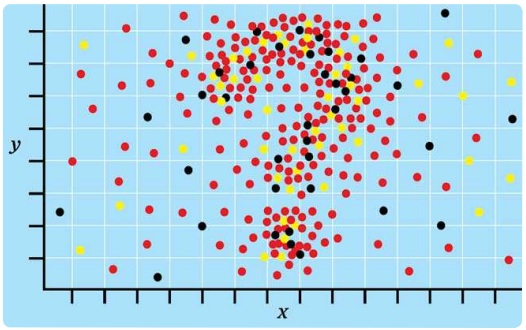
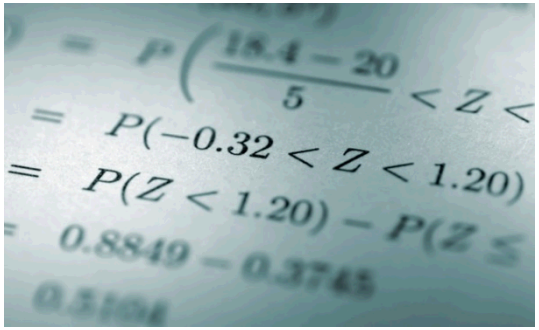
SAND2017-8150C





Human Factors

integrating the human with the system

Courtney Dornburg, PhD

Human Factors Department (9431)

SANDIA STATISTICAL SCIENCES

Plan. Analyze. Inform.

Justin Newcomer, PhD

Statistical Sciences Department (9436)

U.S. DEPARTMENT OF ENERGY | NNSA

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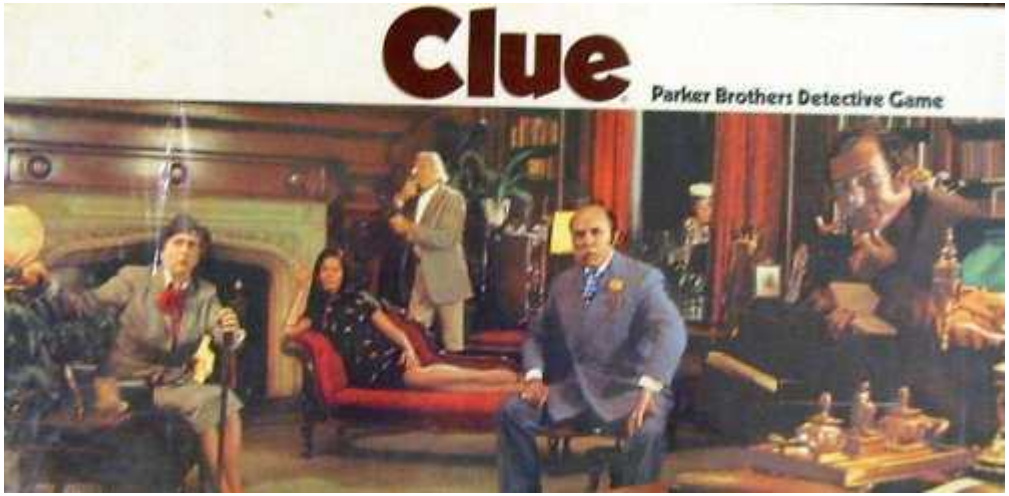
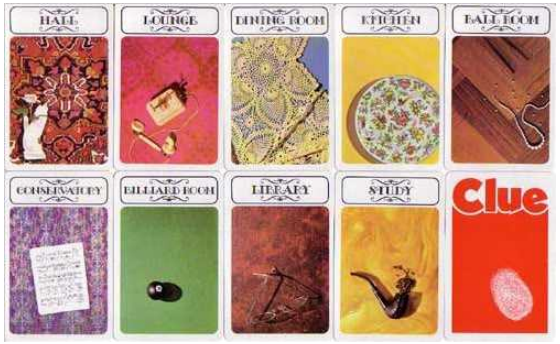
What is a Capability?



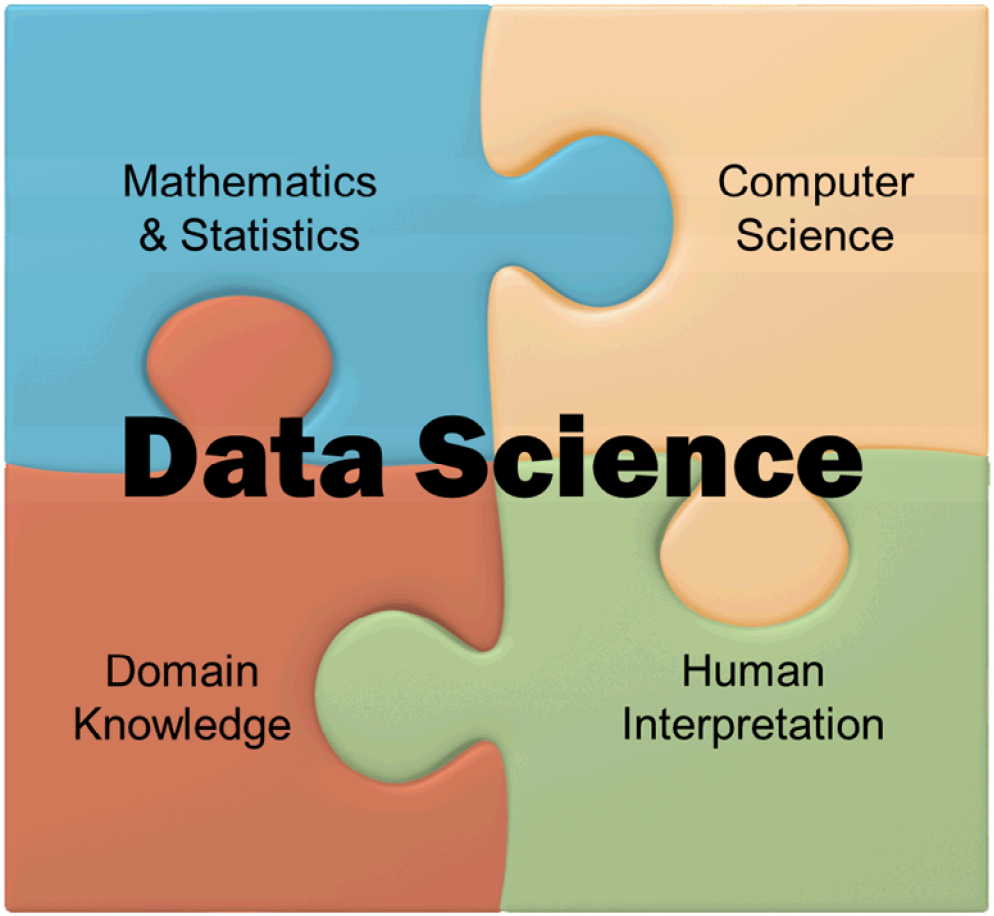
Who?

Where?



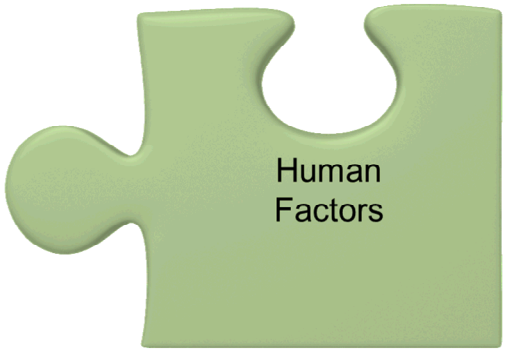
Tools?

What is Data Science?



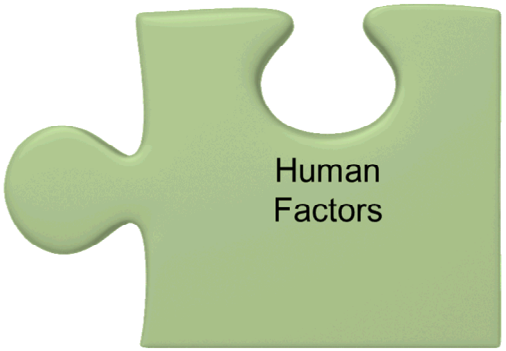
NSF Definition: "*Data Science:* the science of planning for, acquisition, management, analysis of, and inference from data" … "[Data Science] requires a broad set of ***capabilities*** and perspectives; specifically mathematics, statistics, computer science, and domain specific expertise".

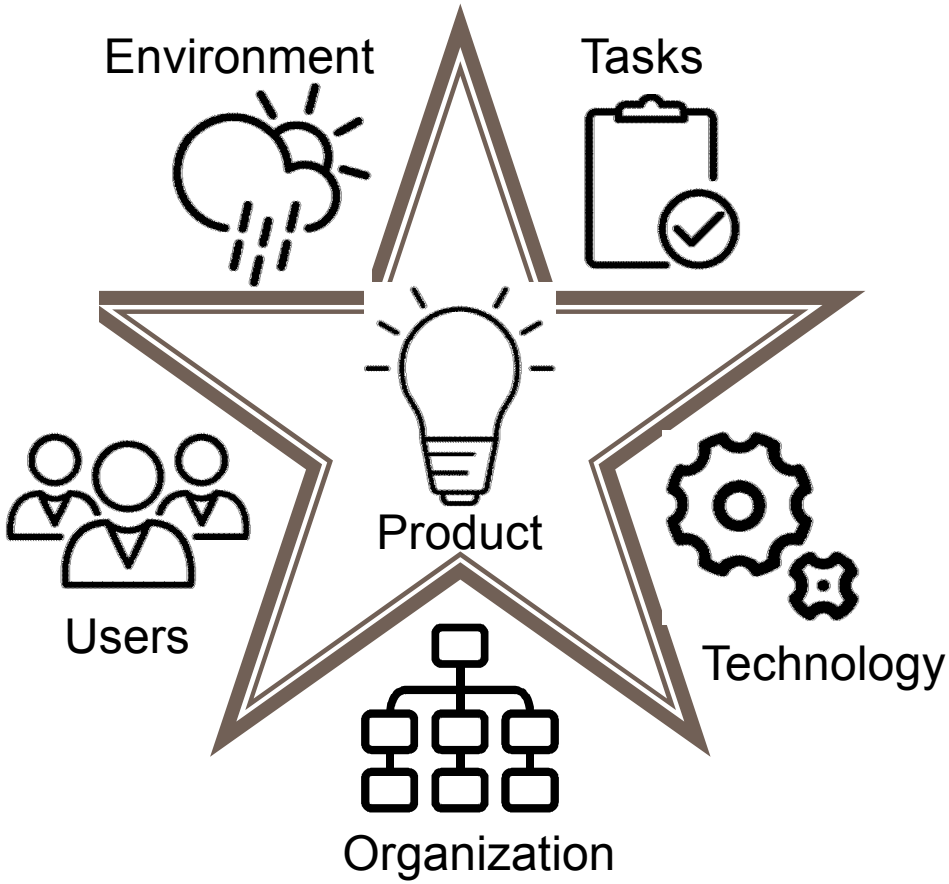
Human Factors Definition



A scientific discipline that "discovers and applies information about human behavior, abilities, limitations and other characteristics to the **design of tools, machines, systems, tasks, jobs, and environments** for productive, safe, comfortable and effective human use" (Chapanis, 1985).

Human Factors Mission





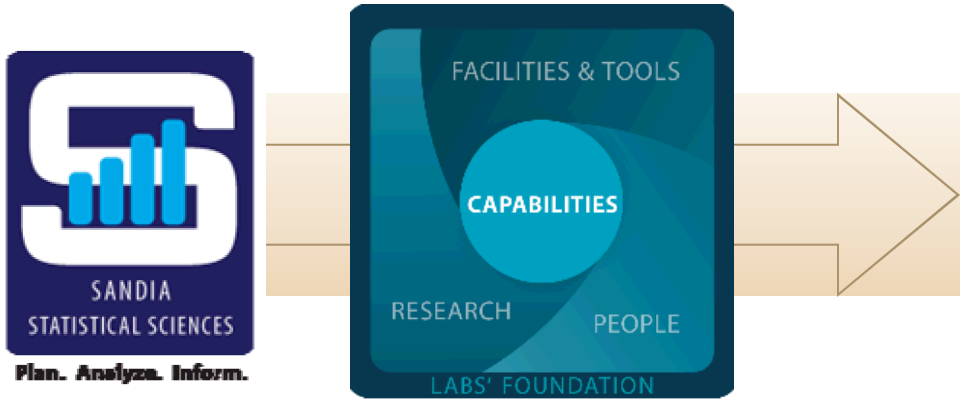
On behalf of our nation, we direct and apply human research through the scientific method, human factors guidelines, and engineering principles in order to anticipate and solve the most challenging human-system problems that threaten safety, security, and effectiveness in the 21st century.

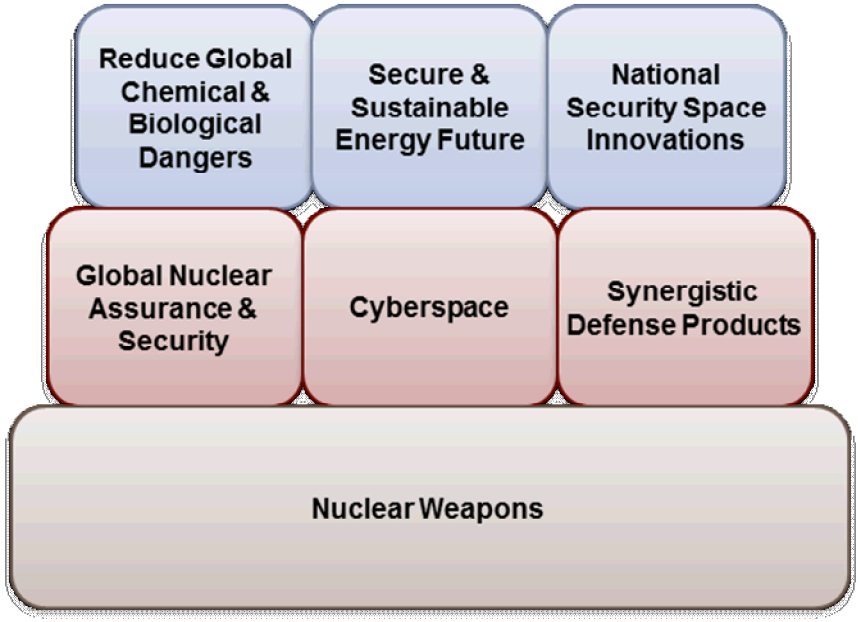
Why Statistics

atistics: The branch of mathematics that deals with the llection, organization, analysis, and interpretation of data

Statistics is a foundational capability across all Sandia mission areas - There are many opportunities to advance the field of statistics, apply statistical methods more broadly in the engineering sciences, and team better to improve Sandia products

- Current Staff
  - 12 full-time statisticians (5 MS, 7 PhDs)
  - 2 year round interns (MS & PhD level)

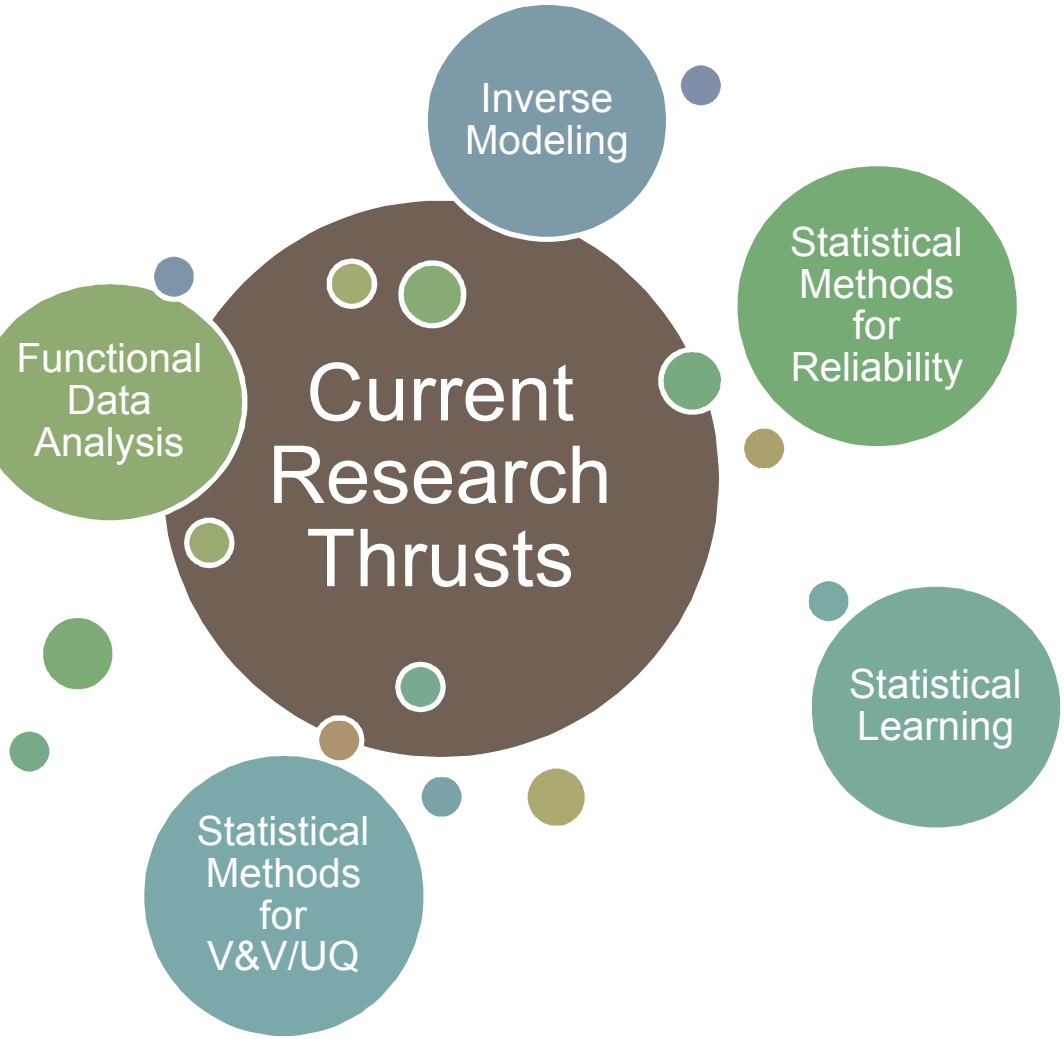




Statistical Sciences Mission

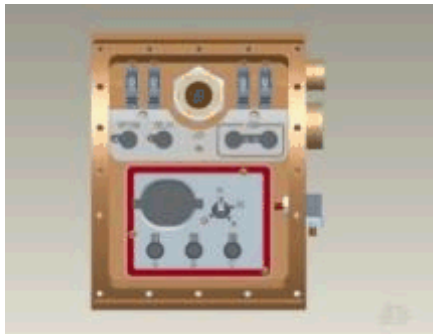
We provide cutting edge statistical expertise to help solve the most challenging national security problems and lead the advancement of statistical methodologies for national defense applications.

Trough research, collaboration, and education we inform the collection, analysis, and interpretation of data to help Sandia execute its missions.



Backups

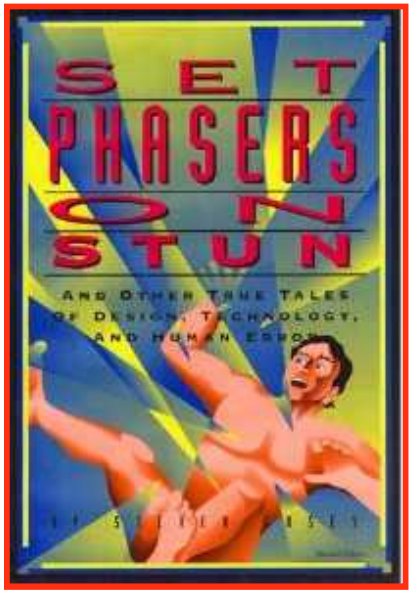
Human Factors Capabilities

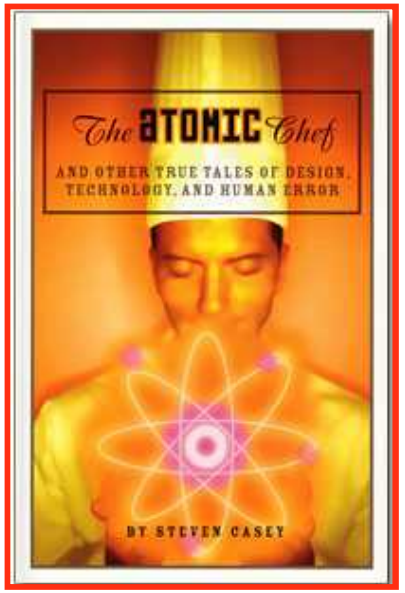


- Design of systems, processes and interfaces (e.g., hardware and/or software) to support effective and efficient human-system integration and human performance
- Reviews of system designs, processes, assembly procedures, handling procedures, test procedures, maintenance procedures
- Risk analysis
- Decision analysis
- Insider analysis
- Data science
- Customer needs analysis and task analysis
- Optimization of human-in-the-loop activities/automation
- Experimental design, data collection, and/or data analysis in support of safety programs, security related systems, or research programs
- Root cause and predictive analytics

Impact

- Quality
- Productivity
- Safety
- Security
- Personnel satisfaction

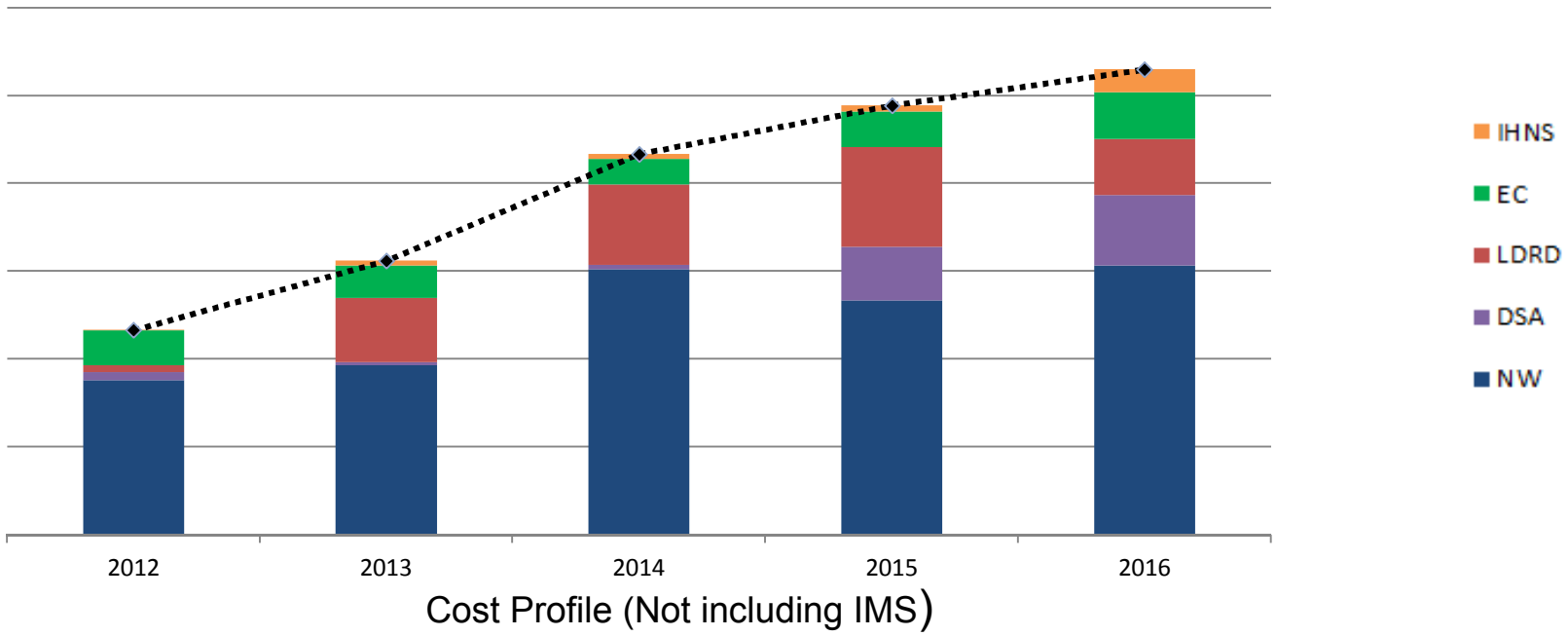




Return On Investment

- **Literature suggests 10:1 ROI (Hinckley, 2001)**
- **PRT involvement = $784,000 investment resulted in $7,563,000 savings (Durham, 2014)**
- **Neutron Generator involvement = operator qualification reduced from 3 months to 1 month (Morris, 2013)**

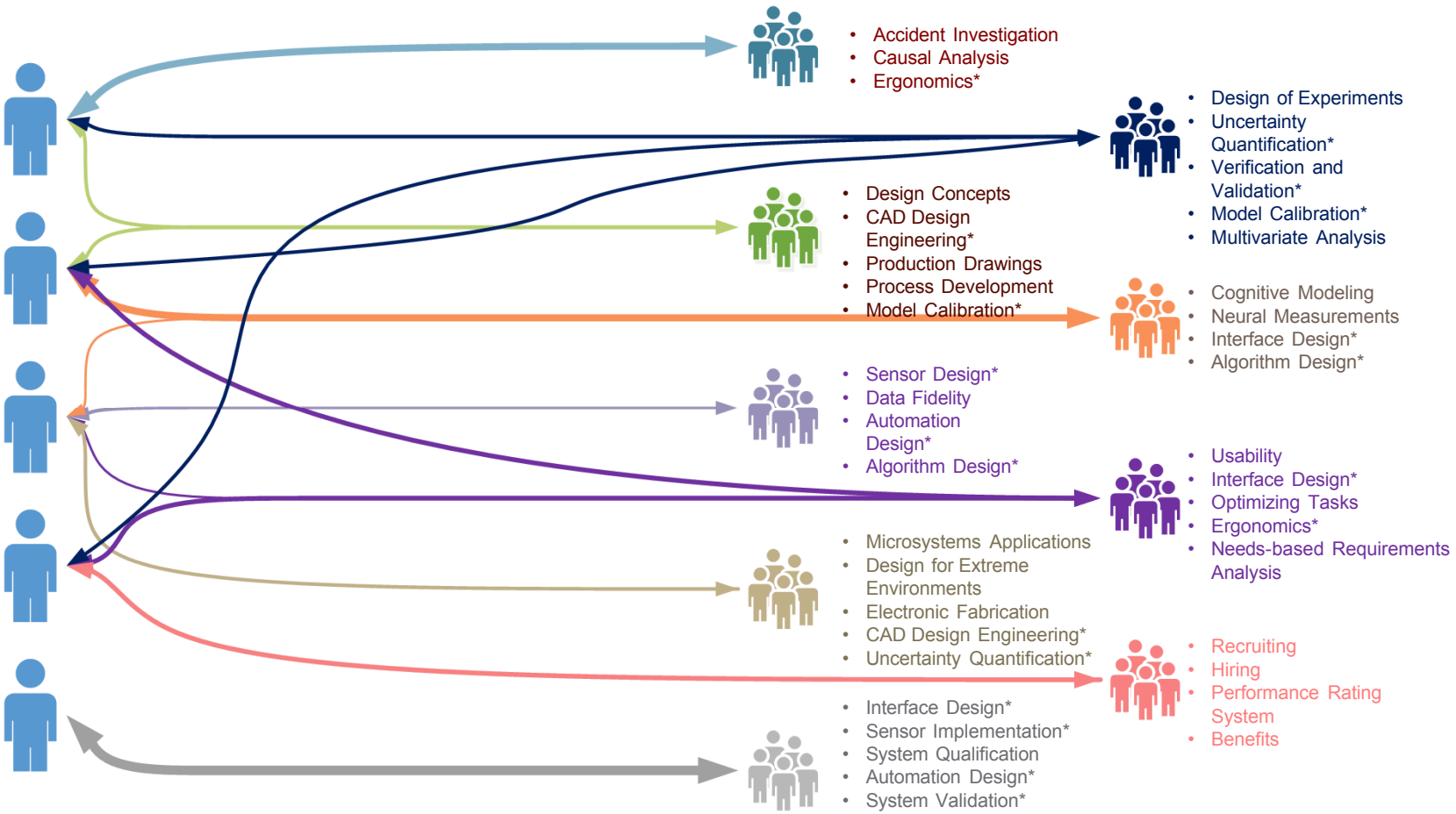
Growth in Diversity and Funding



Cost Profile (Not including IMS)

HF is a Foundational Capability

Current Approach to Solving Complex National Security Challenges



Proposed Approach: Apply a More Scientific and Effective Approach to Solving Complex National Security Challenges

Sandia National Laboratories

Define

Human Factors and Statistical Sciences partner with domain experts to define customer needs

Scope

Human Factors and Statistical Sciences facilitate a systematic scoping of the problems

Systematic Selection

Human Factors and Statistical Sciences help integrate and optimize the right combination of capabilities

- Materials Science
- Weapons Response
- Nuclear enterprise assurance
- Climatology
- Risk Analysis
- Vulnerability Analysis
- Criticality Analysis
- Cyber Security
- Network Security
- Threat Analysis
- Sensor Fusion
- Nuclear Weapons Engineering
- Satellite Operations
- Counter Intelligence
- Signal Intelligence
- Multi-INT
- Grid Resilience
- Renewable Energy
- Monitoring & Surveillance
- Experimental Design
- Optimizing Workflow
- Statistical Analysis
- Designing Control Systems
- Usability
- Root Cause Analysis
- Modeling and Simulation
- Data Analytics
- Interface Design
- Needs-based Requirements

Innovative Solutions

Human Factors and Statistical Sciences are foundational capabilities that enable innovative solutions to National Security challenges

[Customers] [National Security Needs] [Problem Categories] [Notional Capabilities]

Human Factors and Statistical Science Experts come from an academic background focused on **scientifically defining hypotheses, characterizing needs, and providing innovative solutions to complex problems**

Statistics Work at Sandia

- Primary areas of statistical expertise provided by 0436 are:
  - Design of experiments
  - Statistical quality control
  - Statistical reliability and maintainability
  - Margin and uncertainty analyses
  - Measurement error, repeatability, and reproducibility plans and analysis
  - Design of computer experiments
  - Statistical support for V&V/UQ studies
  - Bayesian statistics
  - Functional data analysis
  - Statistical signal processing
  - Spatial data analysis
  - Statistical graphics
  - Statistical computing
- Example Customers:
  - Nuclear Weapons Community
    - Weapon Component and Systems Product Realization Teams
    - Neutron Generator Design and Manufacturing
    - Surveillance planning and metrics
    - Quality and Reliability Engineering
    - QMU Methodology development
  - Strategic Partnerships
    - S&T (1300, 1400, 1500, 1600, 1800)
    - Satellite and Cybersecurity (5000)
    - Renewable Energy and DoD Security (6000)
  - Sandia Infrastructure
    - Safeguards and Security
    - Human Resources
    - Property Inventory
    - Compensation

A Growing Capability Across All Missions