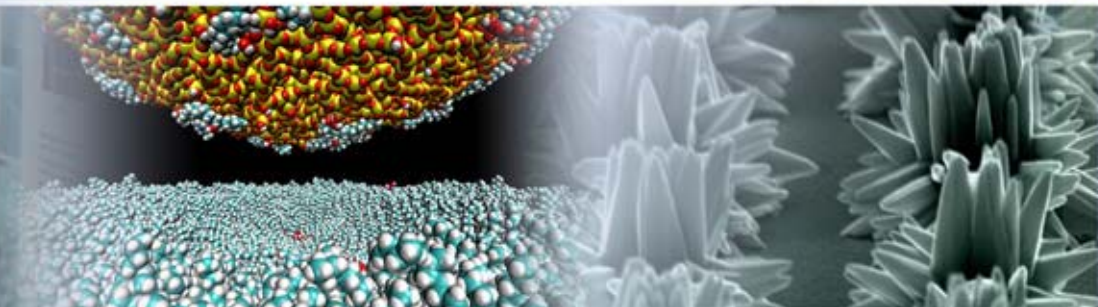
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Gretchen B. Jordan, Ph.D.

Sandia National Laboratories, Albuquerque, New Mexico USA



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

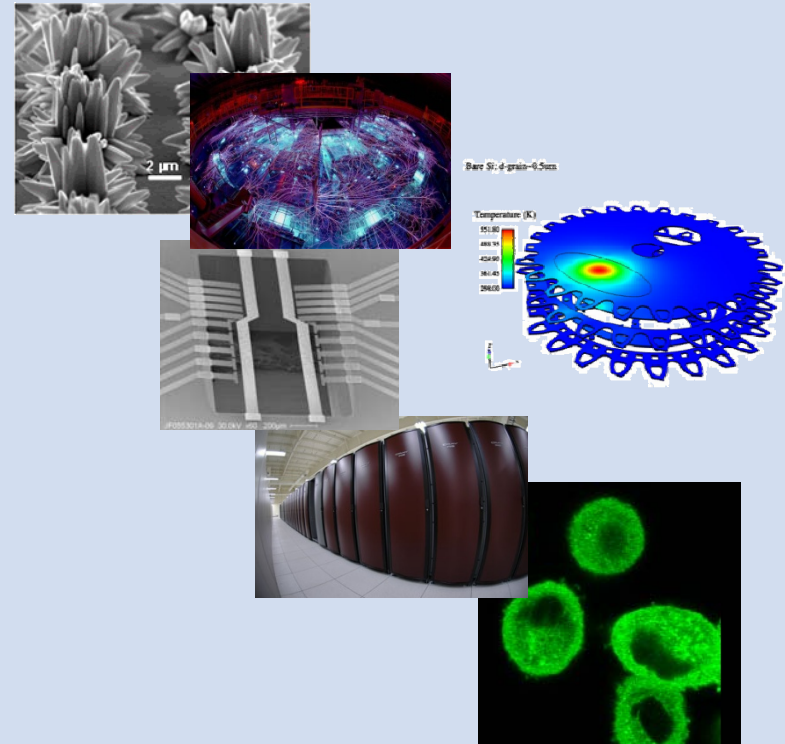
~ 25,000 scientists & engineers



Sandia's ST&E Strategy

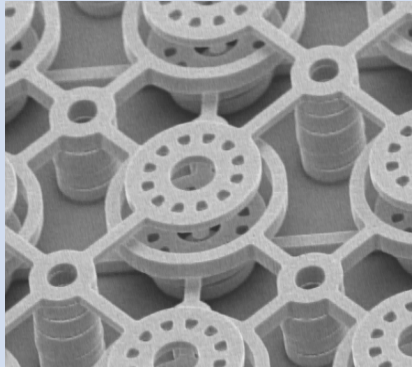
Create, integrate and apply capabilities needed to address national security challenges through strategic investments in six research foundations

- 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,



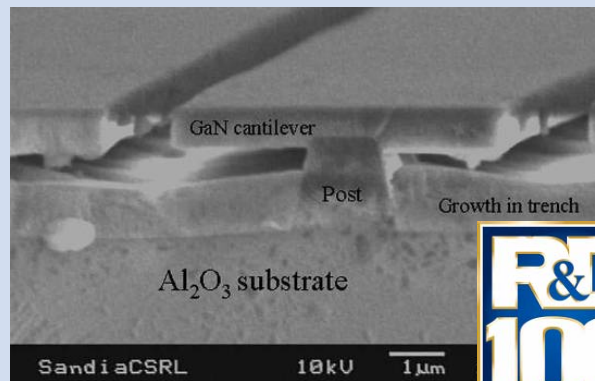
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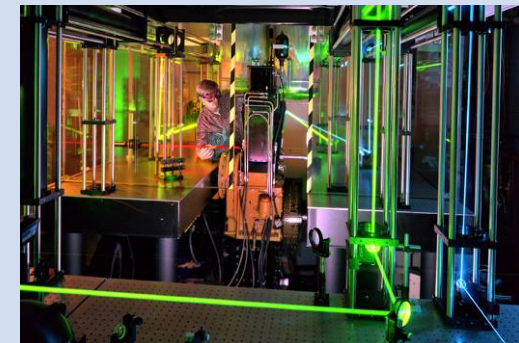
Facilities and equipment for mission needs enable world-class science that pushes the frontiers of knowledge



MESA



SandiaCSRL 10kV 1µm



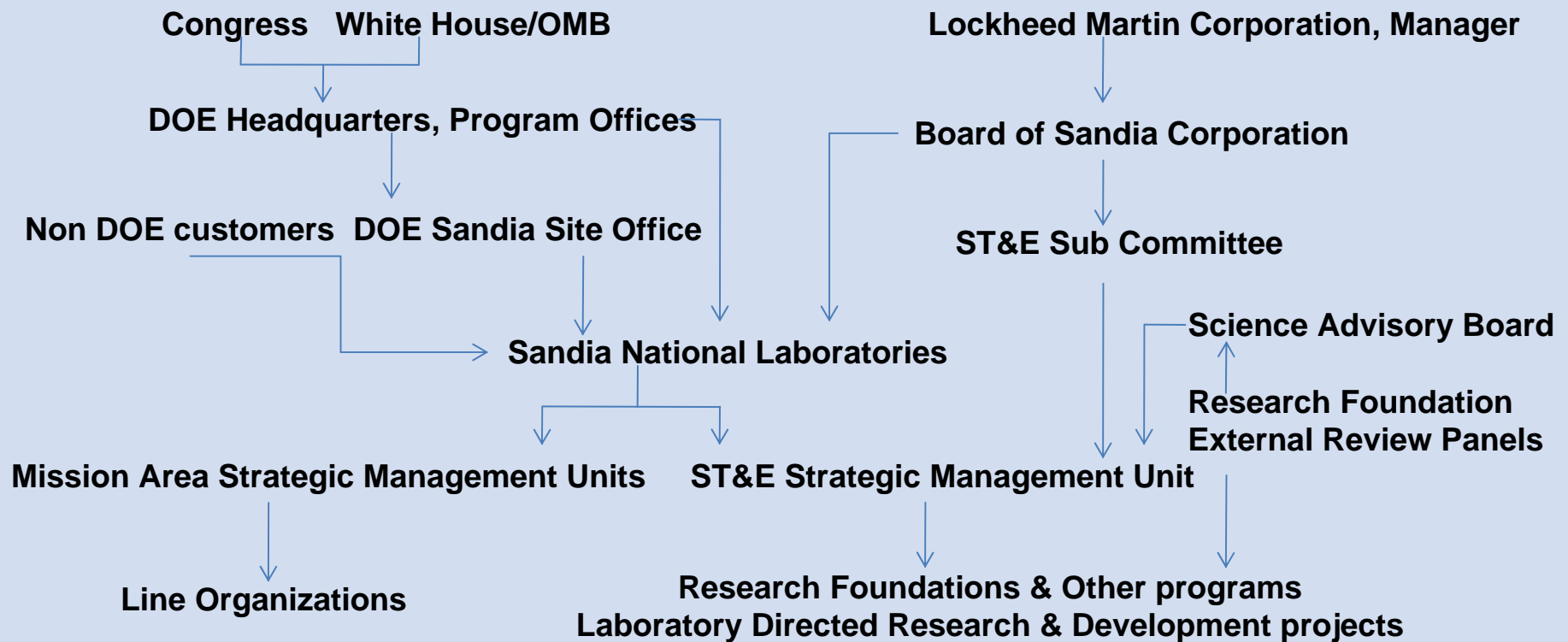


Two Corporate Objectives drive the implementation of ST&E strategy

- 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.

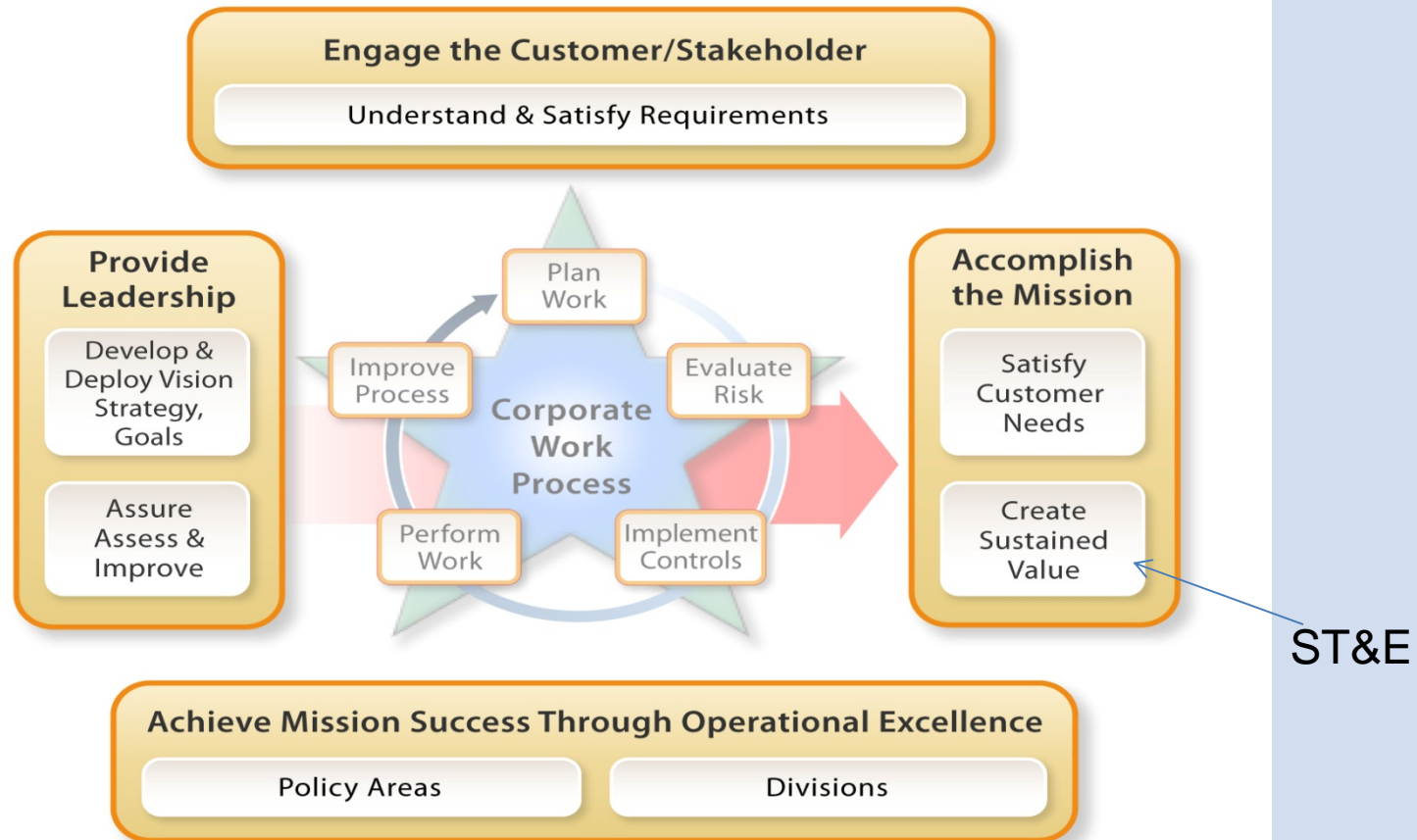


The organizational structure of assessment is complex





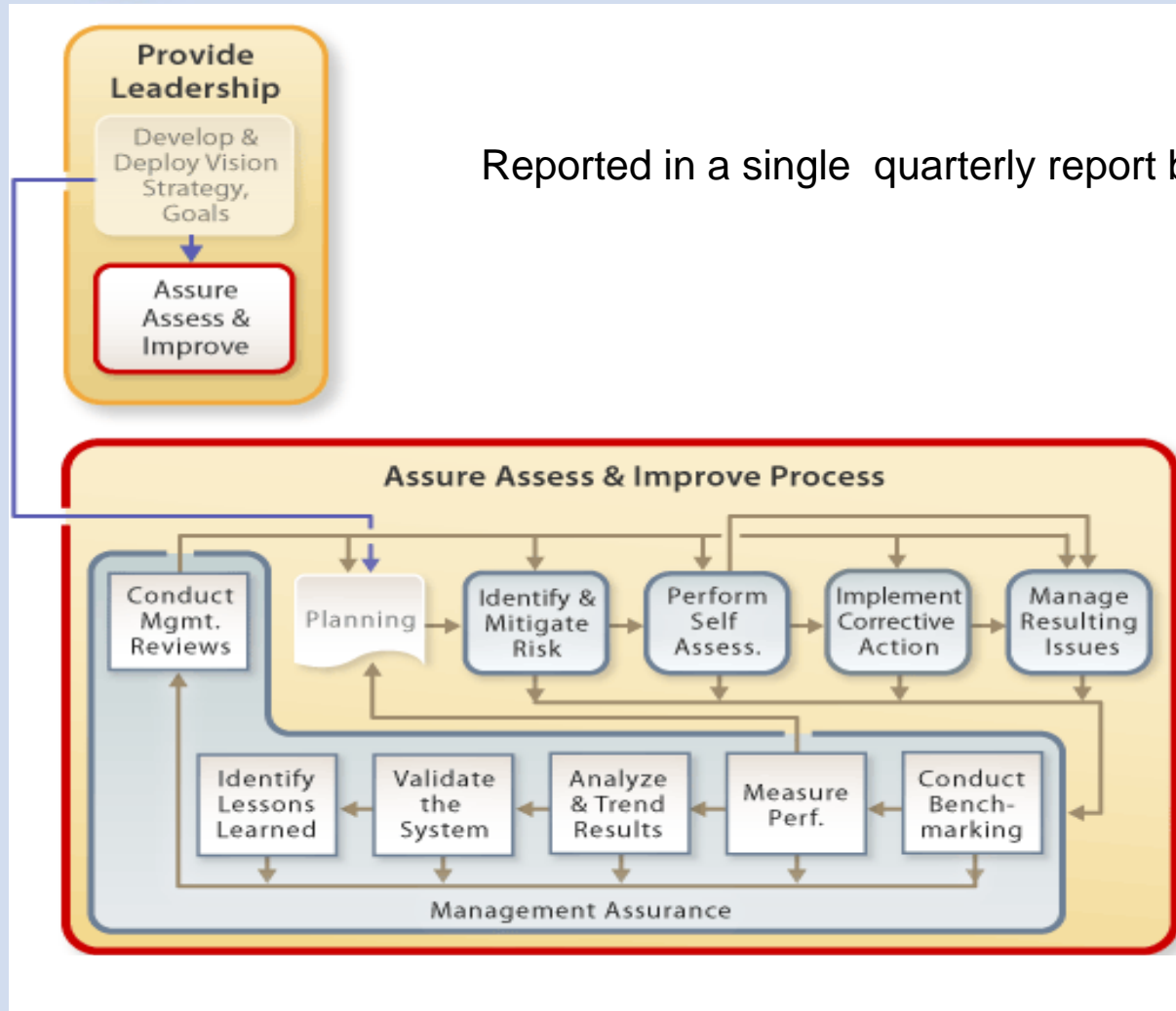
Evaluation Fits Within Sandia's Integrated Laboratory Management System





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

Reported in a single quarterly report beginning 2008.





In addition there is the Annual DOE Performance Management Process

SANDIA NATIONAL
LABORATORIES

LAB PERFORMANCE EVALUATION PROCESS



Performance
Evaluation Plan

Performance
Evaluation
Assessment
Reports
(Sandia)

Performance
Evaluation Report
(DOE)

10 Includes the ST&E corporate objectives and milestones

G. Jordan March 2008



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

- 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.

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



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

SMU & WFO Customers

Citations

Follow on dollars

Value nuggets

ST&E embedded in products

ST&E/Customer Integration

\$ in Joint work

External collaborations,
partnerships

Today's Products

Nurture the core

Enable the Mission

Publications

Value to readiness level

“Breakthroughs”

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

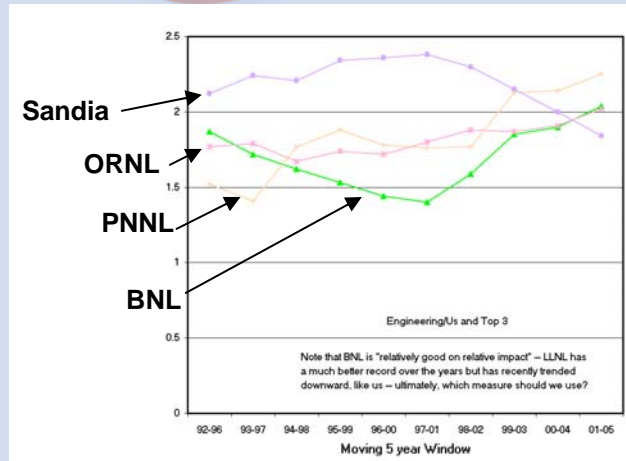
Employee attitudes on work environment

Compliance record, burden

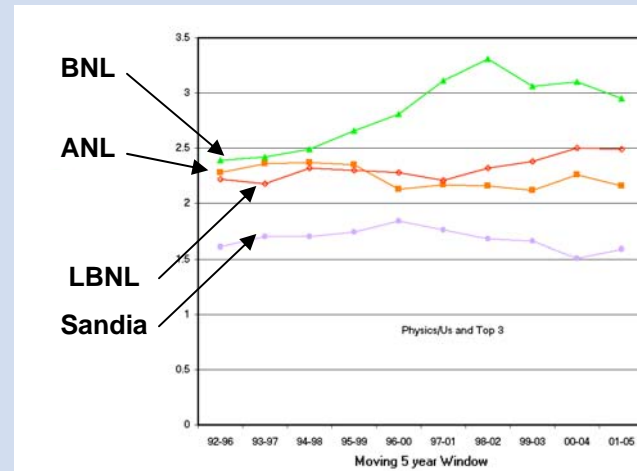


Sandia publication citations are above the world citation impact factor in key disciplines, but cited less than some other Federal labs.

Engineering

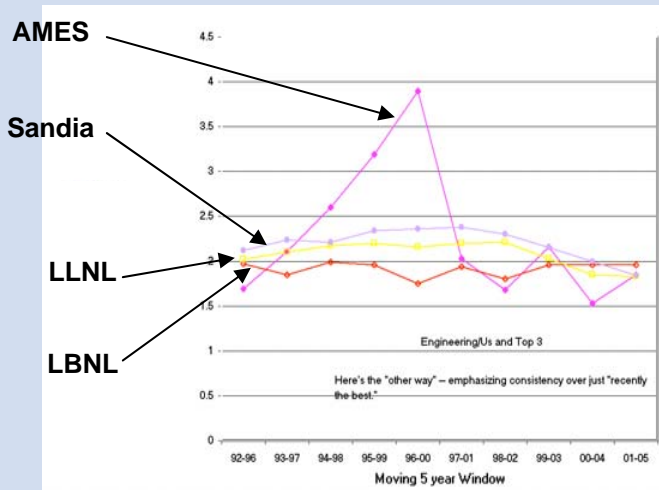


Physics

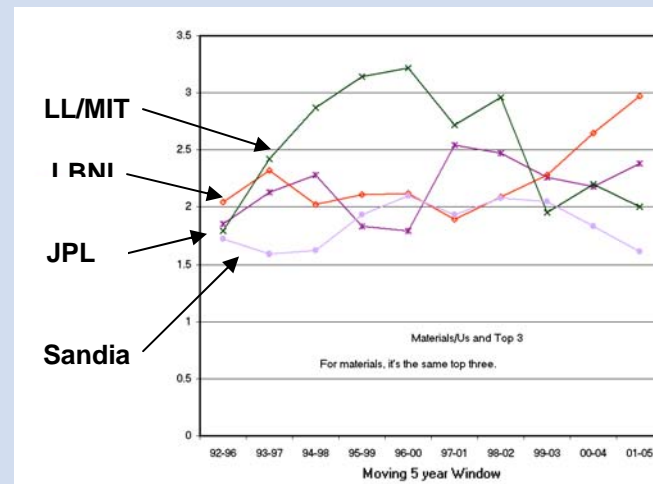


For example, looking at citations...

Engineering – Alternative



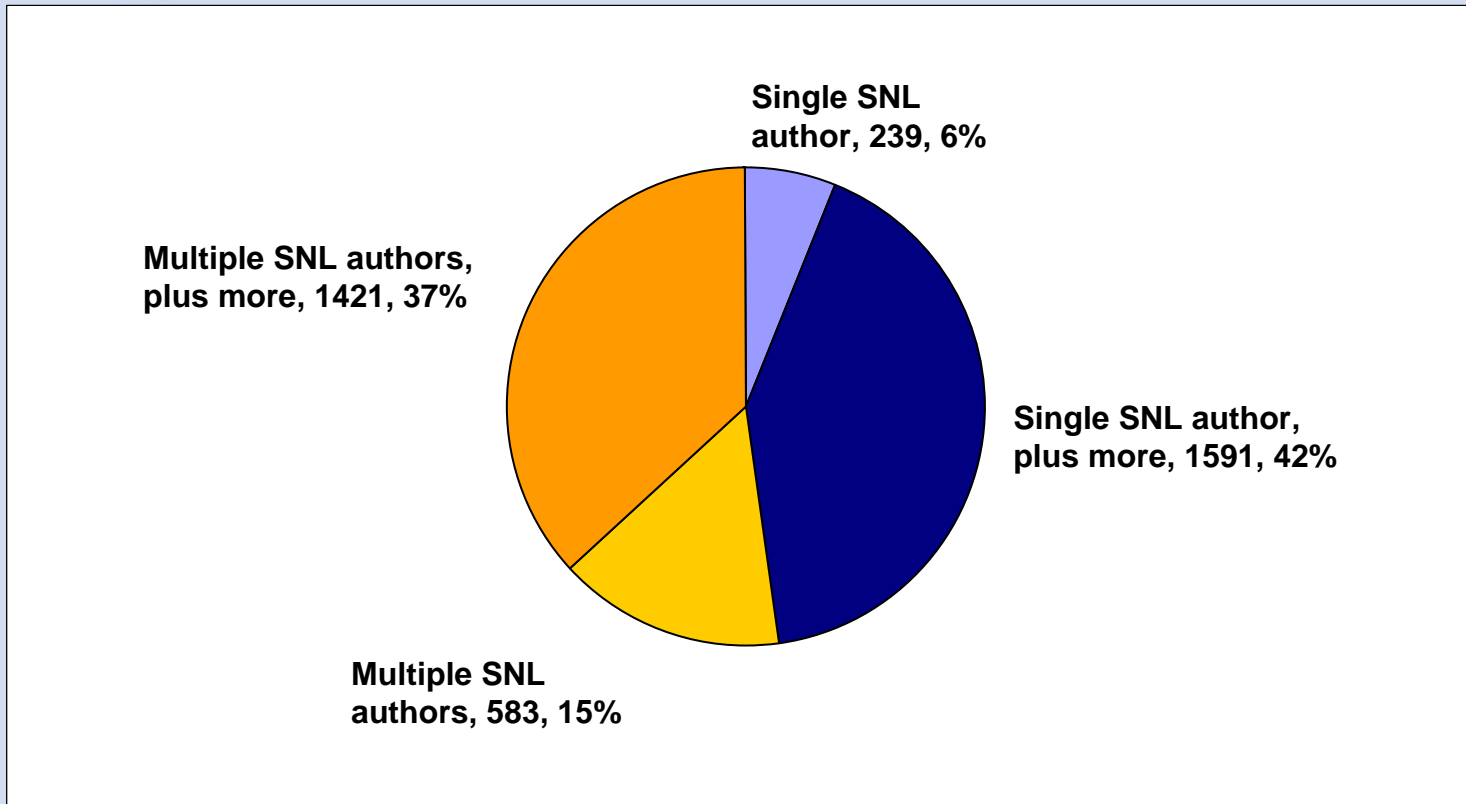
Materials





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 collaboration 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.

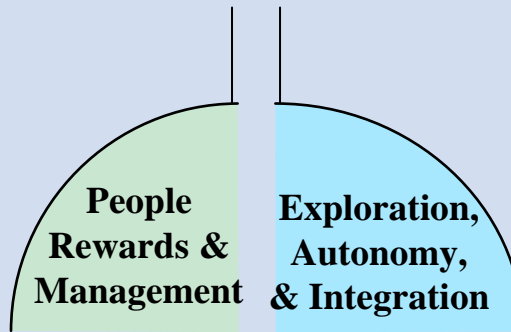


Research Environment Survey

- 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



*Tensions of Achieving
 Organizational Effectiveness*

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

Attribute	S&T MD 2004		CO-LO 2004	
	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)



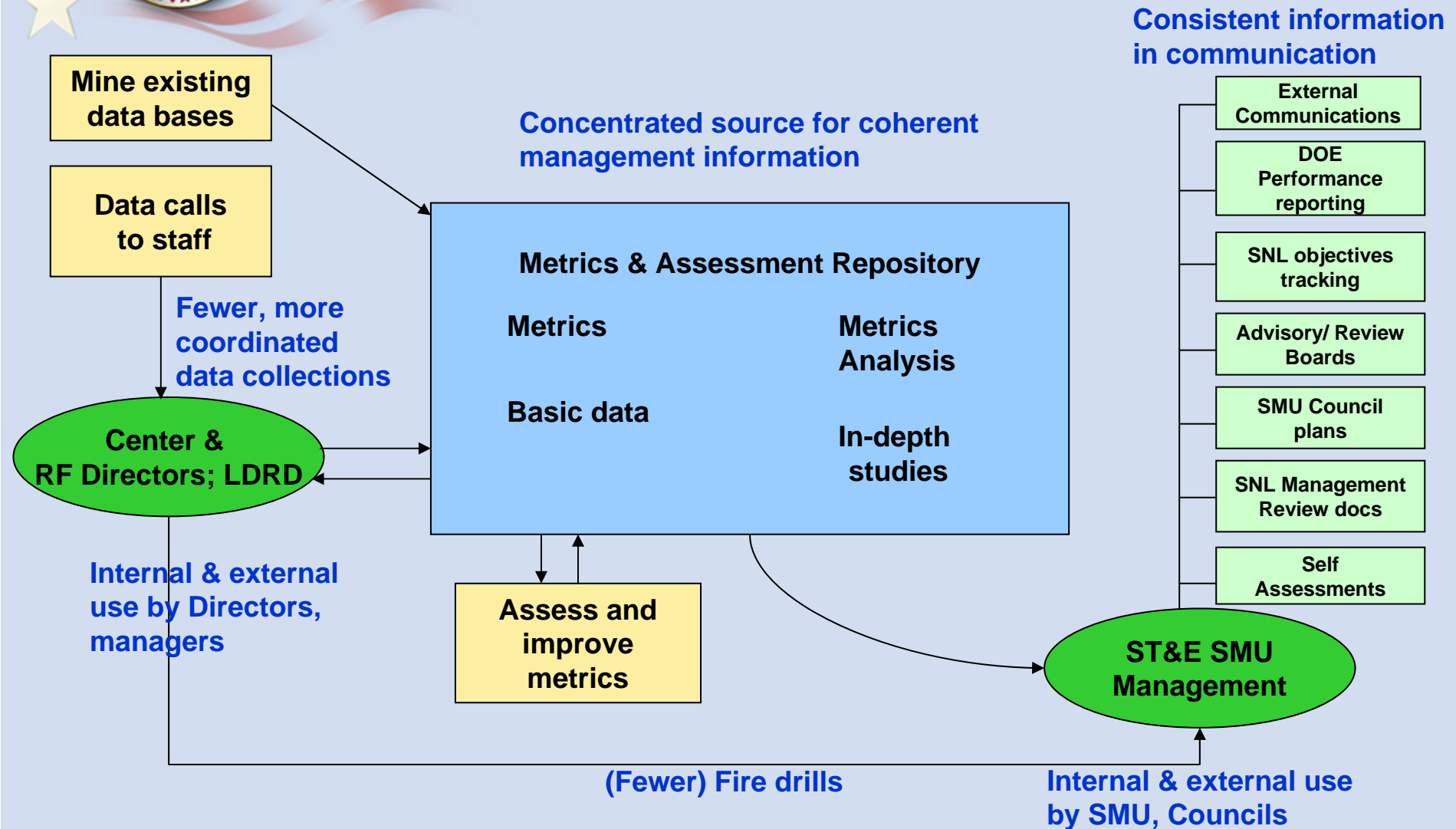
The ST&E metrics project is ongoing.

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.