SAND2012-2424 C
SAND2012-2424C

Exceptional service in the national interest

Sandia National Laboratories



Sandia National Laboratories

Phil C. Bennett, Manager

Cognitive Systems Department

U.S. DEPARTMENT OF ENERGY

National Nuclear Security Administration

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. SAND2011-0439P

Mechanical Engineers

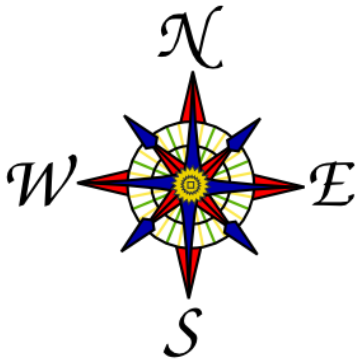
Have Great Tools

Who Are You…

…and what are you doing here?

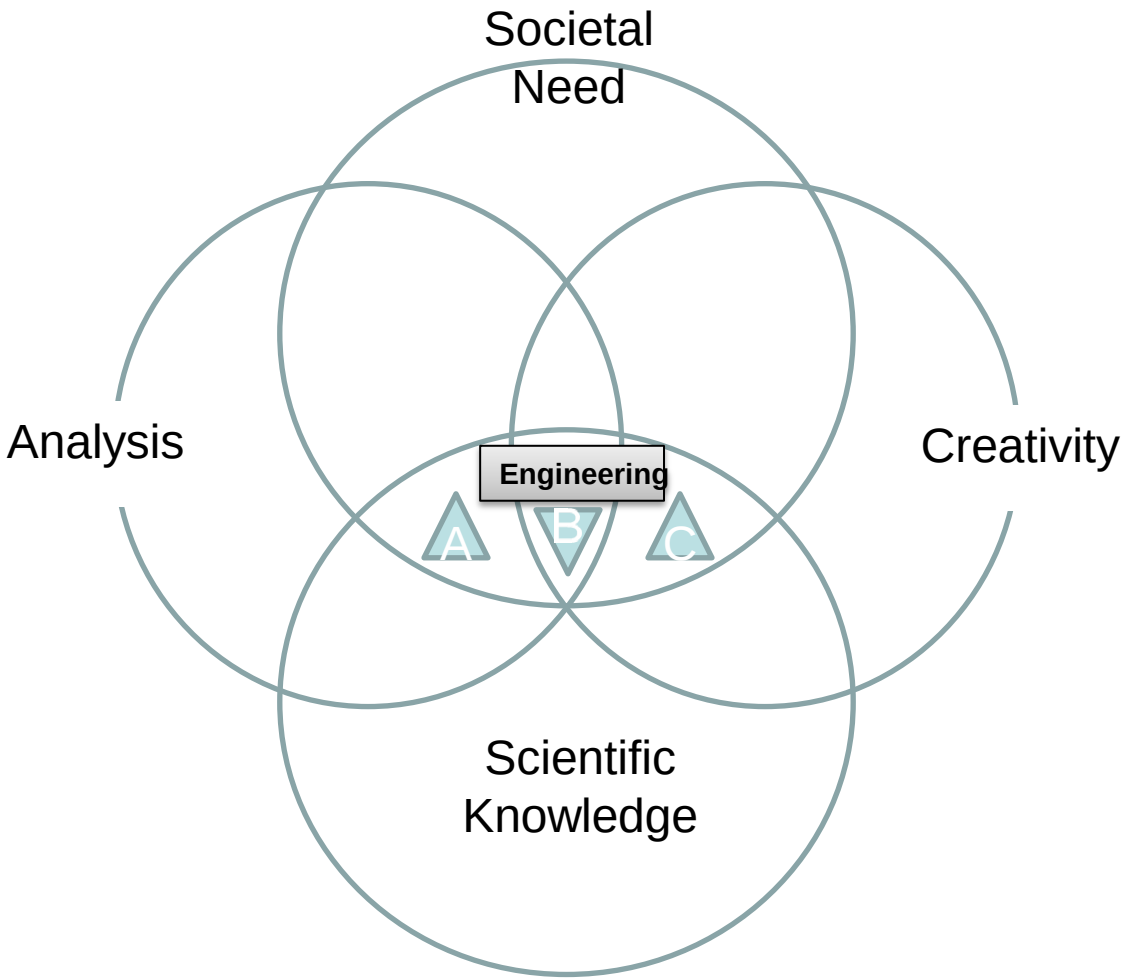
Your values are your guide

- Establish what is fundamentally important to you – these are your values
- Prioritize your values
- Make your career and life decisions base on these prioritized values



- Here is one of my own:
  - I sincerely wish to leave this world a better place than that which I entered. I will work for the betterment of my family, community, country and the world. I will help those in need, support education, and seek to influence cooperation and peace throughout the world.

Some Definitions: Engineering



A: Purely analytical talents intersecting the engineering domain. This may be used to represent engineering science, an ability to model complex systems and predict their response to various inputs under various conditions

B: Engineering design and much "real world" problem solving.

C: Sudden intuitive leaps often responsible for revolutionary advances in technology called "significant novelty" by Spier, as well as those aspects of engineering, not yet fully supported by engineering science, that remain more art than science

After *PROFESSIONAL RESPONSIBILITY: THE ROLE OF ENGINEERING IN SOCIETY*
S.P. Nichols and W.F. Weldon , Center for Electromechanics, The University of Texas at Austin, USA

Sandia's History

Sandia National Laboratories

AMERICAN TELEPHONE & TELEGRAPH CO. AND ASSOCIATED COMPANIES — BELL SYSTEM

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 [illegible] at Albuquerque, New Mexico. This operation, which is a [illegible] atomic [illegible] national defense, and should have the [illegible] national 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. C. E. Buckley.

Very sincerely yours,

Harry Truman

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

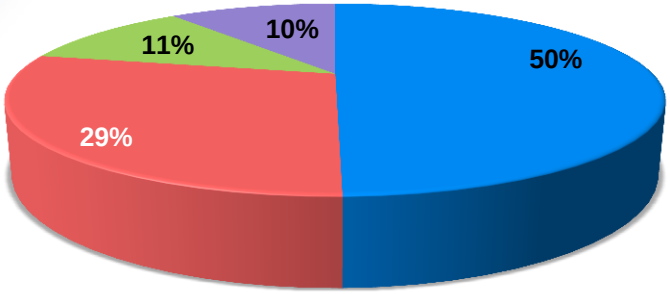
exceptional service in the national interest.

People and Budget

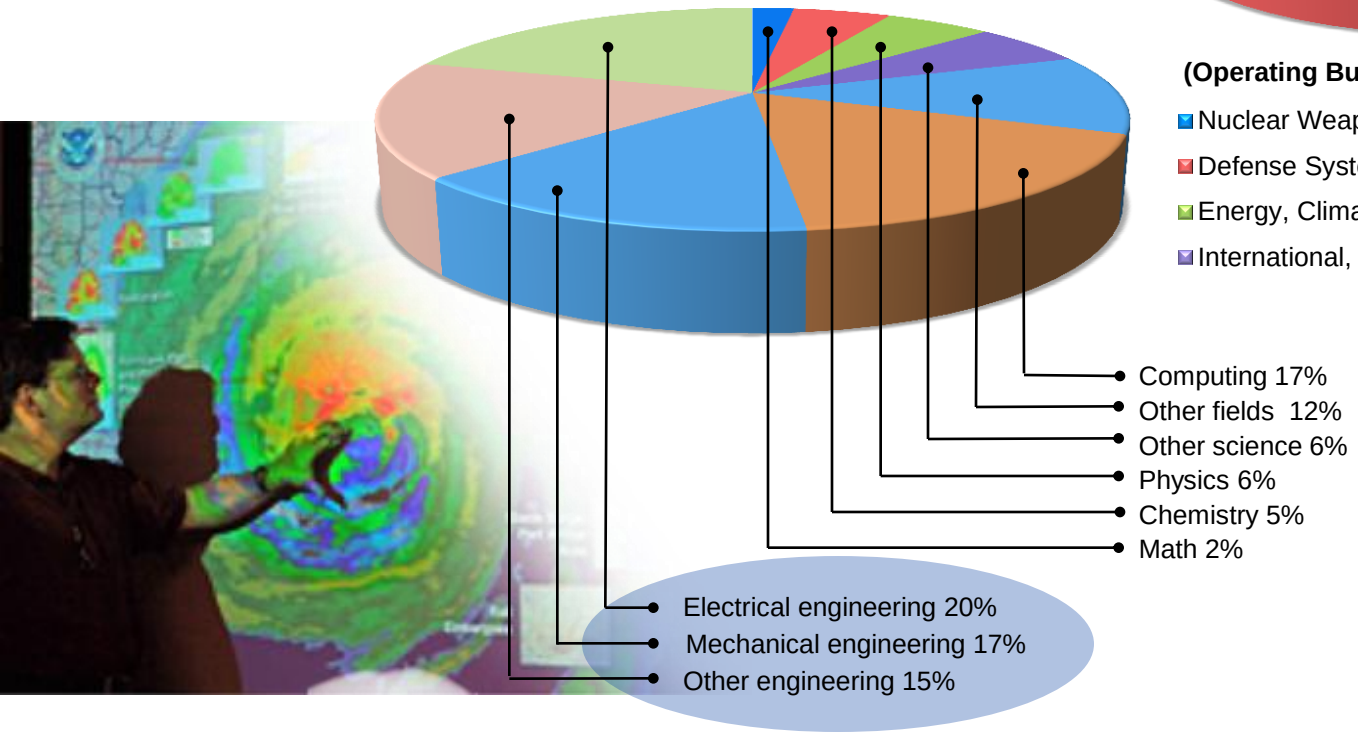
(As of October 11, 2011)

- On-site workforce: 11,876
- Regular employees: 9,122
- Gross payroll: ~$943 million

FY11 Operating Revenue
$2.4 billion

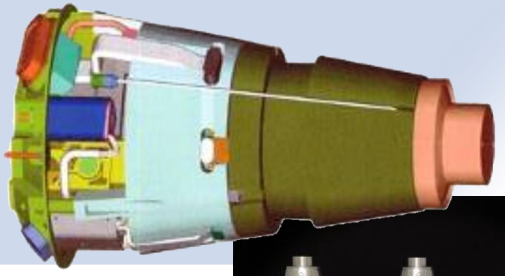


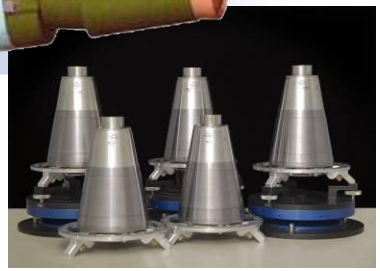
Technical staff (4,557) by discipline



Nuclear Weapons

Integrated, engineered warhead systems

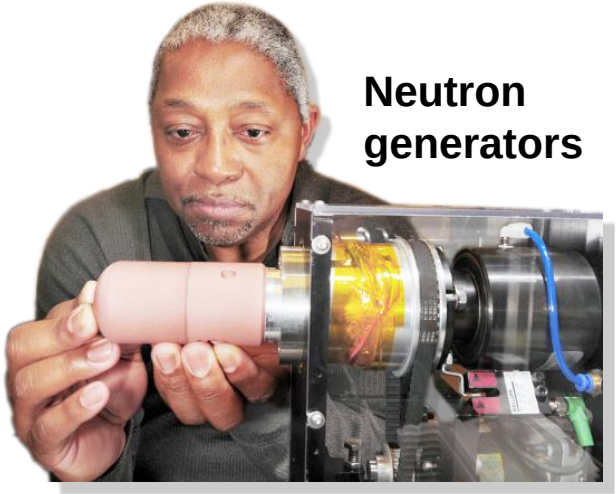




Arming, fuzing, and firing systems

Safety systems

Gas transfer systems



Neutron generators

Nuclear Weapons

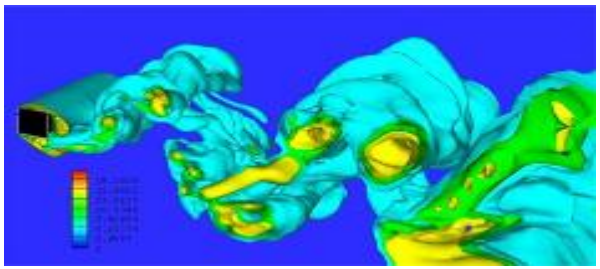
High reliability, high consequence of failure, challenging environments, and technology solutions

Sandia National Laboratories

Facilities and Capabilities

Microelectronics and microsystems

Design, fabricate, package, and test trusted semiconductor components



Computational simulation

High-performance hardware and software tools to enable solutions requiring massively parallel computers

Environmental testing

Simulate environmental conditions and collect relevant data for systems, subassemblies, and components

Energy, Climate, and Infrastructure Security

Sandia National Laboratories

Program Areas

- Infrastructure Security
- Energy Security
- Climate Security
- Enabling Capabilities

Areas of Expertise

- Modeling & Analysis, Cyber, Electricity Distribution, and Energy Assurance
- Renewables, Energy Efficiency, Energy for Transportation, and Nuclear Energy Systems
- Sensing & Monitoring, Carbon Capture, Sequestration, Modeling and Analysis, and Water
- Discovery Science & Engineering, Systems Analysis, and Regulatory & Policy

International, Homeland, and Nuclear Security

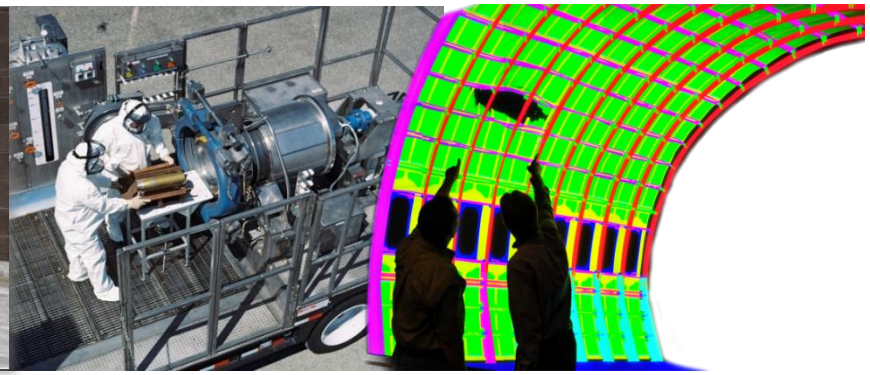
Sandia National Laboratories

Program Areas

- Critical Asset Protection
- Global Security
- Homeland Defense and Force Protection
- Homeland Security

Areas of Expertise

- Countering Bioterrorism
- Nuclear, Radiological, and Chemical Risk Reduction
- Nonproliferation and Arms Control
- Physical Security
- Emergency Response
- Systems Analysis and Engineering
- Border Security
- Aviation and Airworthiness Security

Defense Systems and Assessments

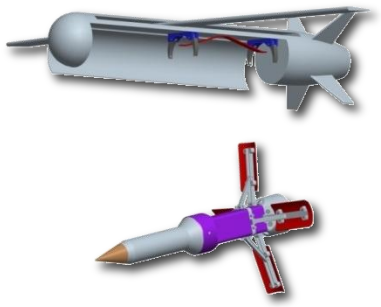
Sandia National Laboratories

Program Areas

- Information Operations
- Integrated Military Systems
- Proliferation Assessment
- Remote Sensing & Verification
- Space Mission
- Surveillance & Reconnaissance

Areas of Expertise

- Nuclear Detonation Detection System
- Nonproliferation
- Cyber Security
- Synthetic Aperture Radar
- Space Situational Awareness
- Data Processing and Exploitation



Research Disciplines Drive Capabilities

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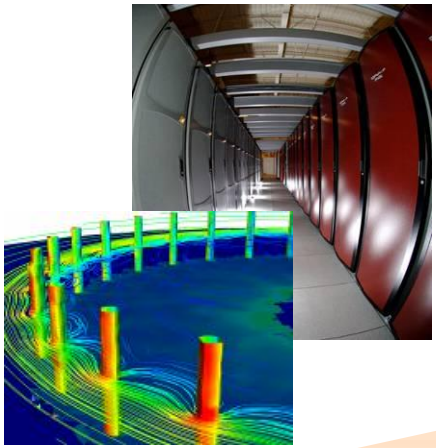
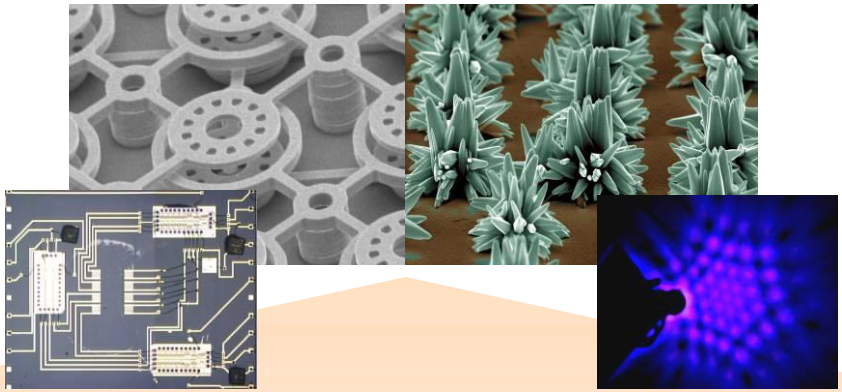
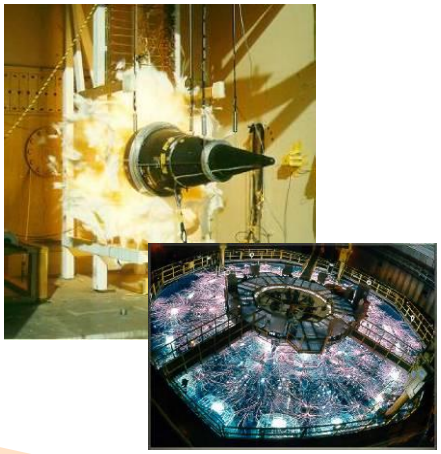


High Performance Computing

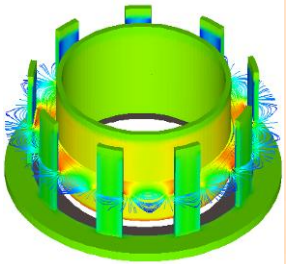


Nanotechnologies & Microsystems

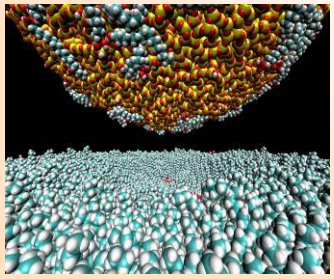


Extreme Environments

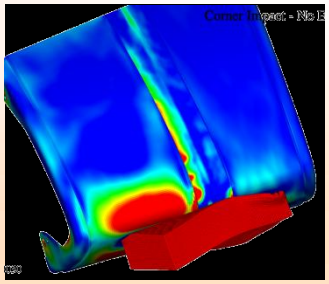
Computer Science



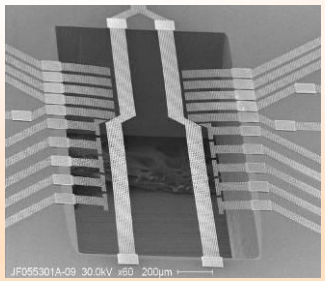
Materials



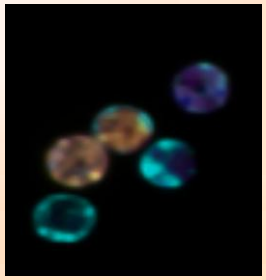
Engineering Sciences



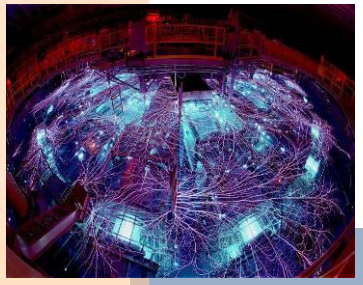
Micro Electronics



Bioscience



Pulsed Power



Research Disciplines

The Civilian Radioactive Waste Management System (CRWMS)

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Rail

MGDS Facility

High Radiation Levels

The Problem: Reducing Occupational Radiation Doses To Acceptable Levels

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Problem Pedigree:

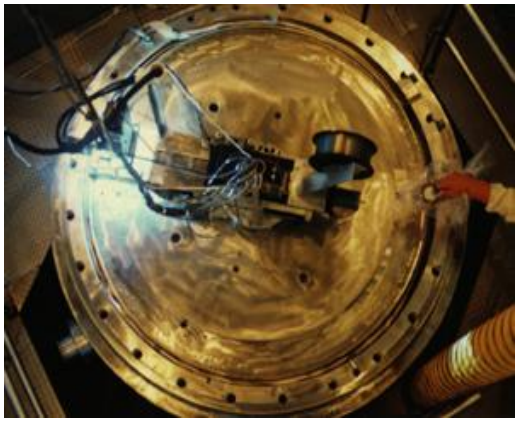
System Conceptual Designs Have Baselined *Existing* Operational Techniques

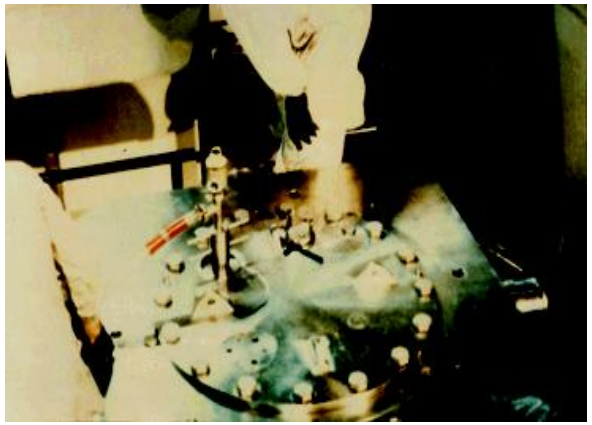
These Operations Result In Significant Doses

Dose Rates Are Unacceptable To M&O/Utilities/DOE

Need For More Cost-Effective Solutions

Robotic Handling Is A Potential Solution





Why Automate or Robotize?

- Safer
- Faster
- Better
- Cheaper

Industrial Robots Have Demonstrated Most Major Cask Handling Tasks Under SNL Control Systems

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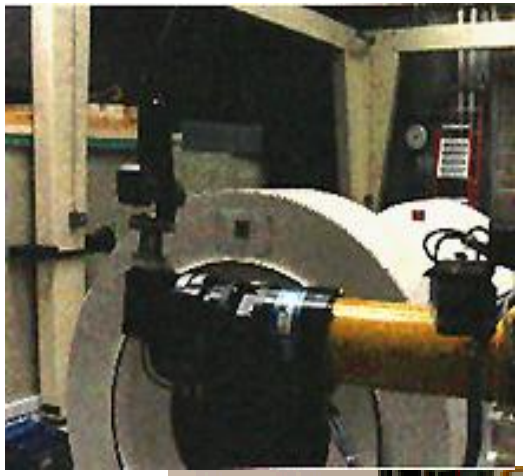

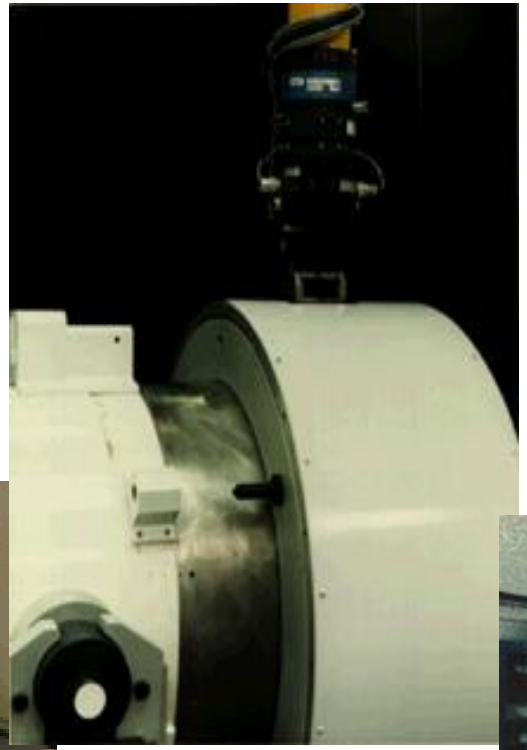

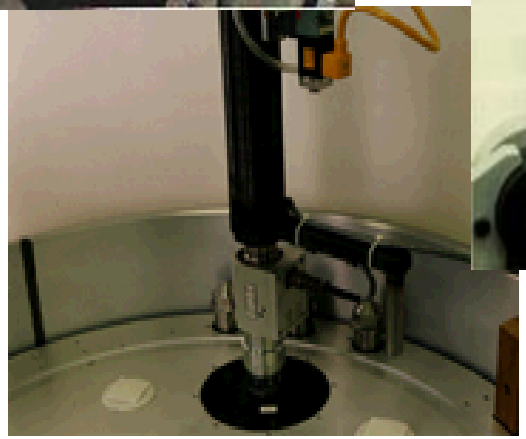

Model-Based Control Implemented On Many Industrial Machines

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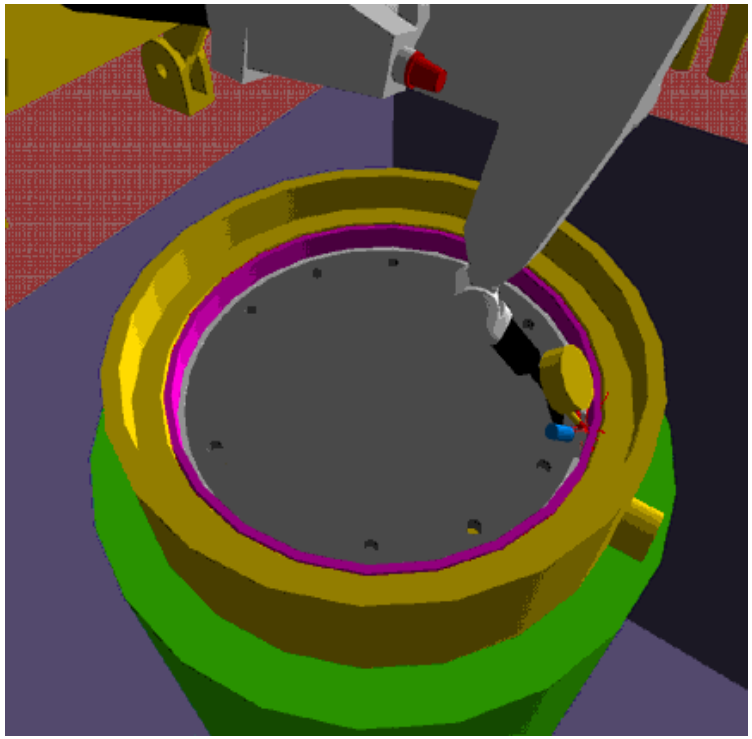
What You See Is What You Get on:

- FANUC
- PAR
- Schilling Development
- SPAR Aerospace
- Staubli Unimation

- CNC
- RETRVIR

Closure And Welding At Commercial Facilities



Normal Conditions

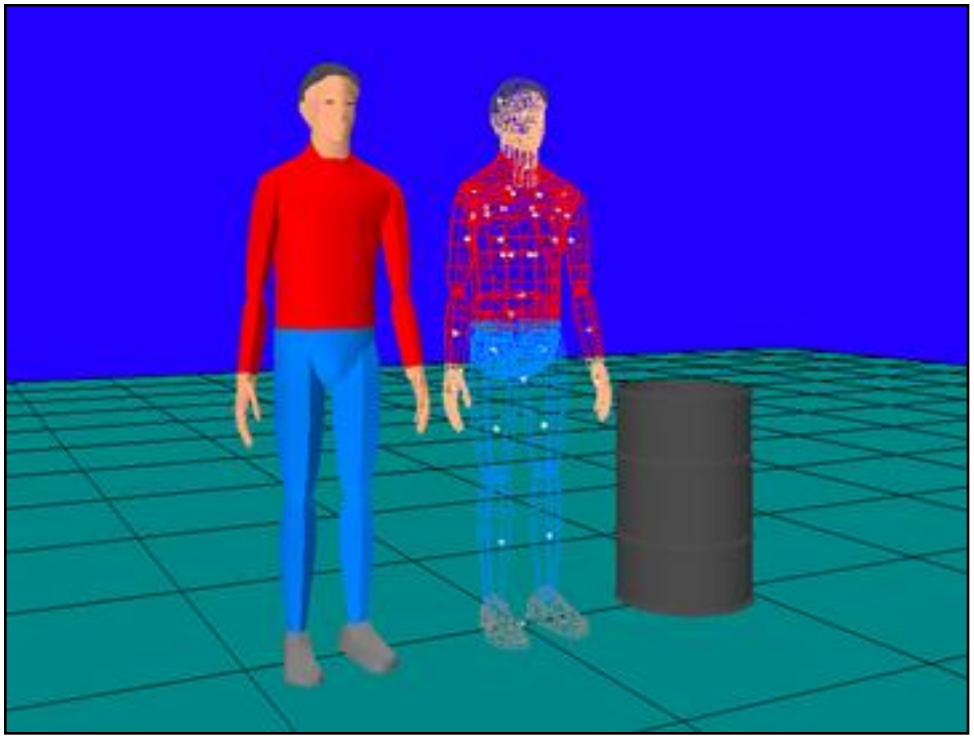
- Weld inner and outer lids closed
- Drain, dry and backfill cavity with He
- Weld drain/dry port covers
- Inspect welds using dye penetrant
- Helium leak check

Off-Normal Conditions

- Remove weld material (grinding)
- Apply weld filler
- Re-inspect welds

The REMS Human Model

- Based on Deneb Robotics' (now Dassault) IGRIP and ERGO simulation software
- Augmented with sensors and tracking code
- Linked to radiation transport codes



What is the radiation dose to humans and its impacts in a new process design?

REMS has been used to analyze new nuclear material process lines

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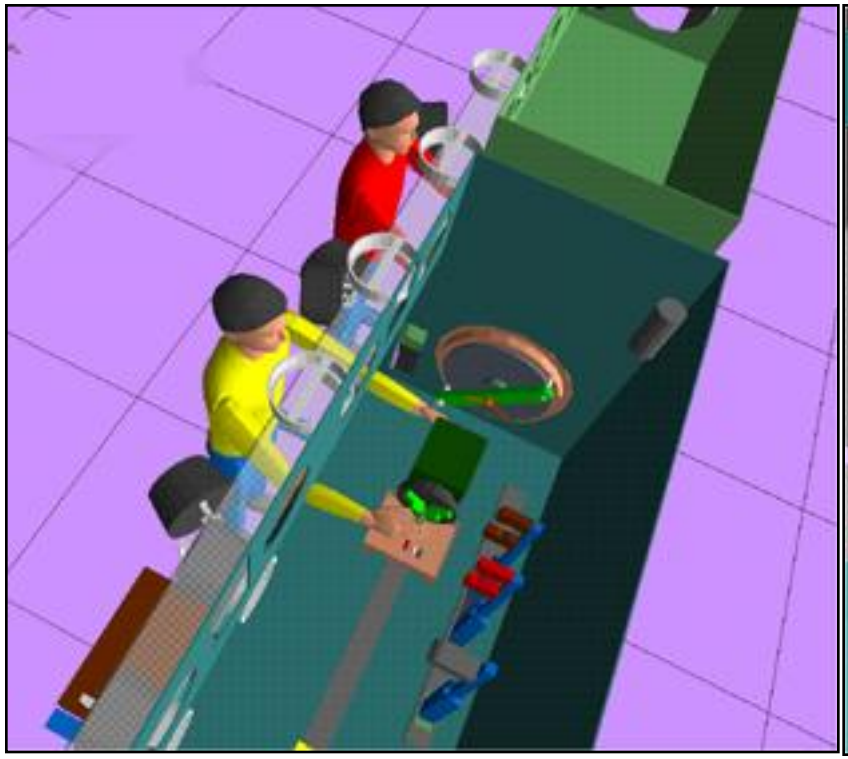

International Atomic Energy Agency

IAEA
International Atomic Energy Agency
Atoms For Peace

Sandia National Laboratories

Consultant:
Nuclear Material Handling
1993-2000

TechDoc publications

Emergency Response (Later)

Sandia National Laboratories

International Safeguards and Nuclear Monitoring Technology

The Nuclear Defense Triad

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Tsar Bomba, Soviet Union, 1961

Sandia National Laboratories

5 mi diameter fireball

40 mi high cloud

New START:
Strategic Arms Reduction Treaty

Sandia National Laboratories

Signing, 4/8/10

"It cuts -- by about a third -- the nuclear weapons that the United States and Russia will deploy. It significantly reduces missiles and launchers. It puts in place a strong and effective verification regime."

-President Barak Obama

Treaty enters into Force, 2/5/11

Automated Monitoring and Inventory System Technology

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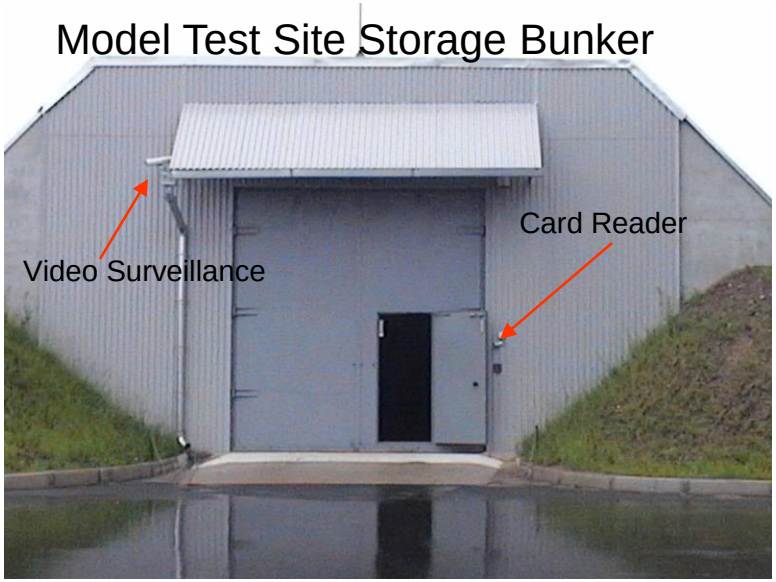
Access Control and Process Monitor

Storage Vault Access

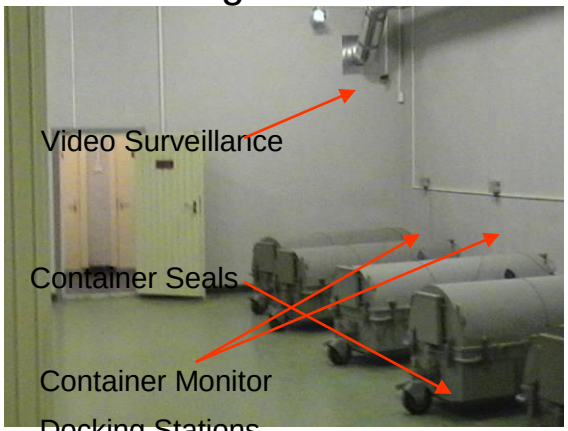
Container Processing Area

Model Test Site Storage Bunker

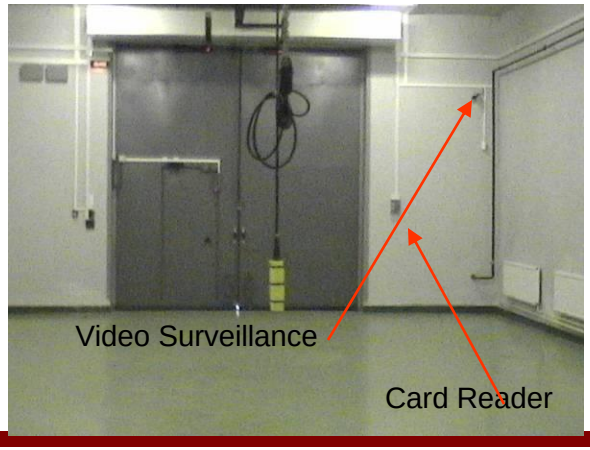


Central Monitoring Station

Storage Vault



Vehicle Unloading Area



WMTP Data Collection and Facility Monitoring System

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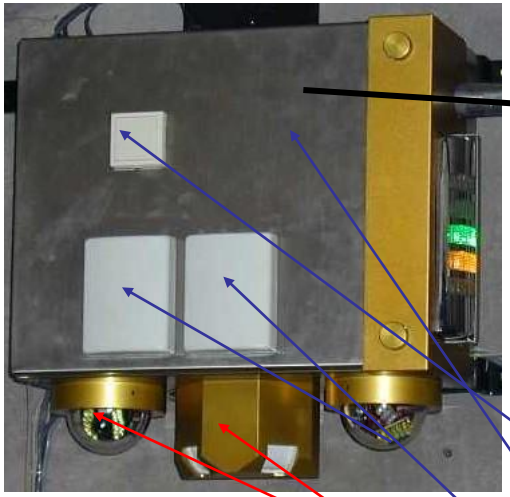
Dual Data Collection Units



Balanced Magnetic Switches
Door Sensors

Barcode Receiver Antenna

Data Collection Computer

Item Monitor Antennas

Image Capture

Volumetric Motion Detection

*** Facility Monitoring Sensors**
 # Data Collection System

Power System and Communication Enclosure

Item Monitor (T-1)

International Atomic Energy Agency

IAEA
International Atomic Energy Agency
Atoms For Peace

Sandia National Laboratories

Consultant:
Nuclear Material Handling

Nuclear Safeguards Technology Development:
Extensive set of technical measures by which the IAEA Secretariat independently verifies the correctness and the completeness of the declarations made by States about their nuclear material and activities

Sandia National Laboratories

Cognitive Science

(What?)

Why Cognitive Science? Engineering

Humans are the reason for every endeavor

Humans judge the value of every endeavor

Humans are the reason we do what we do

The purpose of Engineering is to enable/improve human abilities

Engineers design technical systems toward this end

No system definition is complete without human beneficiaries and roles

Engineer human-centric systems

Humans may offer the greatest leverage for improving systems performance

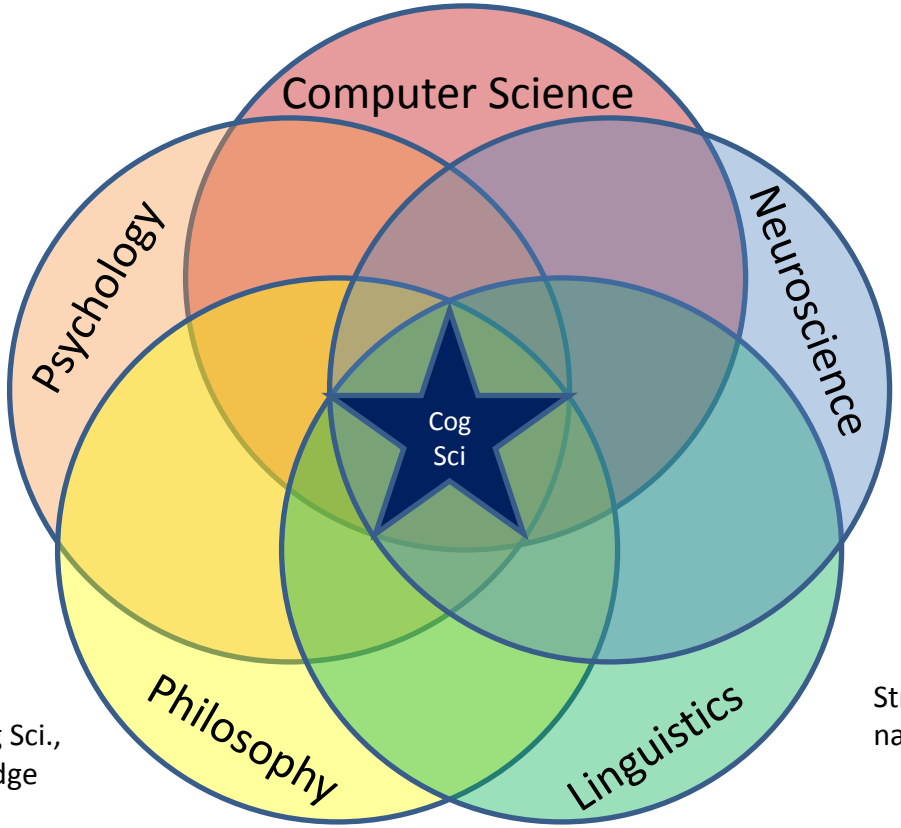
Human capability is unsurpassed to create ideas and innovate with them, to recognize analogies, to judge analytically and ethically.

Humans are most complex, least understood, vulnerable, and remarkably diverse

We must understand the human

What is Cognitive Science?
Connecting Media and Behavior through Scientific Method

Model the Brain and its Function
Implement Thinking Like the Brain



Human mental capacities, e.g. attention and memory; Behavioral motivations

The media: Organization of and signaling within the nervous system

Logic and meaning, clarity of fundamental concepts in Cog Sci., e.g. information and knowledge

Structure of language and nature of language acquisition

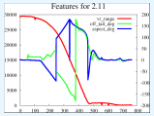
Informed By:

Human Factors | Anthropology | Education | Robotics | Communications

Unifying Program Applications: Knowledge Capture and Expert Modeling

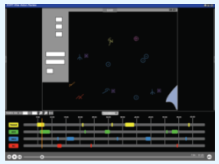
Automated Expert Modeling and Student Evaluation

1. Provide examples of expert performance



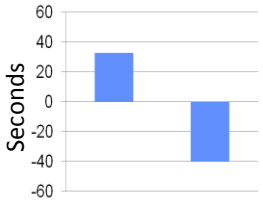
2. Machine learning used to acquire expert model

3. Student compared to expert model to identify and target training to individual deficiencies.

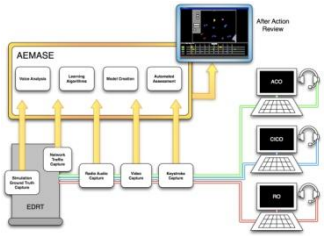


Experimental tests to establish validity and utility for training E-2 Naval Flight Officers

Friendly fighters committed sooner in response to enemy aircraft (*t* =2.03*; *p<0.05)*



Integration with operational training system



E-2 Enhanced Deployable Readiness Trainer

Scheduled to be Fielded

NSAWC Fallon (Top Gun School)

NS Norfolk

NAS Point Mugu

R&D activities have spun-off other applications

Common Distributed Mission Training System

Submarine Multi-Mission Team Trainer

SMART Tactical Readiness Debrief Evaluation System

Cyber Tracer Fire Instructor Debrief Tool

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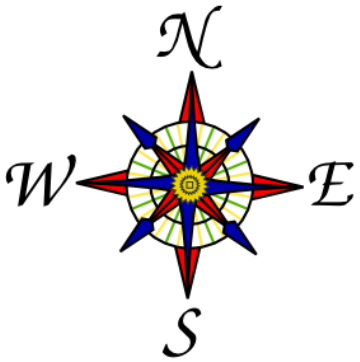
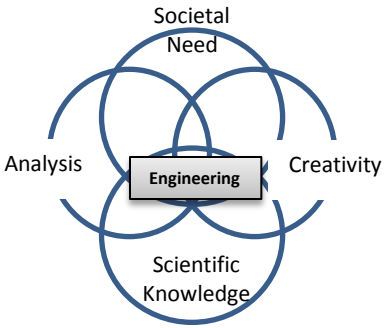
Emergency Response:

White Sands Missile Range

SAND 2006-0607C

Concluding Advice:





Establish good values and live by them
Your guide to critical decisions

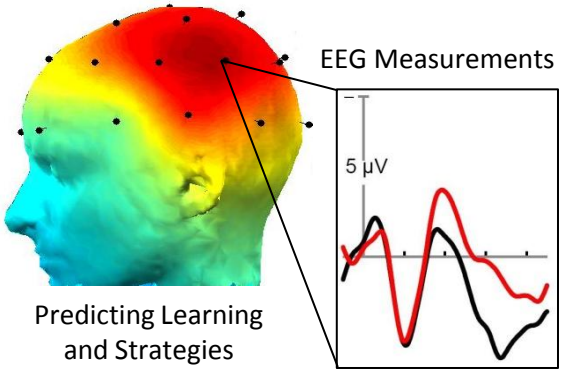
Remember that Engineering is all about people
Enable and Enhance
Ethical and Thorough

Appreciate and Embrace Diversity
Multi-disciplinary
Multi-cultural

Think and Act Globally

Thank You

Technical Strengths and Applications



EEG Measurements

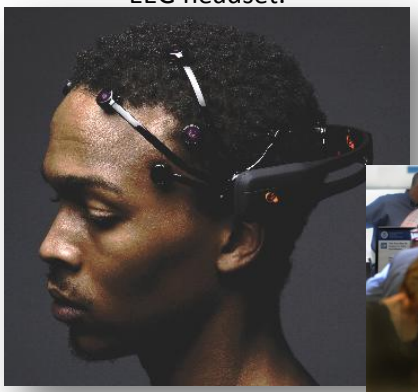
Predicting Learning and Strategies

Team Orlando and Advanced Distributed Learning

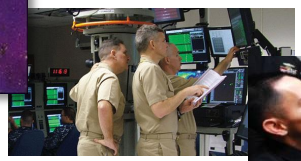
Augmented Cognition Systems

Understand Populations through Gaming

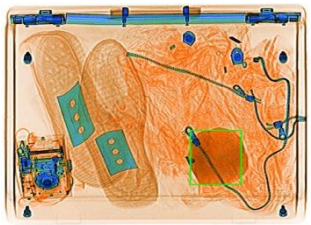
IC: Assessment of neurotechnologies: The Emotiv EEG headset.



Architecting Production Software

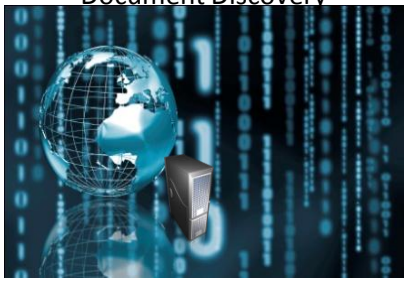


Submarine Tactical Training

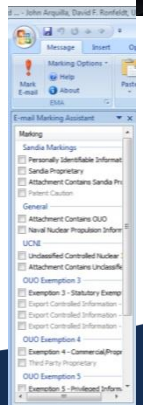


TSA: Human subjects experiments in support of Transportation Security Officer checkpoint decision making

DOE Non-Proliferation Document Discovery



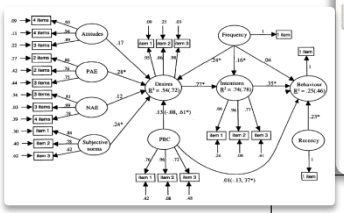
Text, Images, Sources

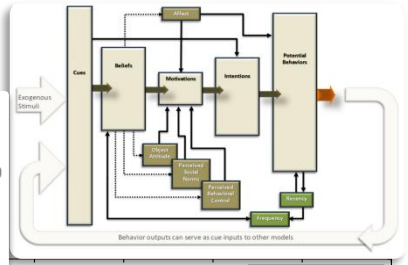


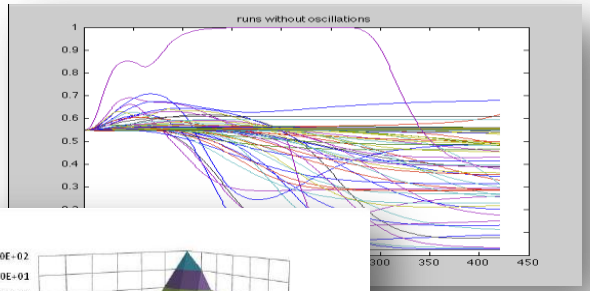
Email Marking Tool

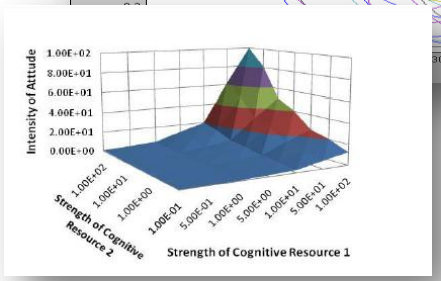
Technical Strengths and Applications

Assure psychological and social theory are reconciled in software



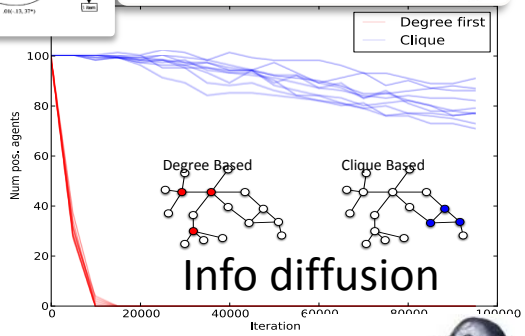






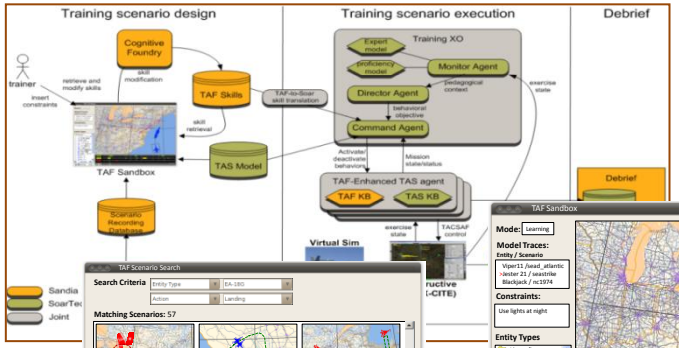
UQ

EdPsych-AMAESE

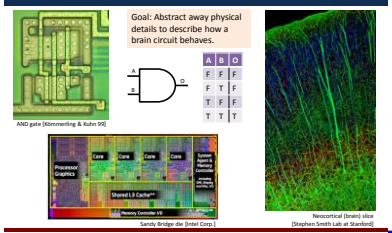


Info diffusion

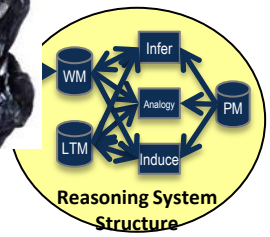
Provide constructive component for Naval aviation Live Virtual Constructive simulation training



Neurons to Algorithms (N2A)



Reasoning



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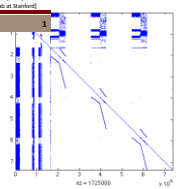
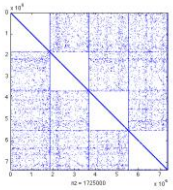
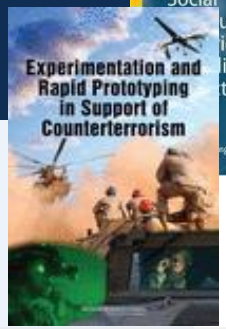




Sandia National Laboratories

Where are we today?



- Annual cognition revenue lab wide of over $25M
- Manage a $3.5M LDRD portfolio for the Laboratory
- Partnerships with over 100 University researchers developed over 9 years
- Partnerships throughout the Laboratory with ~ 80 researchers
- Two patents, over 130 Technical Advances, over 50 copyrights
- Over 100 external publications, 60 SAND reports, 6 book publications
- Membership in numerous national communities:
  - Decade of the Mind
  - National Neurotechnology Institute
  - National Academies
  - National Augmented Cognition community