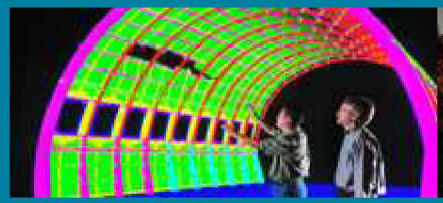
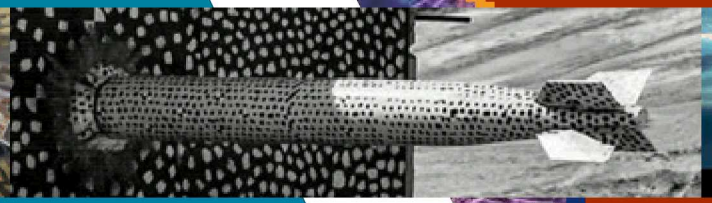
SAND2019-13656C

Exceptional service in the national interest








Excelling at an Engineering Laboratory While Being True to Your Mathematical Roots

Jim Redmond
November 9, 2019

UPDATED SEPTEMBER 2019

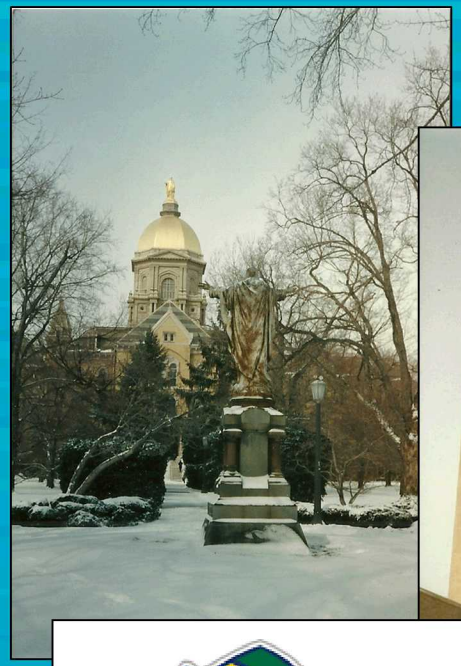
Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia LLC, a wholly owned subsidiary of Honeywell International Inc. for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.
SAND 2018-4900 PE

Overview

- My Background
- Introduction to Sandia
- Sandia connection to KU/Math
- Math Staff vignettes
- Lessons Learned

My Educational Background

High School Guidance circa 1983 – "You like Math?....Major in Engineering!"



TUITION AND REQUIRED FEES

(*Approximate rates*—see enclosed statements for exact rates)

UNDERGRADUATES

Hours	Residents of North Carolina	Nonresider
0-5	$122	$ 4
6-8	243	8
9-11	365	1,2
12 +	439	1,6

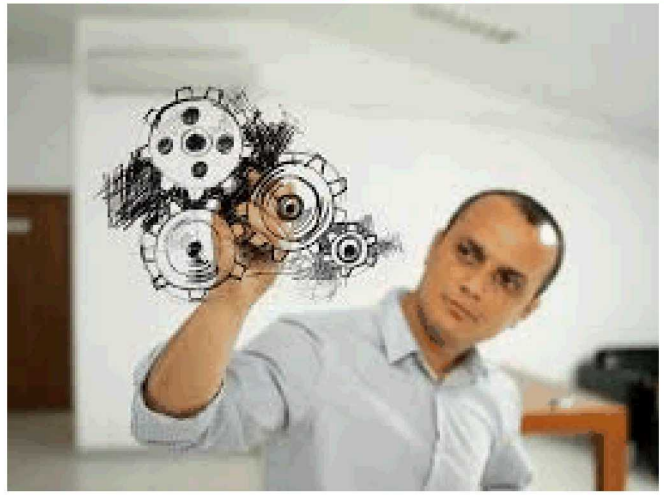
Notes: (1) Audits ..... Rates sa e as for cre
(2) Cooperative Education Program Fee $1
(3) Full time faculty/staff course fee .....

Early validation of my math skills

My Background – An Engineer..... and amateur mathematician

- Pursued Math electives as an undergrad Aerospace Engineer
  - Linear Algebra
  - Numerical Mathematics
  - Advanced Calculus
- Completed as many Math courses as Engineering courses in grad school
  - Applied Engineering Mathematics
  - Orbital/Celestial Mechanics
  - Stability and Time Optimal Control of Hereditary Systems
- My experience: engineering often relies on assumptions in the problem formulation to ensure practical solutions
- Mathematicians:
  - Formulate the problem
  - Prove that a solution exists
  - Solve the abstract problem
  - Project solution onto the space defined by practical constraints

Don't always end up in the same place!



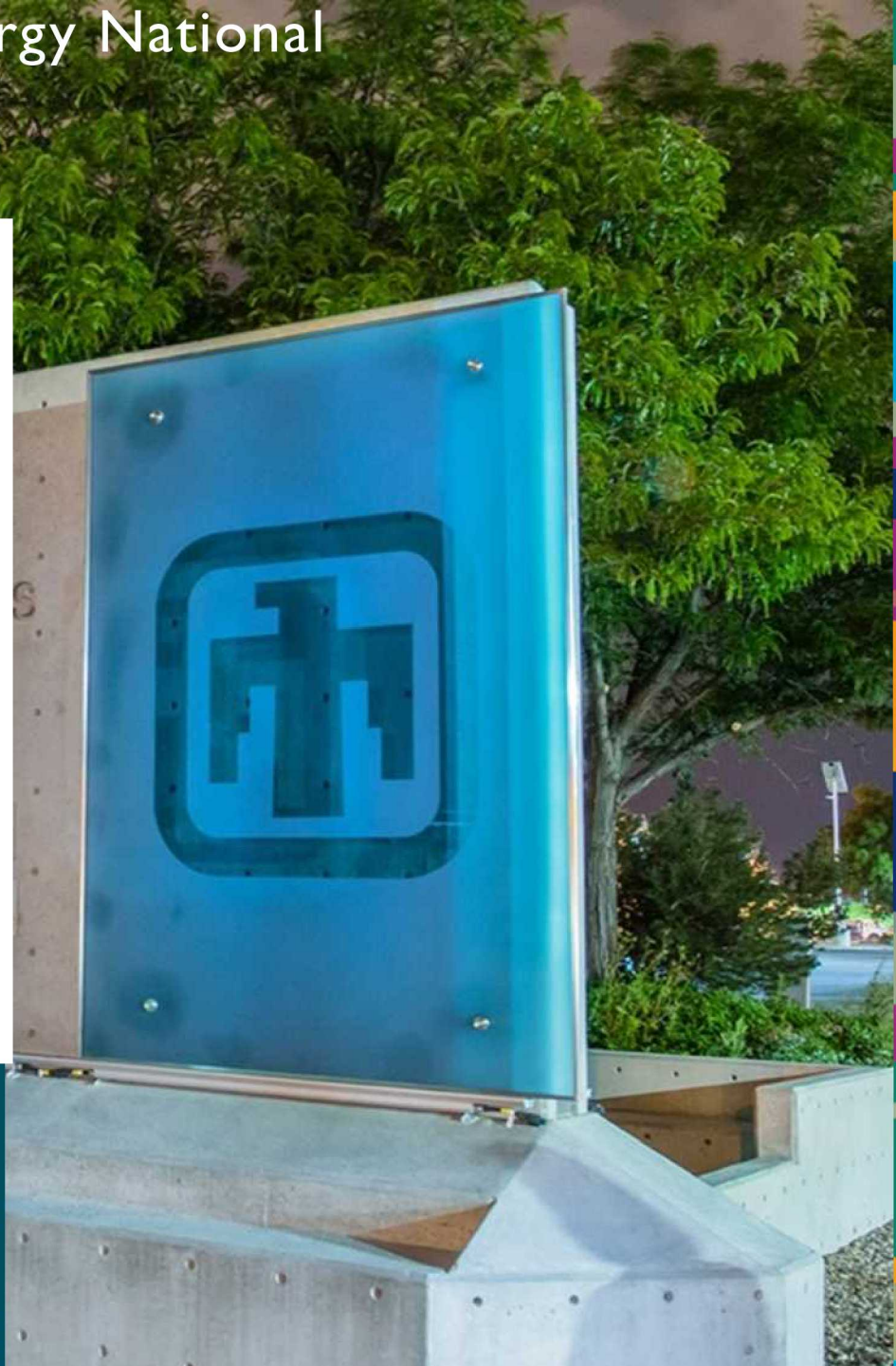
B.S. Aero Engineering 1987
M.S. Aero Engineering 1989
Ph.D. Mech Engineering1992

Sandia National Laboratories

Started a post-doc at Sandia National Labs strongly motivated by...

DESPERATION!

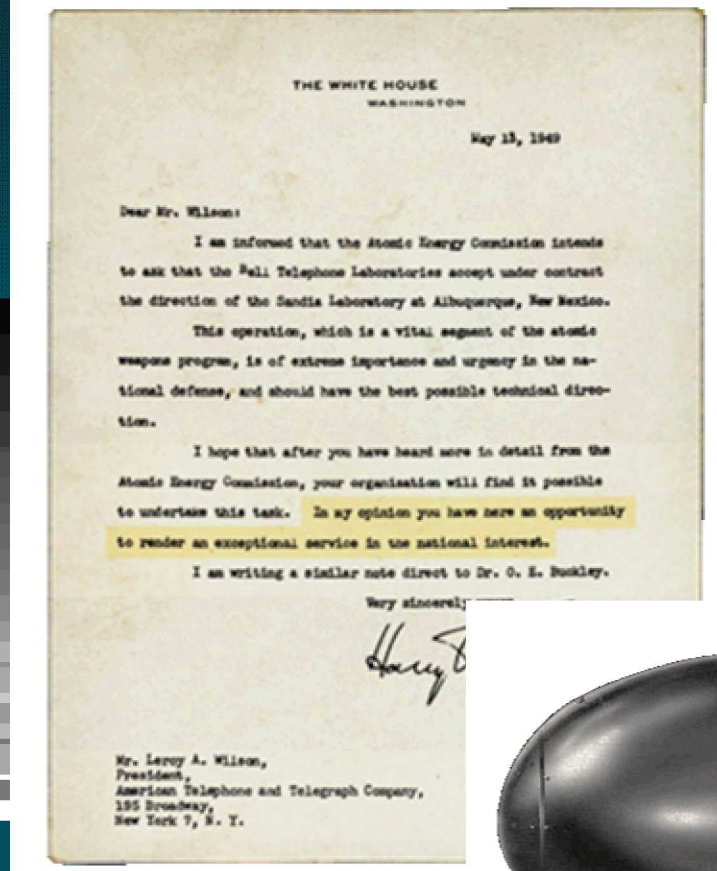
Sandia is a vital Part of the U.S. Department of Energy National Laboratory System



SANDIA'S HISTORY IS TRACED TO THE MANHATTAN PROJECT

…In my opinion you have here an opportunity to render an exceptional service in the national interest.

- July 1945
  Los Alamos creates Z Division
- Nonnuclear component engineering
- November 1, 1949
  Sandia Laboratory established
- AT&T: 1949–1993
- Martin Marietta: 1993–1995
- Lockheed Martin: 1995–2017
- Honeywell: 2017–present



THE WHITE HOUSE
WASHINGTON

May 13, 1949

Dear Mr. Wilson:

I am informed that the Atomic Energy Commission intends to ask that the Bell Telephone Laboratories accept under contract the direction of the Sandia Laboratory at Albuquerque, New Mexico.

This operation, which is a vital segment of the atomic weapons program, is of extreme importance and urgency in the national defense, and should have the best possible technical direction.

I hope that after you have heard more in detail from the Atomic Energy Commission, your organization will find it possible to undertake this task. In my opinion you have here an opportunity to render an exceptional service in the national interest.

I am writing a similar note direct to Dr. O. E. Buckley.

Very sincerely

Mr. Leroy A. Wilson,
President,
American Telephone and Telegraph Company,
195 Broadway,
New York 7, N. Y.

SANDIA HAS FACILITIES ACROSS THE NATION

Activity locations

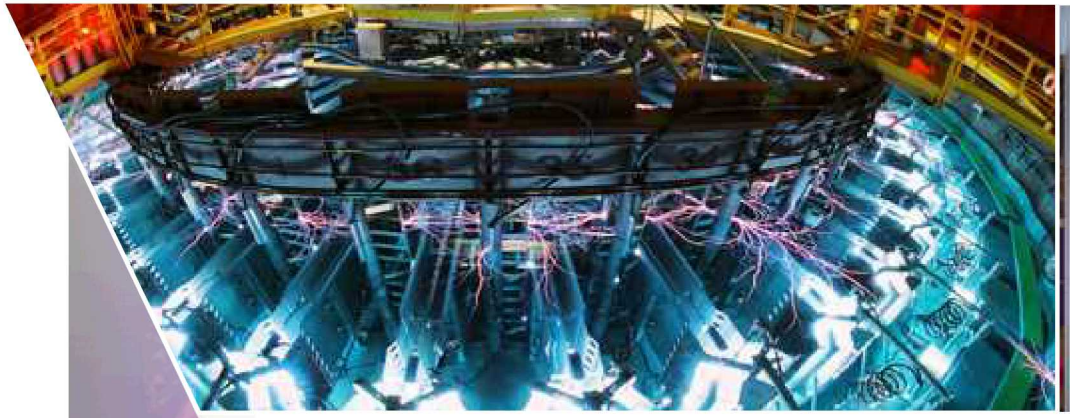
- Kauai, Hawaii
- Waste Isolation Pilot Plant, Carlsbad, New Mexico
- Pantex Plant, Amarillo, Texas
- Tonopah, Nevada

Main sites

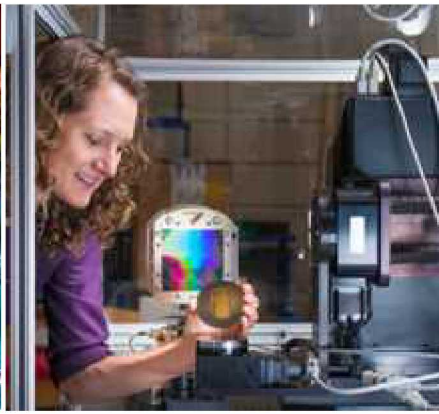
- Albuquerque, New Mexico
- Livermore, California

Research Foundations play an integral role in mission delivery

Nanodevices & Microsystems

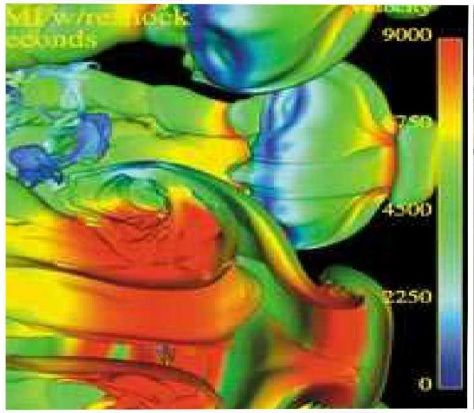


Radiation Effects & High Energy Density Science



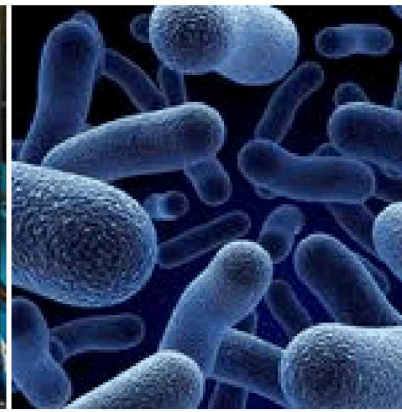
Materials Science

Computing & Informa



Engineering Science

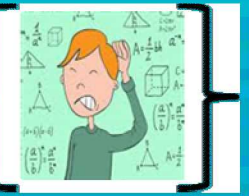
Geoscienc
e



Bioscience

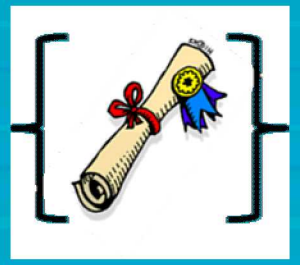
Sandia Workforce – Math and KU by the Numbers

{ } ∩ { } 12,635 members

{  } ∩ { } 437 members

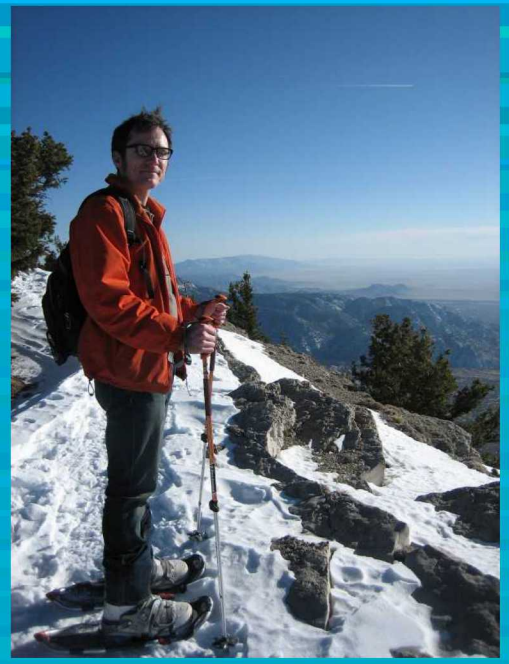
{ } ∩ { KU } ∩ { } 44 members

{  } ∩ { KU } ∩ { } 10 members

{  } ∩ {  } ∩ { KU } ∩ { } 4 members

{ Ph.D., Ph.D., MS, BS }

A Math Centric Career At Sandia...



On Sandia Peak

Stephen Bond

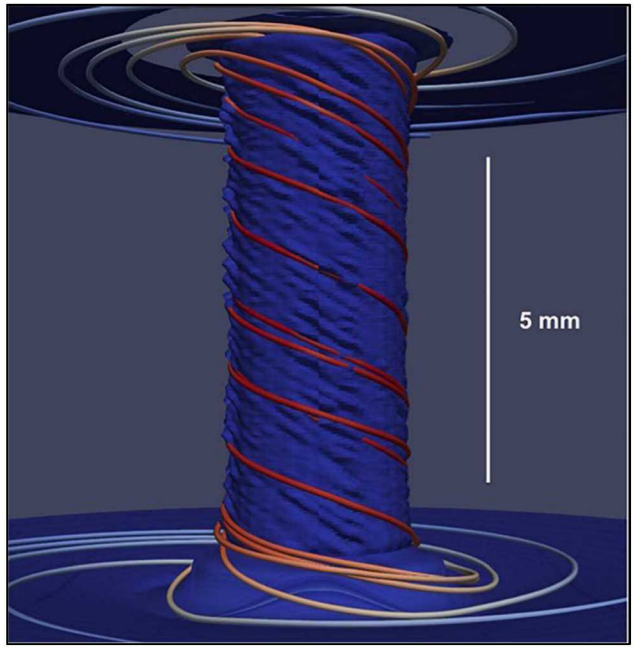
BS in Mech. Eng. from KU
Exch. student at ETH Zurich
Ph.D. in Math from KU
Postdoc in Biochem. at UCSD
Enjoys hiking in the foothills and remodeling/investing in residential real estate.

Computational Math Department

Discontinuous Galerkin methods for Hall MHD plasma models
Hybrid Particle-in-cell for Z-Machine simulation
Applications of machine learning

Why Sandia?

Impact on issues of national importance
Great work-life balance
Work with talented people in industry, academia, and the labs



PERSEUS simulation: Plasma helical instability during inertial confinement fusion on Z-Machine

"A mathematics degree with a focus on numerical analysis and scientific computing helped prepare me for work on a wide range of important problems from machine learning for manufacturing to plasma simulation for pulsed power."

A Math Centric Internship At Sandia...

"Interning at SNL has been a great way to expand my technical skills and see how math can be used to solve important problems. I highly recommend it!"

Cassidy Krause

BS in Mathematics (2015) *University of Wisconsin-Platteville*
MA in Mathematics (2017) *University of Kansas*
PhD in Mathematics (expected 2021) *University of Kansas*

Internship Tips

- Be able to communicate and collaborate with scientists in other disciplines
- Know good programming practices (not just Matlab)
- When asked "Red or green?" the correct answer is "Christmas!"

Current research at SNL

Implement exponential-type integrators to solve stiff initial value problems for the HOMME-NH nonhydrostatic atmosphere model

A Math Centric Career At Sandia...

Jordan E. Massad

Ph.D., M.S. Industrial Applied Mathematics, North Carolina State University

B.S. Physics & Mathematics, Worcester Polytechnic Institute

Family, photography, basketball.

Engineering Sciences

Adaptive structures, smart materials and metamaterials research.

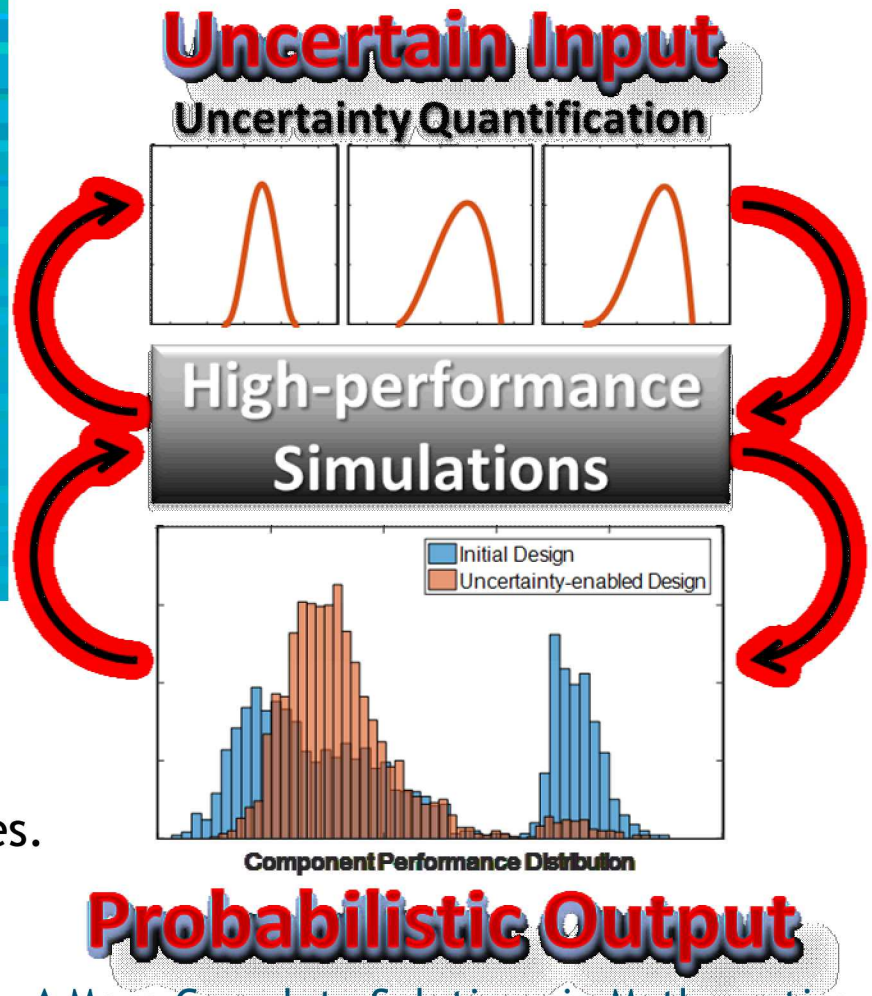
Mechanical design with uncertainty quantification and optimization.

Why Sandia

Diversity of work/research/ problems.

Access to world-class resources.

World-class subject matter experts just steps away.



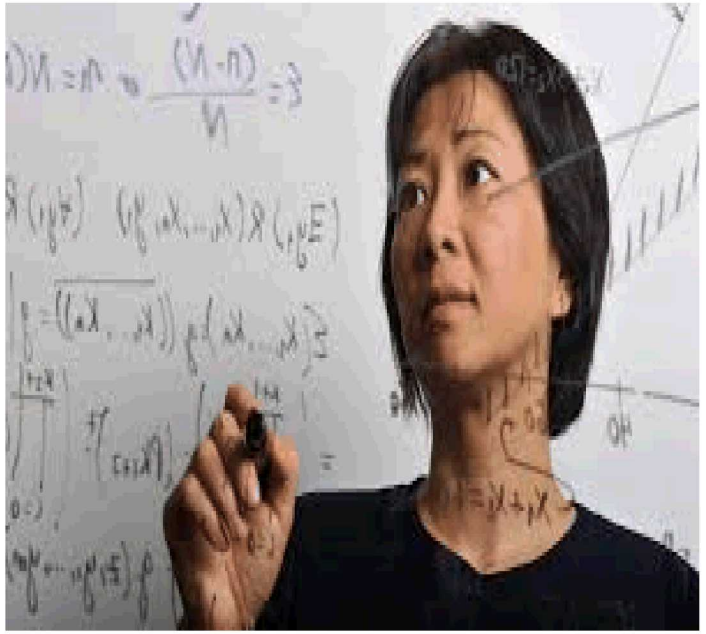
A More Complete Solution via Mathematics and Statistics:
Uncertainty-enabled Design

"A degree in mathematics can provide one with an expansive toolset and capability in science and engineering problem identification, quantification, resolution. GET AN INTERNSHIP WHILE AT SCHOOL! TELL YOUR ADVISOR I SAID SO."

Be True to your roots….

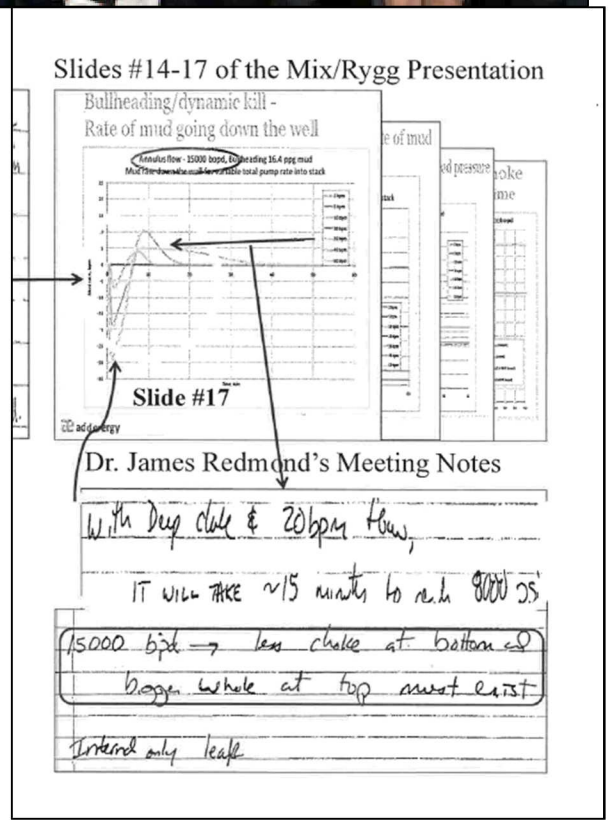
“Resistance is….NOT futile”
“Assimilation is….NOT inevitable”

- Historic cultural identities strongly mold the way organizations conduct work
- Your challenge is to leverage your unique skill sets in ways that break the mold!
- Aided by the growing realization of the multidisciplinary nature of
  - Technology Development
  - Academic Training
  - Workplace Dynamics



Lessons Learned

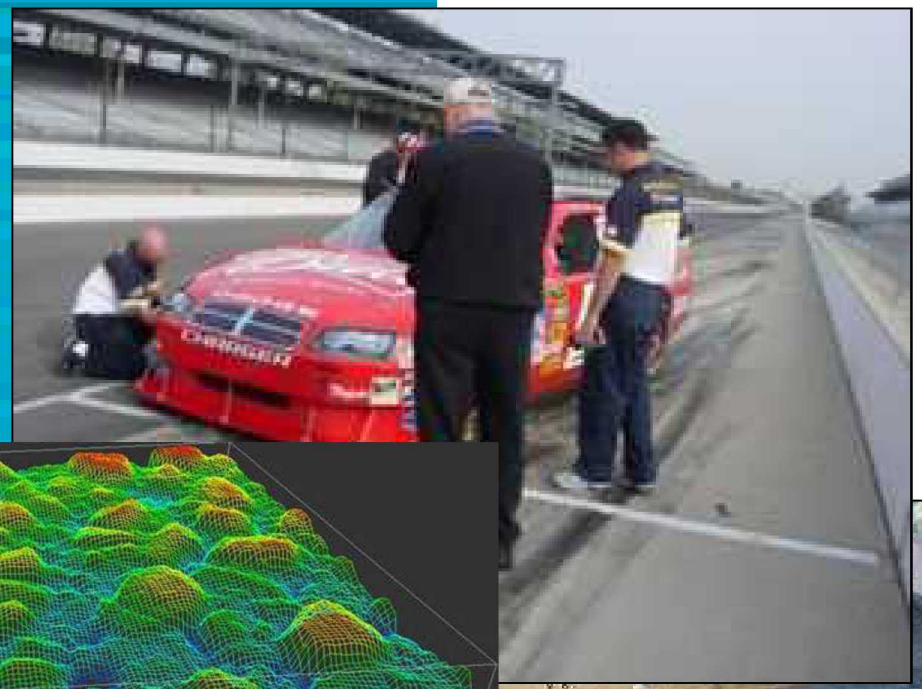
Your work matters in unexpected ways...

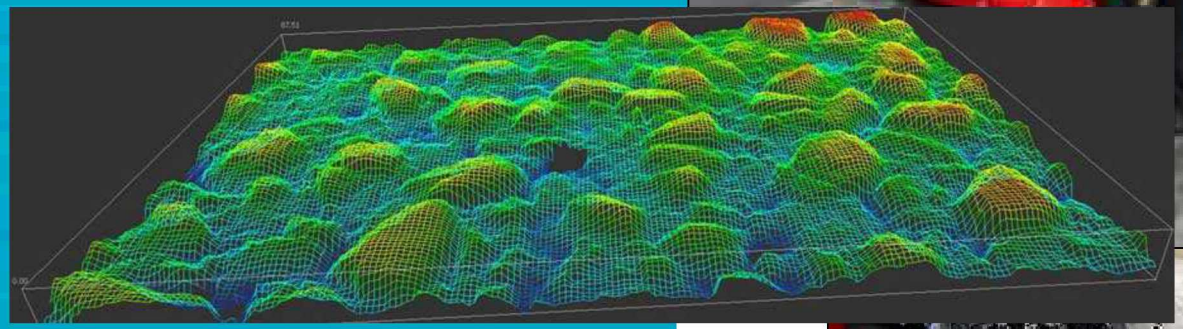


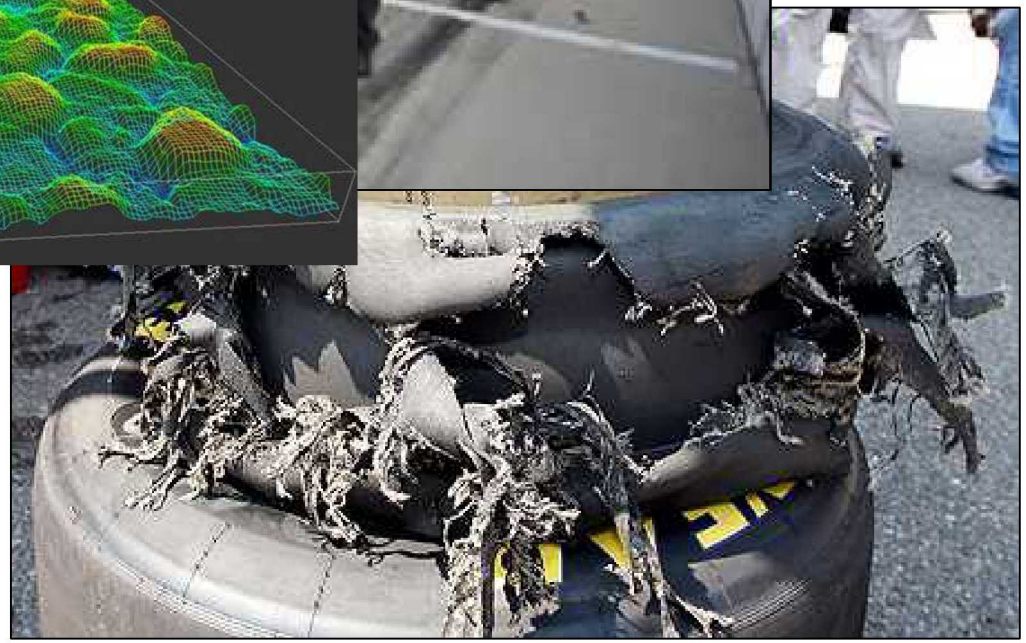
Take good notes, or don't take any notes at all.

Lessons Learned

You'll spend >80,000 hours working in your career...



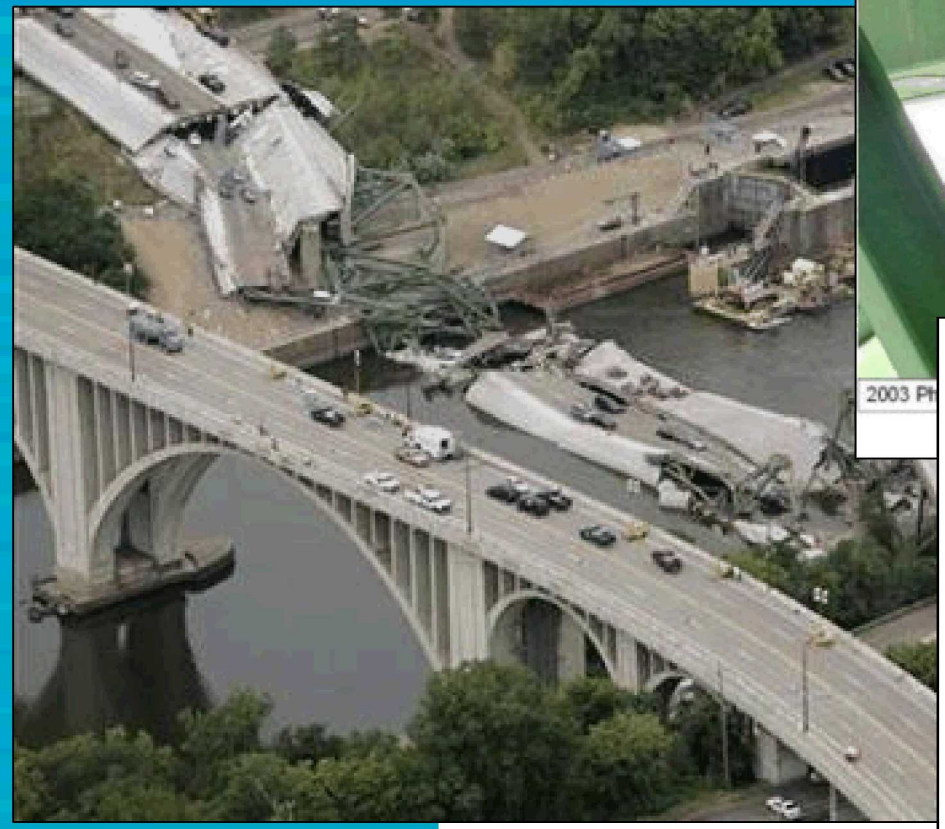




Spend them learning new things that interest you.

Lessons Learned

Choose to work on things that matter...



SANDIA REPORT
SAND2008-6206
Unlimited Release
October 2008

Peer Review of the National Transportation Safety Board Structural Analysis of the I-35W Bridge Collapse

Kenneth W. Gwinn, Gerald W. Wellman, James M. Redmond

Prepared by
Sandia National Laboratories
Albuquerque, New Mexico 87185 and Livermore, California 94550

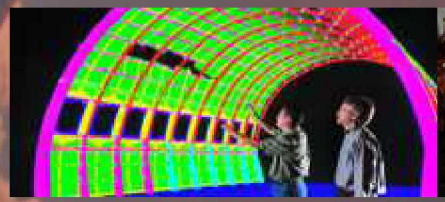
Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under Contract DE-AC04-94AL85000.

Approved for public release; further dissemination unlimited.

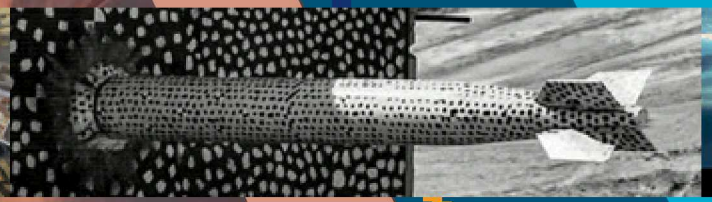
Sandia National Laboratories

Where skill sets intersect passion is where jobs become careers.

Exceptional service in the national interest







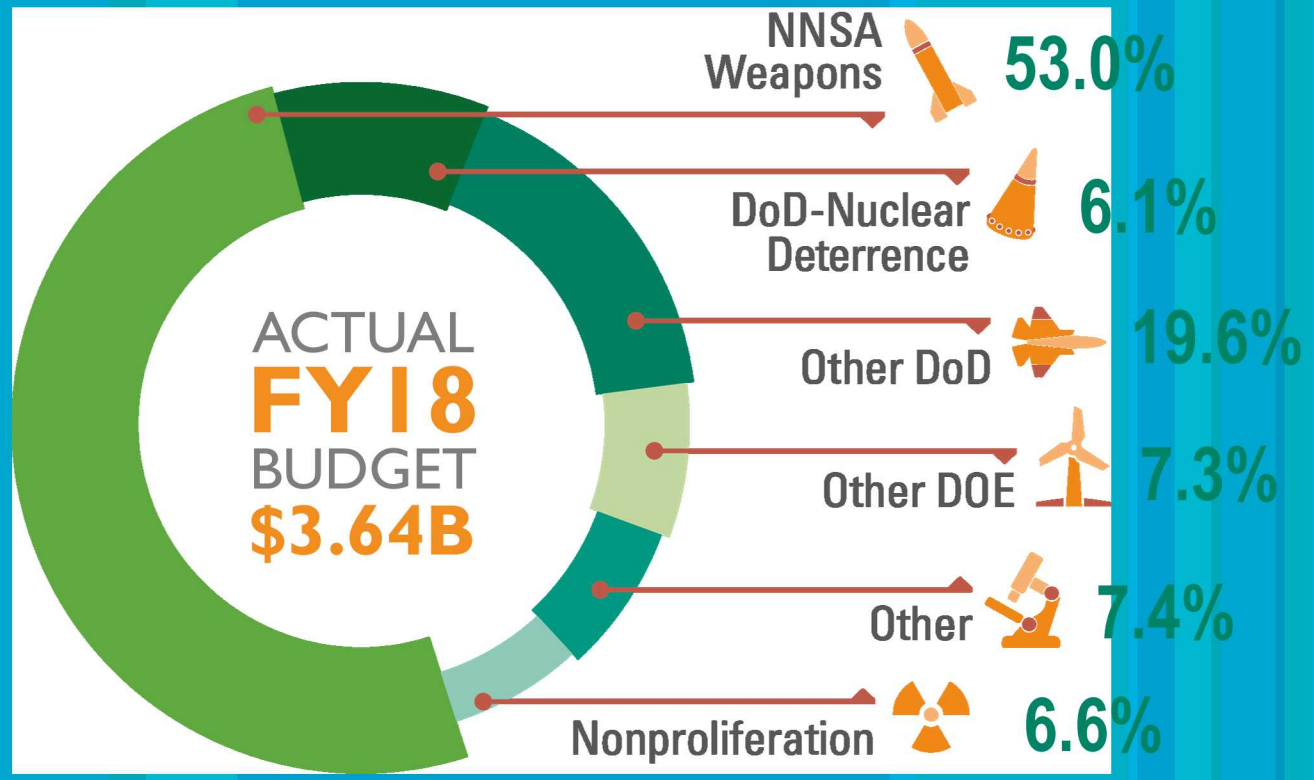

Back up

PURPOSE STATEMENT DEFINES WHAT WE DO

Sandia develops advanced technologies to ensure global peace

SANDIA ADDRESSES NATIONAL SECURITY CHALLENGES

SANDIA'S BUDGET COVERS A BROAD RANGE OF WORK



DoD

Air Force | Army | Navy
Defense Threat Reduction Agency
Ballistic Missile Defense Organization
Office of the Secretary of Defense
Defense Advanced Research Projects Agency
Intelligence Community

OTHER DOE

Science
Energy Efficiency and Renewable Energy
Nuclear Energy
Environmental Management
Electricity Delivery and Energy Reliability
Other DOE

OTHER

Department of Homeland Security
Other federal agencies | Nonfederal entities
CRADAs, licenses, royalties | Inter-entity work

NONPROLIFERATION

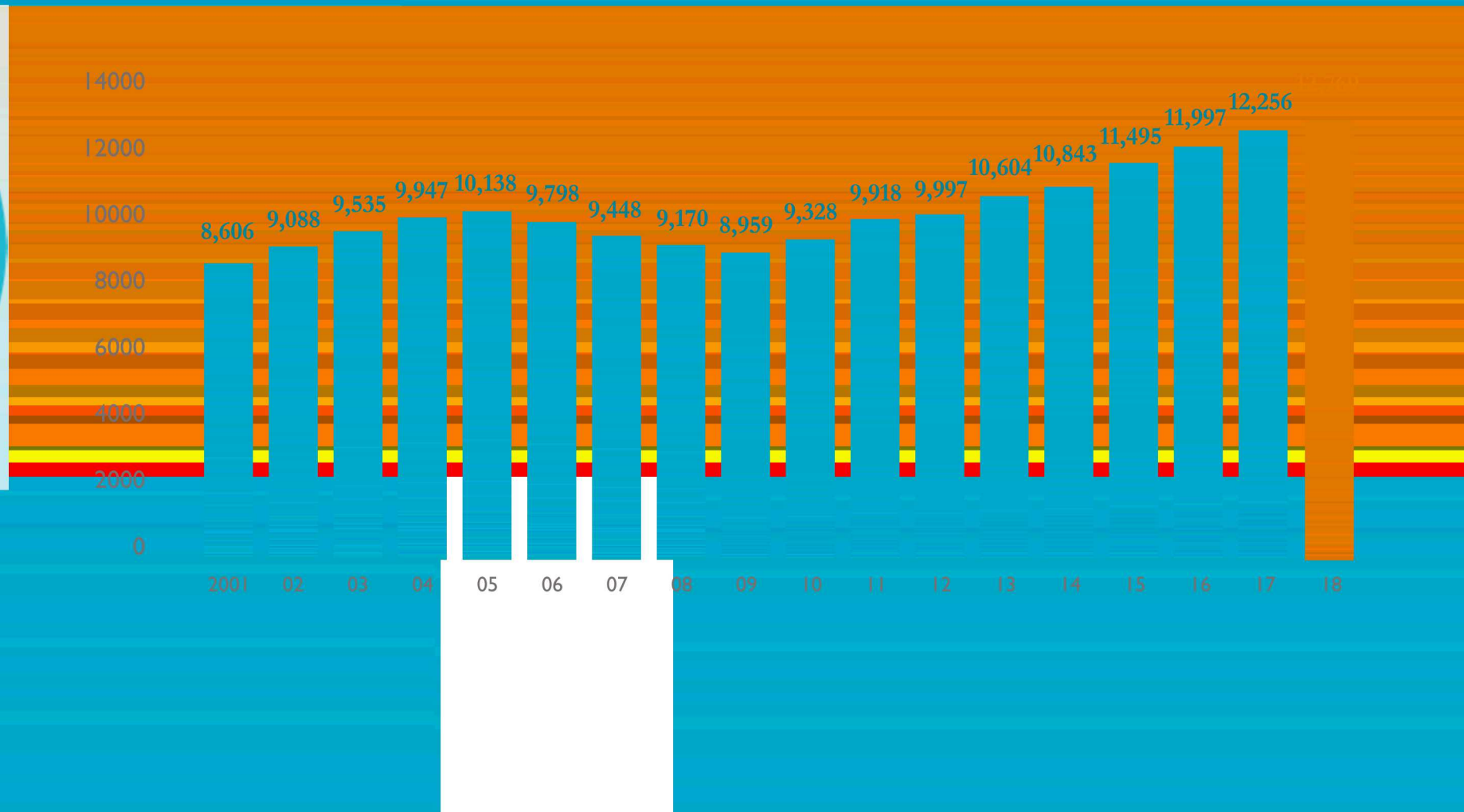
NNSA/NA20 | State Department

)WING

Staff has grown by over 3,800 since 2009 to meet all mission needs

11,341 New Mexico

1,428 California



A Little About Sandia Laboratories

SANDIA IS A FEDERALLY FUNDED RESEARCH AND DEVELOPMENT CENTER

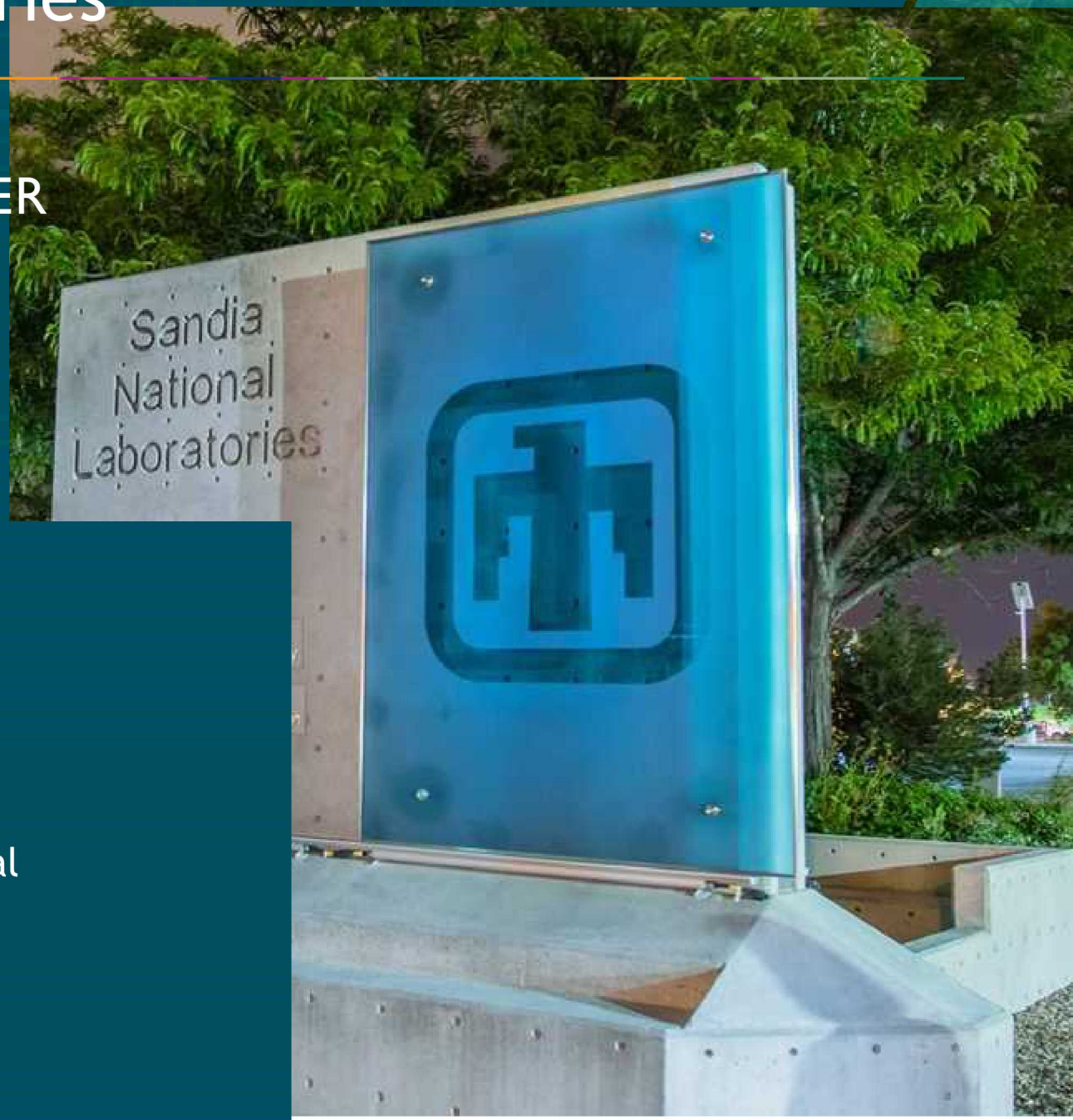
Government owned, contractor operated

MANAGED AND OPERATED BY

National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc.: 2017 – present

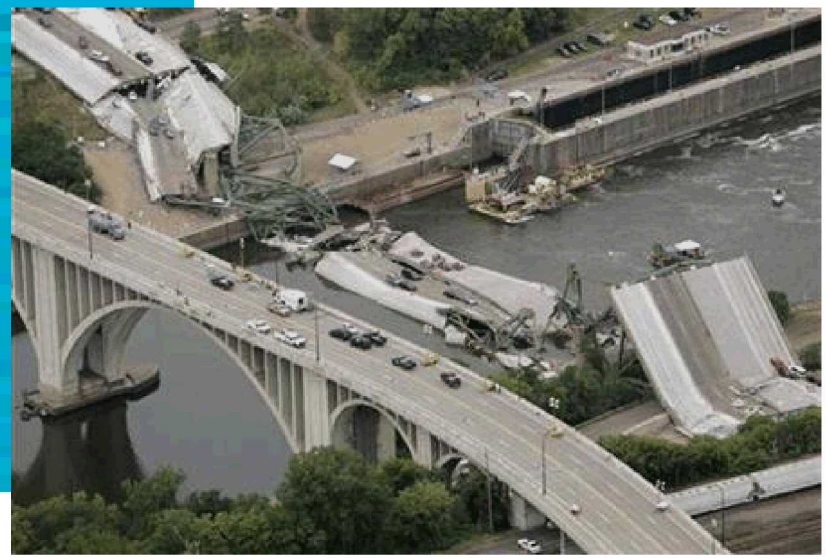
42 FFRDCs, 16 run by Department of Energy

Sandia is 1 of 3 Labs under the auspices of the National Nuclear Security Administration



My Sandia Career – 27 years and counting.....

- Hired as post doc in 1992 in Structural Dynamics and Controls
- Converted to Senior Staff 1993
- Gave up on Academic Career in 1997
- Moved to Management in 2001
  - Hired a lot of engineers and a handful of mathematicians
- Unexpected events have provided most meaningful career highlights....and important lessons



Lessons Learned

- Your work matters....in ways you can't possible imagine.
- Take good notes....or don't take any notes at all
- Don't let the barriers to do everything....prevent you from doing something
- If it's not worth doing.....it's not worth doing well.

There are many interesting jobs, but a meaningful career happens when passion and skillsets intersect....