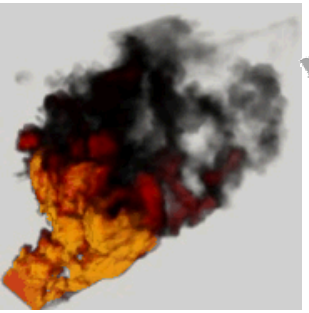
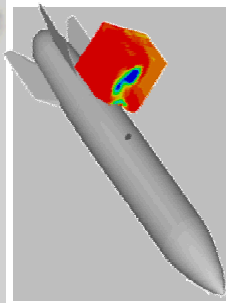
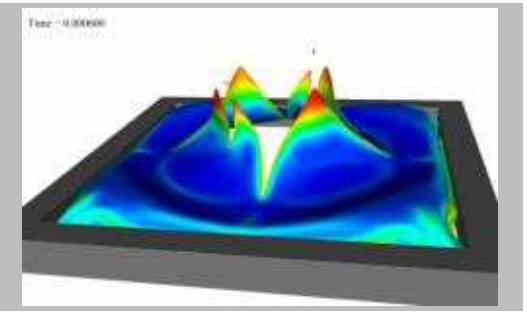
SAND2013-3380C







Engineering Sciences Research Foundation

External Panel Review

Justine Johannes

Director, Engineering Sciences Center

Sandia National Laboratories

Exceptional service in the national interest

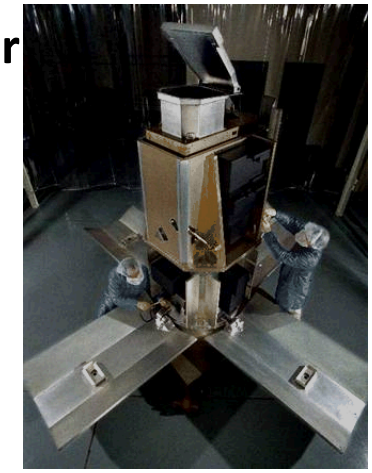
U.S. DEPARTMENT OF ENERGY

NNSA

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Sandia Has 4 Major Business Units Called Strategic Management Units (SMUs)

- Nuclear Weapons
- Defense Systems & Assessments (DSA), DoD and Intelligence
- Energy, Climate, & Infrastructure Security (ECIS)
- International, Homeland, and Nuclear Security (IHNS)



SNL has “corporate S&T” largely located in Division 1000/8000 and a CTO that manages Research Foundations & LDRD

Changes in Executive Management for Research Foundations and S&T

Julia Phillips
Chief Technology Officer, Acting

CTO responsible for Research Foundations, LDRD and Partnerships

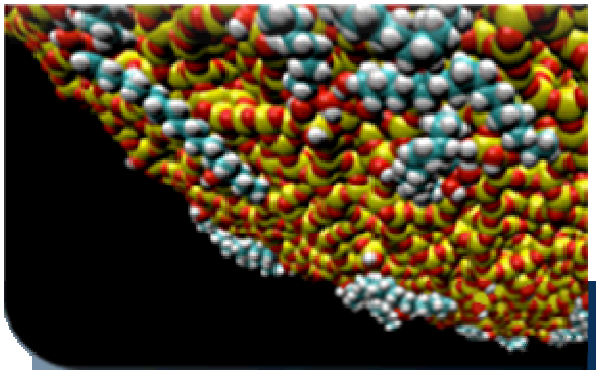
Duane Dimos
Vice President of Science and Technology, Acting

Vice President for Division 1000, Science, and Technology

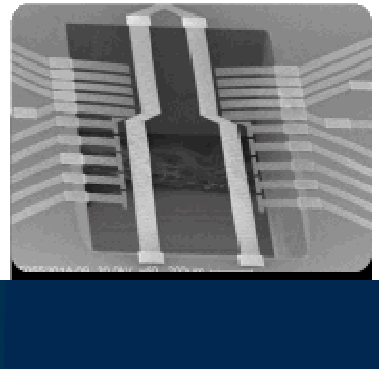
Science and Engineering Research Foundations

Computing and information science

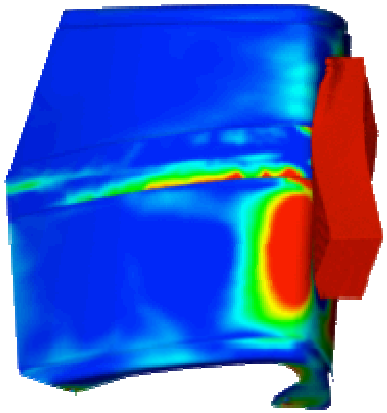
Materials science



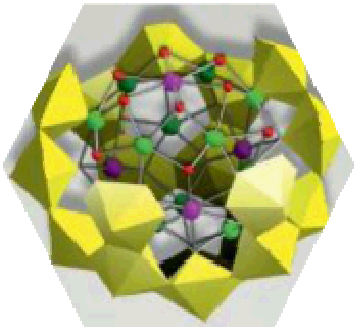
Nanodevices and microsystems



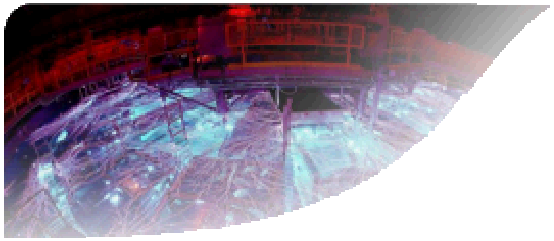
Engineering sciences



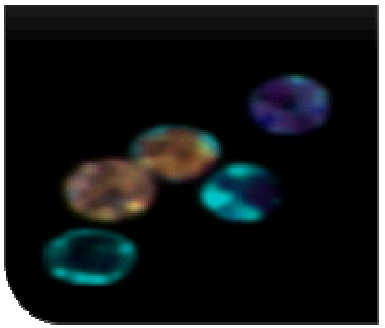
Geoscience



Radiation effects and high-energy density science



Bioscience



Engineering Sciences Research Focus

Building on the statement of intent, we strive to:

- Advance the scientific understanding of physical phenomena underlying problems of interest to Sandia,
- Drive innovation and broad usage of state-of-the-art, validated computational modeling and simulation tools, and
- Accelerate the development of high-fidelity, spatially and temporarily resolved experimental diagnostics for discovery, model validation, and enhancement of our test and evaluation capabilities.

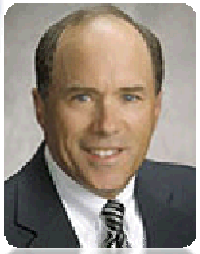
ESRF Stewards a Broad Set of Engineering Disciplines

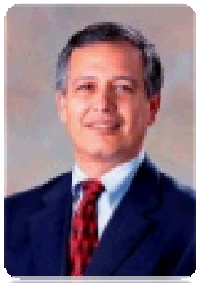
Sandia National Laboratories

***Core technical areas*:**

- Solid mechanics
- Fluid mechanics of reacting and non-reacting systems
- Structural dynamics
- Thermal and combustion sciences
- Aerodynamics
- Shock physics and energetics
- Electrical and electromagnetic sciences

Engineering Sciences Research Foundation Leadership Team





Engineering Sciences Center: Justine Johannes - Director (chair)

David Womble - Senior Manager (Eng. Sci. COO)

Dennis Croessman, Steve Kempka, Dennis Miller - Senior Managers

CA Weapon Systems Engineering Center: Russ Miller - Director

Mary Gonzales - Senior Manager

Transportation Energy Center: Bob Carling - Director (LDRD lead)

Dawn Manley - Senior Manager

Energetic Components Center: Anthony Medina - Director

Jamie Moya - Senior Manager (LDRD investment team)

Senior Managers representing additional Engineering Sciences technical areas:

Larry Schneider: electromagnetics***

Terry Aselage: materials science

Bruce Hendickson: shock physics & electrical modeling***

Electrical Sciences Have Been Consolidated to Strengthen Stewardship of the Capabilities

Sandia National Laboratories

Circuits, Devices, Atomistic / Sub-scale

Electrical System Modeling

Coupled EM and Full System Models

Interdependence

Electromagnetic Effects

EMR, EMI, EMP, HPM, ESD, Lightning

Codes: Xyce CHARON

SANDIA NATIONAL LABORATORIES ELECTRICAL SCIENCES

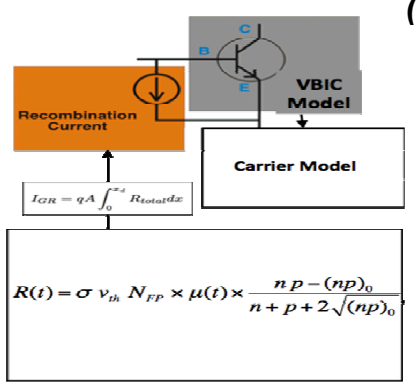
Code Suite: EMPHASIS Sandia National Laboratories

Qualification Alternatives without Pulsed Reactors (QASPR)

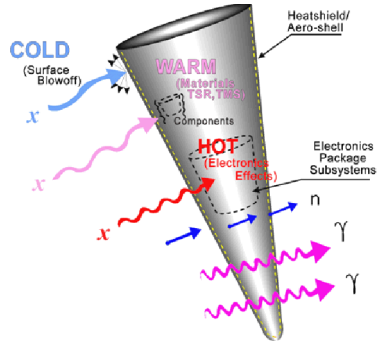
Interdependence

Interdependence

System Generated EMP (SGEMP)



Radiation Effects



Consolidates RAMSES Code Suite development in Center 1300 (NuGet, Xyce, Charon, ITS, SCEPTRE, EMPHASIS, Habanero)

Nuclear Weapons Program is providing increased work load for ESRF organizations

Sandia National Laboratories

- **Advanced Simulation and Computing capabilities, and needed validation data, for support of NW stockpile activities. (led by Engineering Sciences)**
- **Stockpile modernization programs – significant new workload for Sandia**
  - B61-12 (bomb), W88 Alt (Navy submarine warhead), W78 Life Extension Program (Air Force missile warhead), etc.
- **Existing Stockpile Stewardship and Assessment**
  - Annual Assessment Review of aging stockpile
- **Resolution of weapon production issues**
  - neutron generator production
  - W76-1 production support
- **Secure transportation**
  - MGT design analysis
  - Completed the first full-scale rocket sled test and full-scale burn test since 2008. The test was of an air transport container that was designed to meet U.S. and international requirements

ESRF engagement in Defense Systems & Assessments has shifted significantly in the last year

- ***Space missions***
  - *Satellite program is preparing for future competitions*
  - Propellant evaluation for NASA flight safety
- **Defense systems**
  - Beginning next Advanced Hypersonic Weapon program
  - Navy rail gun
- **Computational simulation for design**
  - Navy Enhanced Sierra Mechanics
- **Intelligence assessments**
  - Computational and experiment support
  - Non proliferation proposal

Energy, Climate, & Infrastructure Security

Sandia National Laboratories

- **Combustion:** Advanced engine, diagnostics, chemistry and reacting flows
- **Wind:** structural mechanics and dynamics
- **Solar:** photovoltaic and concentrated solar
- **Energy storage:** Compressed Air Energy Storage, batteries
- **Geoscience:** CO_2 sequestration (coupled fluid-structural models)
- **Electrical Microgrids**: Advanced control theory and technology

International, Homeland, and Nuclear Security

- **Air transportation safety assessments**
  - Completed explosive effects and improvised explosives effort this year and preparing for future work

ESRF Leadership has significant programmatic leadership responsibilities for the laboratory

Sandia National Laboratories

Programmatic responsibilities of ESRF Senior Managers:

ASC* Physics and Engineering Models – **Steve Kempka**

ASC* Verification and Validation – **Mary Gonzales**

ASC* Integrated Codes – **David Womble**

Engineering Campaign, Weapon System Engineering – **Dennis Croessman**

Major Environmental Test (facility support) – **Dennis Miller**

Basic Energy Sciences, Chemical Sciences– **Dawn Manley**

LDRD: Engineering Sciences LDRD Investment Area – **Bob Carling**(Director) , **Jaime Moya** (investment area senior manager)

Mission Challenges and **Research Challenges** being defined by the executive leadership

*ASC – Advanced Simulation & Computing program (NW)

Publications and citations can be informative

#	ENGINEERING, MULTIDISCIPLINARY Institutional Publications	Web of Science Documents	Times Cited	Cites per Document (Impact)	Impact Relative to Subject Area	Impact Relative to Institution
1	RICE UNIV	25	366	14.64	6.50	1.27
2	TULANE UNIV	6	79	13.17	5.85	1.42
3	UNIV CALIF IRVINE	84	832	9.90	4.40	0.90
4	LAWRENCE LIVERMORE NATL LAB	42	390	9.29	4.12	0.77
5	NORTHWESTERN UNIV	141	1,276	9.05	4.02	0.74
6	YALE UNIV	21	167	7.95	3.53	0.61
7	UNIV TEXAS AUSTIN	187	1,482	7.93	3.52	0.86
8	STANFORD LIN ACCEL CTR	2	15	7.50	3.33	0.35
9	NATL RENEWABLE ENERGY LAB	2	15	7.50	3.33	0.58
10	PRINCETON UNIV	70	512	7.31	3.25	0.57
15	**SANDIA NATL LAB**	**188**	**1,274**	**6.78**	**3.01**	**0.89**

(Data represents 5 year average from 2008-2012)

- Number of publications and citations can be informative of course they don't tell the whole story
- Helpful to look at other significant contributors in the field
- Classified and OUO work is limited to internal publications

Publications and citations can be informative, cont.

#	Subject Area	Web of Science Documents	Times Cited	Cites per Document (Impact)	Impact Relative to Subject Area
62	COMPUTER SCIENCE, INTERDISCIPLINARY APPLICATIONS	122	513	4.20	1.25
30	COMPUTER SCIENCE, SOFTWARE ENGINEERING	56	137	2.45	1.38
43	ELECTROCHEMISTRY	122	1,010	8.28	1.21
27	ENERGY & FUELS	289	2,102	7.27	1.33
42	ENGINEERING, AEROSPACE	47	108	2.30	1.36
15	ENGINEERING, CHEMICAL	251	1,906	7.59	1.73
14	ENGINEERING, CIVIL	36	158	4.39	1.40
3	ENGINEERING, INDUSTRIAL	32	290	9.06	3.04
22	ENGINEERING, MECHANICAL	334	1,598	4.78	1.93
30	MECHANICS	322	1,703	5.29	1.60
39	PHYSICS, FLUIDS & PLASMAS	291	1,778	6.11	1.34
7	TRANSPORTATION SCIENCE & TECHNOLOGY	10	38	3.80	2.27

Data represents 5 year average from 2008-2012

Leadership in advancing engineering sciences

Sandia National Laboratories

Peer Recognition

- Professional society fellows and other awards
- Numerous professional society leadership positions
- Best paper/poster awards
- Members of multiple advisory boards and editorial boards
- Organized meetings and professional society symposium, for example:
  - Direct Simulation Monte Carlo
  - International Meshing Roundtable
  - Co-chair of 34th International Symposium on Combustion
- Numerous DOE and NNSA awards and recognition
- Sandia Cooler Development Team received R&D 100 award

Additional metrics of research foundation health

Intellectual Property:

- ~100 software use licenses/yr
- 6 patents/yr., 2-7 technical disclosures for patents/yr

University collaborations:

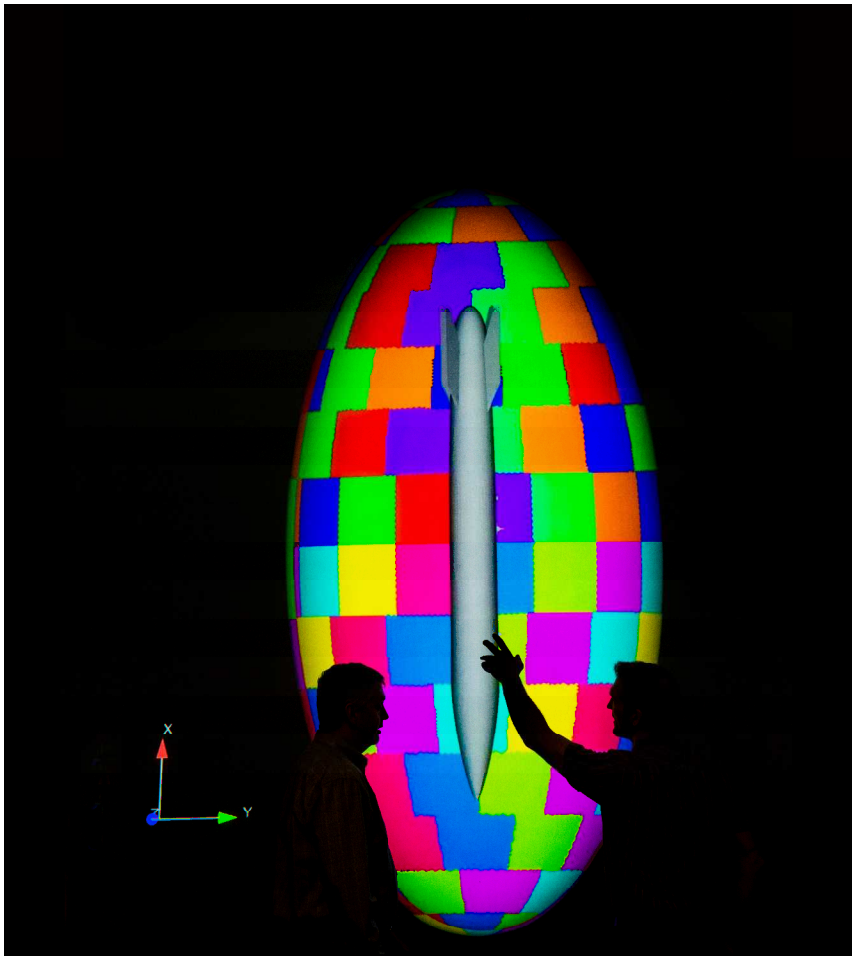
- $2.1 M/yr. funded university contracts
- Predictive Science Academic Alliance Program (PSAAP): NNSA Program
- DOE Energy Frontier Research Center Participation
  - Center for Nano and Molecular Science and Tech., Prof Rossky, U. Texas
  - Combustion Energy Frontier Research Center, lead Prof. Law, Princeton

Industrial partnerships:

- $2.96 M/yr. funded Cooperative Research & Development Agreements

  Increase from previous year due to addition of 8300 to ESRF Scope
- $1.6 M/yr. in funded contract work

Inverse Methods Provide Unique Capability for Acoustic Loads Characterization



- B61 is subjected to acoustic loads during captive carry and free flight.
- Computational models of acoustic environment are extremely challenging.
- We use inverse methods to combine experimental and computational loads.
- This is a unique capability with ongoing research in:
  - Inverse methods for load ID.
  - Inverse methods of coupled structural acoustic systems.
  - Linear solver extensions in frequency domain.

Navy Enhanced Sierra Mechanics

Approved as Navy Surface Ship Analysis Tool

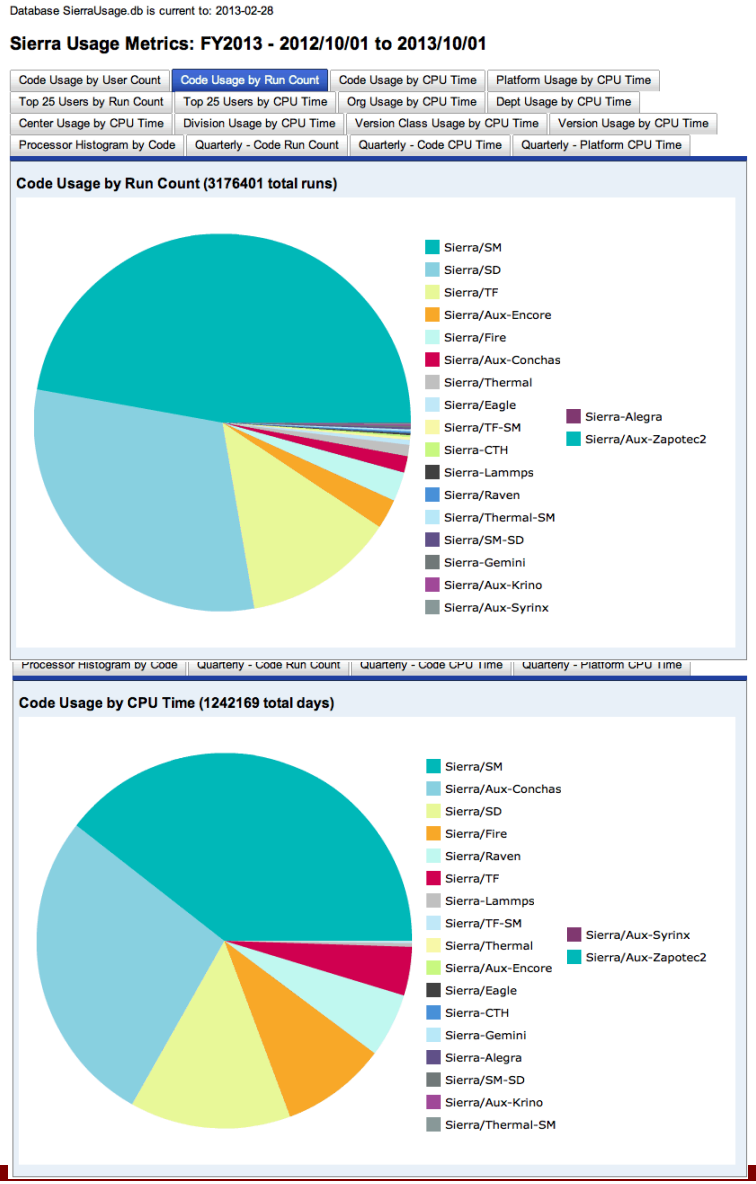
- Research in multi-scale modeling of shells and solids.
- Development of composite orthotropic layered shells
- Research and development of fluid/structures interfaces.
- 12 year development program for Navy analysis. Future work in:
  - Improved SD/SM coupling
  - Adaptive multi-scale failure
  - Advanced threat modeling

Significant Increase in Sierra Utilization Driven by our NW customers

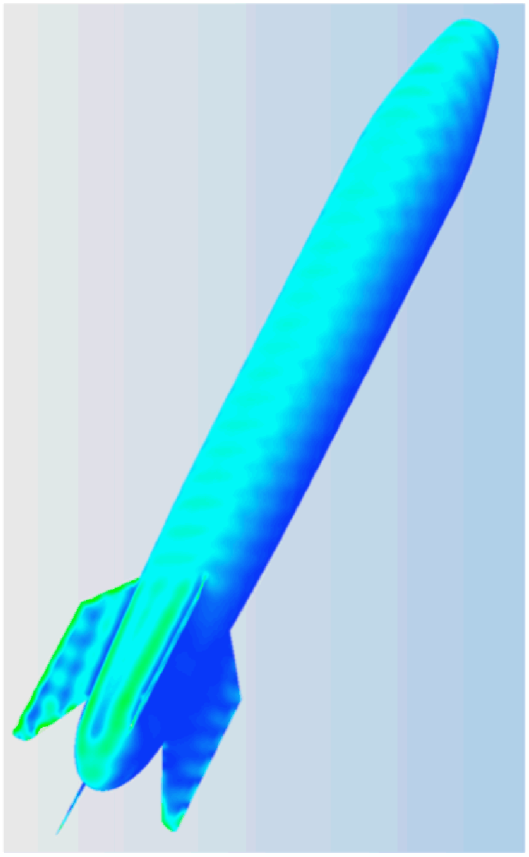
Sierra Usage Statistics	2012/Q2	2013/Q2
Number of Users	211	228
Number of runs	451,177	3,176,401
CPU time (processor-days)	365,828	1,242,169

Notes

- The increase supports the LEPs and ALTs.
- The biggest increase in the number of runs (capacity) is Sierra/StructuralDynamics
- The biggest increase in the CPU usage per run (capability) is Sierra/Aero (Conchas)
- Overall the CPU time/run has decreased => Increased usage for V&V and UQ



Enhancing Electromagnetic Capabilities For Multiple Environments and Systems



- Demonstrated an enhanced capability to predict normal environment electromagnetic shielding at higher frequencies than previously possible using advanced algorithms.
- Evaluating physics-based models for nuclear safety components in the abnormal electrical environment of lightning.
- Validating tools using data from complex geometries in collaboration with AWE for hostile ionizing radiation environments.

Charge to the External Review Panel

Sandia National Laboratories

1. Quality of science, technology and engineering
   - What is the technical quality of the work?
   - How much impact is and/or can our work having in the broad engineering sciences field?
2. Relevance to national need and agency mission
   - Is the connection between the research and Sandia's missions clear?
   - Is it clear why Sandia needs to be doing this work?
3. Programmatic performance, management and planning
   - Does our strategy make sense for Sandia? Are we executing it?
   - How well are we managing the engineering sciences research foundation – people, technology, programs?
4. Strategic Plan
   - What is missing from our strategic plan or needs strengthening?
   - Are we making progress against the plan?