SANDIA NATIONAL LABORATORIES

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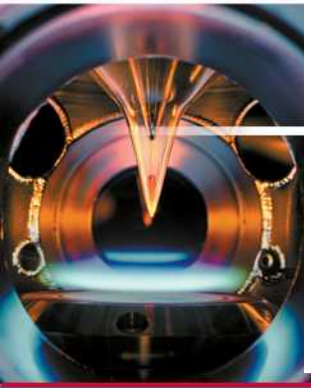

Excellence in Engineering: The Role of Education and Knowledge Management

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Sandia National Laboratories

Our Goal is "Excellence in Engineering"

Provider of innovative, Science-based, systems engineering solutions to our nations most challenging national security problems.

Sandia National Laboratories should be a place:

- Known as one of the very best in the practice of engineering.
- Academia seeks out to better understand new approaches to engineering.
- Industry comes to find best practices in engineering.
- Sandians are actively involved in the national and international community in defining new approaches, standards and best practices in systems engineering.

Our Core Purpose

Securing a Peaceful and Free World through Technology

Nuclear Weapons

Safe, Secure, Reliable Weapons

Defense Systems and Assessments

Detection

Remote Sensing and Verification

Integrated Military Systems

Energy, Resources, & Nonproliferation

Energy

Safety and Security

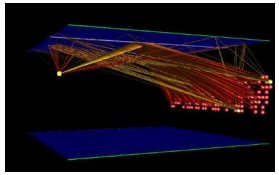
Critical Resources

Efficiency

Homeland Security and Defense

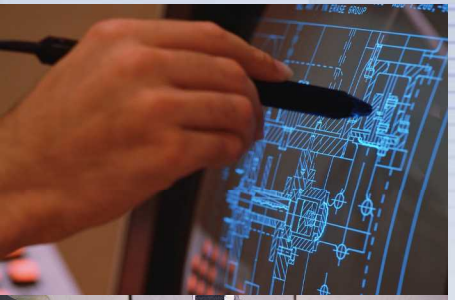
Chem-Bio Defense

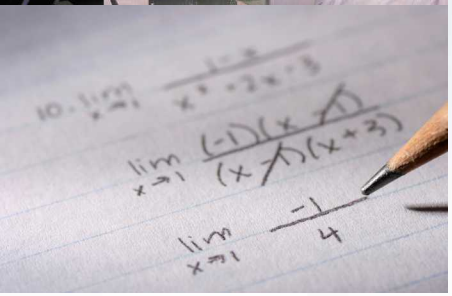
Cyber Protection



Explosives Countermeasures

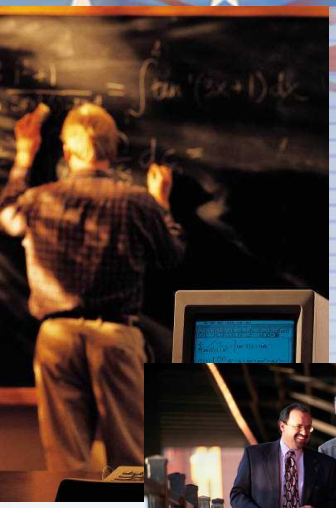
What Education & Knowledge Management do to help achieve Excellence in Engineering





- Transformed state: Sandia has an exceptional workforce and outstanding leaders.
  - Emphasize and support *continuous* learning opportunities.
  - Enhance learning opportunities through partnerships with universities.
  - Create and sustain an environment where people do their best work.
  - *Learn* from the past and build for the future.

Partners in Education and Knowledge Management

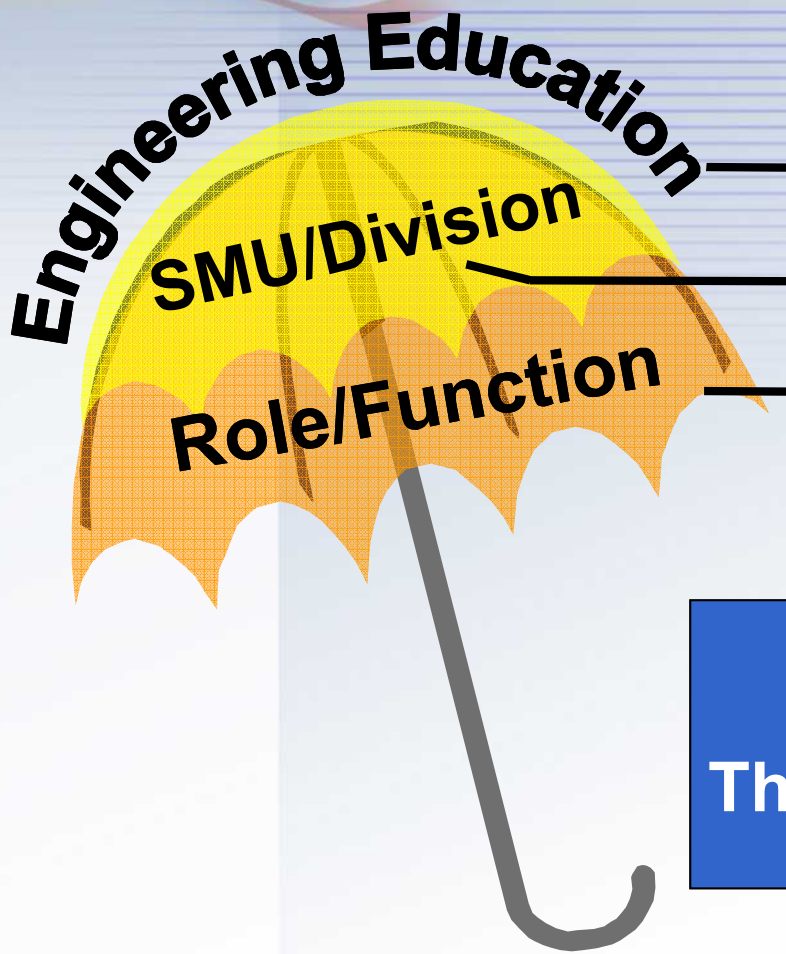


- Stakeholders provide Leadership (vision, direction, etc.) and Subject Matter Expertise.
- Corporate Learning and Professional Development (CL&PD) provides performance improvement, adult learning, instructional design, and course management expertise.
- Line training organizations meet specific needs.
- Standards are used to develop and measure education.
  - International Society for Performance Improvement
  - American Society for Training and Development

Corporate Learning & Professional Development
Clear your course!

Sandia National Laboratories

Education and Knowledge Management: The Framework



Corporate Wide (CL&PD)

Division-Specific

Line Specific

Like an umbrella…
They should all work together.

STRATEGIC

Strategic Alignment

- Provide direction and leadership.
- Strategic Education Committee
- Product Lifecycle Management

Knowledge Management

- Disseminate historical Information, lessons learned & better practices.
- Systems Engineering Case Studies
- Systems Engineering Colloquia and Technical Symposiums
- KM Capabilities

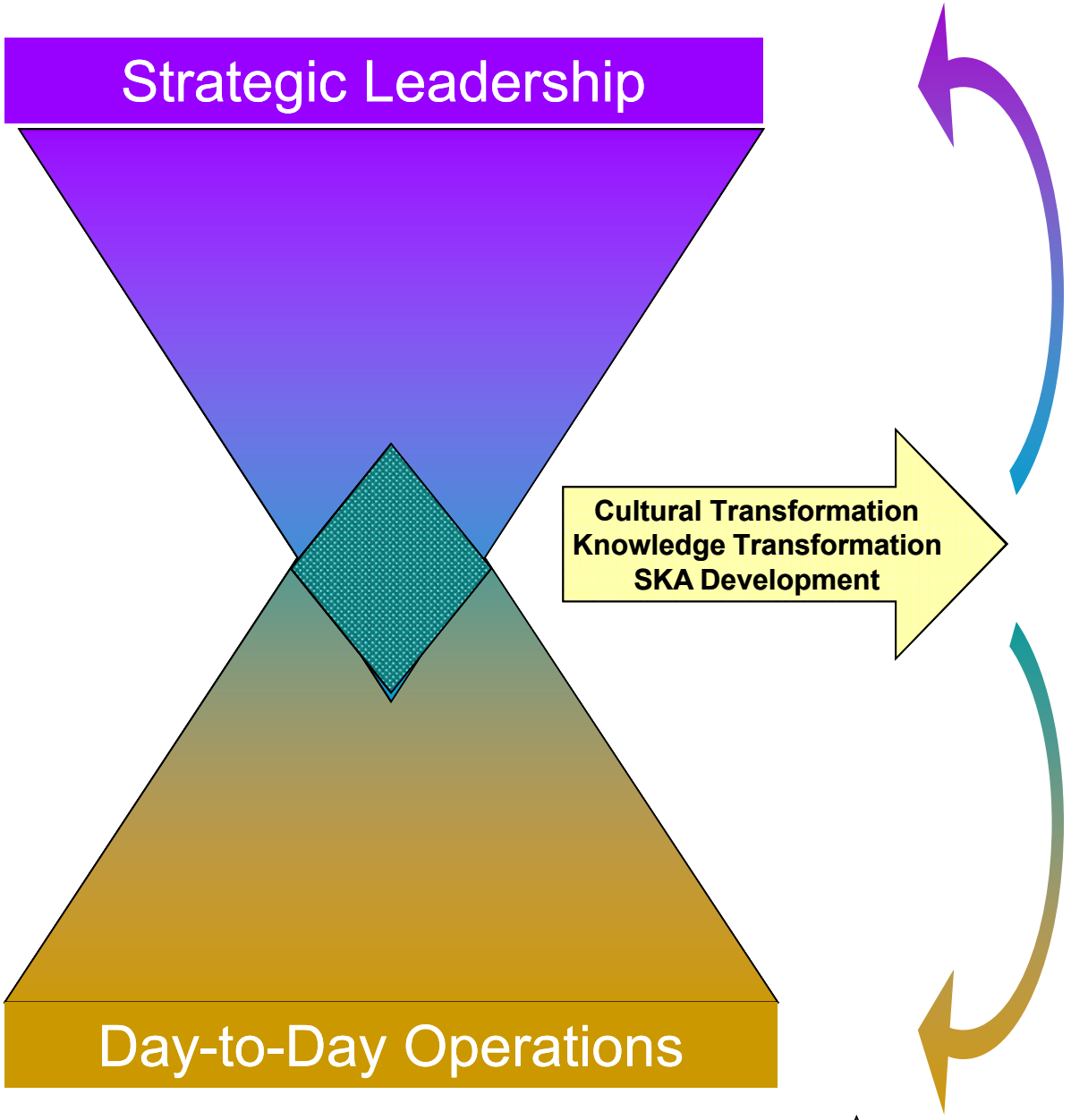
Professional Development

- Improve Technical Expertise and Build Credibility
- University Programs
- Strategic Educational Initiative
- Professional Memberships

Skill and Task Training

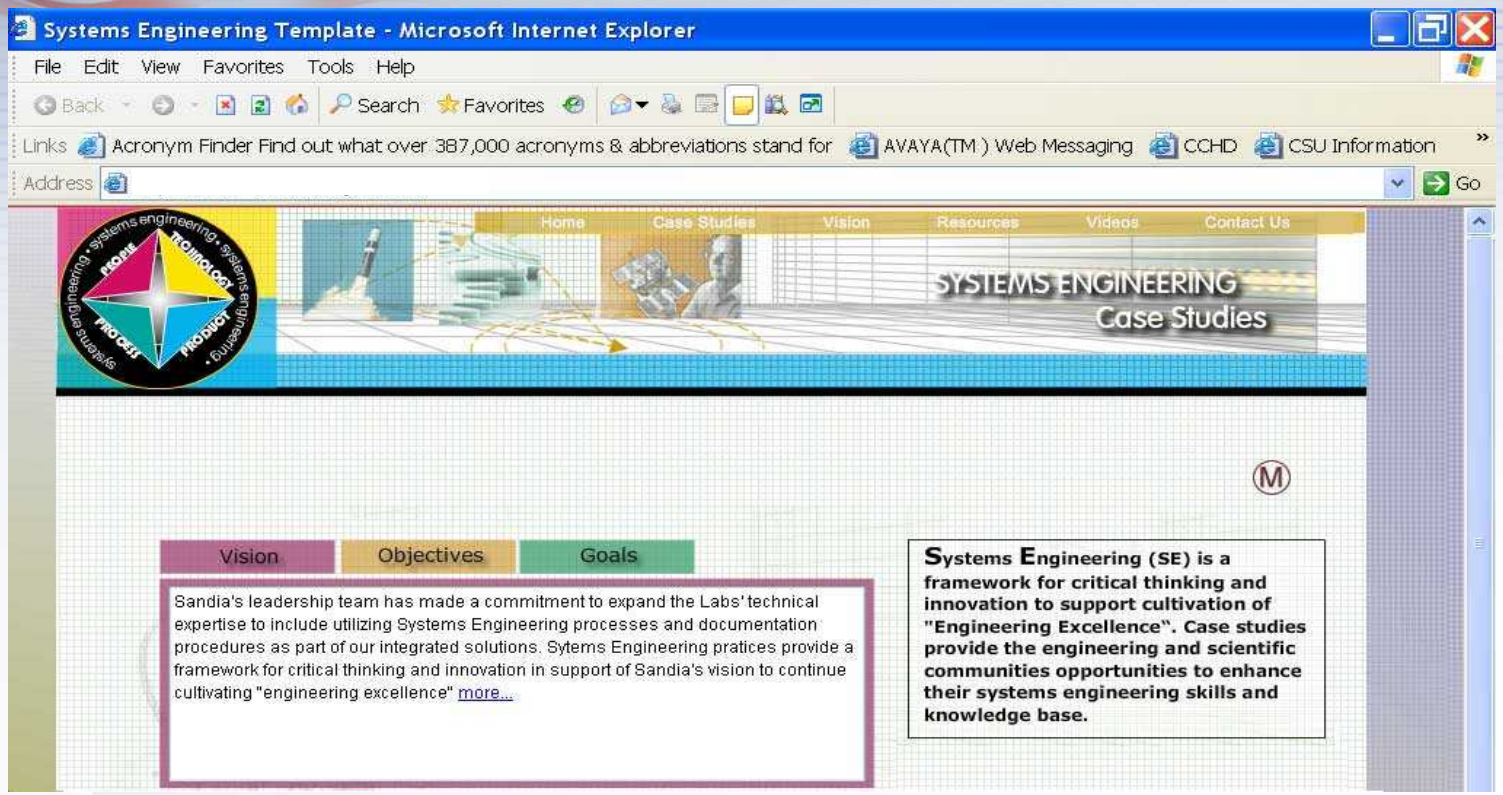
- Teach technical staff members basic Sandia concepts, processes & procedures.
- Engineering Applications Education
- Weapons Education
- Line Specific Training

TACTICAL



Adapted from Source: Marsick & Watkins (1999)

Knowledge Management: Systems Engineering Case Studies



Stories socialize Systems Engineering processes, procedures and practices.

Knowledge Management: Systems Engineering Colloquia

- Provides a venue where systems engineering lessons learned and better practices can be shared.
- Gives exposure to systems engineering processes and problems.
- Facilitates discussion and reflection on experiences.
- Creates opportunities for networking and collaboration.
- Creates opportunity for individual and organizational learning and collaboration.

Knowledge Management: Capabilities for Education & Everyday Work

- Knowledge Management Streaming Archive Library (KM-SAL)
  - A searchable video archive.
  - Enables transfer of product knowledge from one generation of “weaponeers” to another.
- Image Management System (IMS)
  - A storage database for digital images of drawings, standards, bills of materials, ES&H, and much more.
  - Thousands of older drawings from the pre-CAD (Computer Aided Drawing) days are in IMS.

Accessible on both the classified and unclassified networks.

Professional Development: University Programs

- Sandia provides education assistance benefits to eligible employees.
  - Tuition Assistance Program (TAP)
  - University Part-Time (UPT)
  - Special Masters Program (SMP)
  - Doctoral Study Program (DSP)
- Approved courses and degree programs
  - Business, accounting, computer science, engineering or technology
- Programs must
  - Be accredited by nationally recognized agencies.
  - Maintain or improve an employee's job-related skills.
  - Enhance the employee's ability to perform his or her job.

University Programs – An Example:

STEVENS Institute of Technology

Systems Engineering at Stevens Institute of Technology

Doctoral Degree (60 additional credits, after a Master's Degree)

Master's Degree (30 credits)

Core course requirements must be satisfied along the way towards a Master's Degree:

ALL students must take:
SDOE-625: Fundamentals of Systems Engineering
SDOE-650: System Architecture and Design

PLUS

PLUS, two of the following five options:
SDOE-611 Simulation and Modeling or SDOE-670 Forecasting & Demand Modeling Systems
SDOE-612 Project Management for Complex Systems
SDOE-660 Decision and Risk Analysis or SDOE 675 Dynamic Pricing Systems
SDOE-605 Systems Integration
SDOE 775: Systems Thinking or SDOE-780 Engineering of Agile Systems

At least 3 credits must be applied towards a project (SDOE-800), or 6 credits towards a thesis (SDOE-900). Multiple choices of electives exists. Selections must be approved and coordinated with the faculty advisor.

Graduate Certificate – Focus Areas (12 credits or 4 courses)

Agile Systems and Enterprises
- SDOE 775: Systems Thinking
- SDOE 780: Engineering of Agile Systems
- SDOE 785: Architecting the Extended Enterprise
- SDOE 790: Design of Agile Systems

Systems Engineering and Architecting
- SDOE-625: System Operational Effectiveness & Life Cycle Analysis
- SDOE-650: System Architecture and Design
- SDOE-612: Project Management of Complex Systems
- SDOE-605: Systems Integration

Systems and Supportability Engineering
- SDOE-625: Fundamentals of Systems Engineering
- SDOE-650: System Architecture and Design
- SDOE-645: Design for Reliability, Maintainability, and Supportability
- SDOE-640: System Supportability and Logistics

Systems Engineering Management
- SDOE 612: Project Management of Complex Systems
- SDOE 620: Simulation-Based Costing and Acquisition
- SDOE 660: Decision and Risk Analysis
- SDOE 680: Designing and Managing the Development System

Value Chain Enterprise Systems
- SDOE-665: Integrated Supply Chains
- SDOE-670: Forecasting and Demand Modeling Systems
- SDOE-675: Dynamic Pricing Systems
- SDOE-640: System Supportability and Logistics

Skill and Task Training: Engineering Training

- Engineering Training provides information on courses relating to the following disciplines:
  - Energy Surety
  - Electrical Engineering
  - Nuclear Engineering
  - Mechanical Engineering
  - Software Engineering
  - Systems Engineering

Engineering Training – An Example: Systems Engineering Curriculum

1. **Systems Engineering**
   a. Systems Engineering Overview
   b. Engineering Excellence
   c. Introduction to Systems Leadership
2. **Requirements**
   a. Requirements Engineering
   b. Requirements Engineering for Management
   c. Requirements Engineering Guidance Document
3. **Architecture and Design**
   a. Design for Six Sigma
   b. Design of Experiments
   c. Process and Procedures Guides
4. **Technical Management**
   a. Project Management
   b. Cost Financial Overview
   c. Cost Estimation
   d. Risk Management for Project Teams
   e. Cost Estimate Guide and Checklist
5. **Production, Maintenance and Support**
   a. Sustained Production
   b. Design for Production
6. **Research/Technology Maturation and Transfer**
7. **Verification (Qualification) and Validation**
   a. SNL Project Reviews

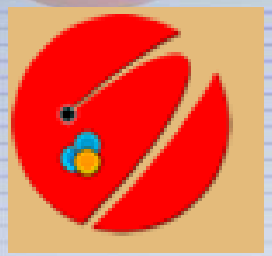
Legend

Blue = Novice/Practitioner Level
Purple = Practitioner/Expert Level
Green = Other Educational Opportunities
Gold = Other Resources

Skill and Task Training: Nuclear Weapons Training

- Nuclear Weapons courses provide a broad range of technical training opportunities for personnel involved with the nuclear weapons program:
  - Introduction to Nuclear Weapons
  - Policies & Processes
  - Subsystems & Components
  - Safety & Surety
  - Weapon Intern Program (WIP)

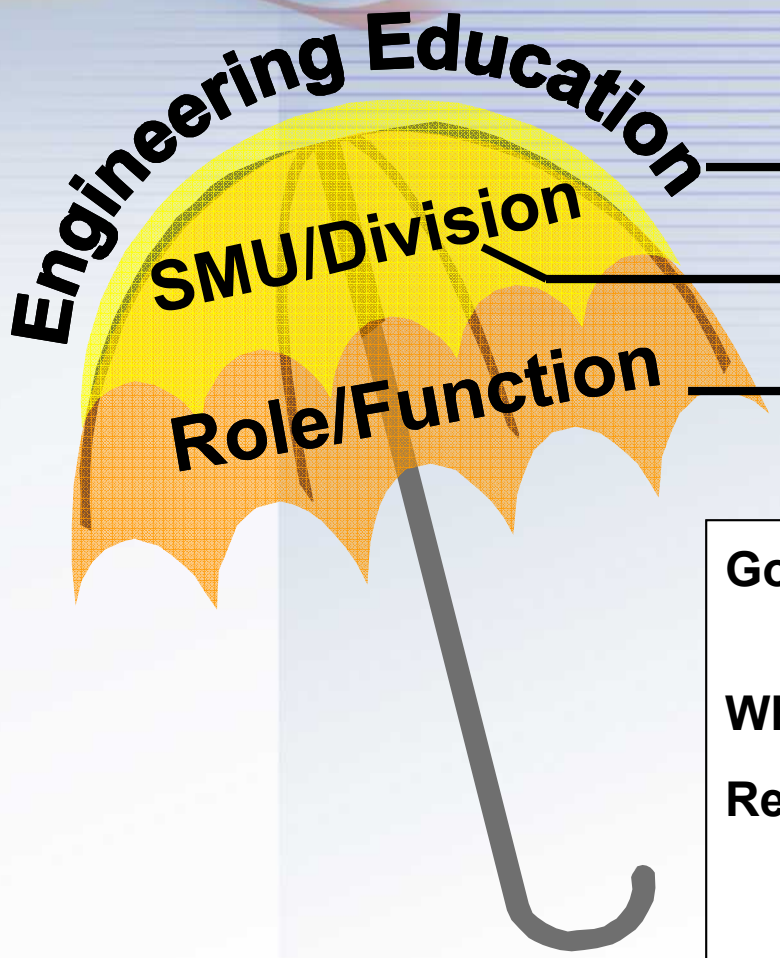
Weapons Training– An Example: Weapon Intern Program



- Sandia's responsibility associated with its nuclear weapons' mission requires the continuing transfer of nuclear weapon-related knowledge & experience to new generations of nuclear weaponeers.
- The Weapon Intern Program (WIP) was created in 1998 with the objective to significantly accelerate the process of providing this knowledge and experience to individuals that are new to the nuclear weapons area.
- Participation includes not only individuals from both the Sandia New Mexico and California sites, but also others from within the NWC, government, and the military, such as the USAF, NNSA, KCP, DTRA and LANL.

An Education and Knowledge Management Program

2008 Education Design Review



→ **Corporate**

→ **Division-Specific**

→ **Line Specific**

Goal: Develop a single, integrated curriculum for engineering professionals

Who: SMEs from eight SNL divisions

Result:

1. Gap & Overlap Analysis
2. Prioritized Educational Needs

FY09 and Beyond

- Provide learning solutions for gaps
  - Sandia Capabilities, Policies and Processes Knowledge
  - Creativity, Innovation and Problem Solving
  - Systems Thinking and Systems of Systems
  - Technology Maturation
  - Evaluating Standards
- Analyze and if Necessary Reduce Overlaps
  - Systems Engineering
  - Requirements Engineering
  - Technical Project Management

The challenge: "Faster, cheaper, and with limited resources."
The opportunity: Alternative learning solutions, such as blended learning.

Back Up Slides

Embodying Excellence in Engineering

- **How Corporate Learning and Professional Development Plays a Role**
  - Develop Staff:
    - Orient new people to procedures.
    - Assign staff to develop/exercise skills.
  - Make “excellence” a fundamental, observable characteristic of Sandia and of our work.
  - Take steps to eliminate the two main causes of failure in complex tasks: Ballistic Thinking and Failure to Follow Procedures.
  - Engage the Science and Technology community.
  - Engage others in dialogue on how to achieve excellence.
  - Learn from our successes…And our failures…

Corporate Learning & Professional Development (CL&PD) Goals, Objectives, and Milestones

2.0 Provide Extraordinary Talent

- **2.1 Exceptional Workforce & Outstanding Leaders**
- **2.2 Emphasize/Support Continuous Learning Opportunities**
  - **2.2.1 Enhanced Efficiency**
  - **2.2.2 Industry Best Practices**
- 2.3 Develop Partnerships w/Universities to enhance learning opportunities
- 2.4 Environment where people do best work
- 2.5 Strategic Partnerships to enhance talent

Skill and Task Training: Line Specific Training

- Line Specific Training developed for and/or by specific organizations, centers or divisions. This training may be specific to a particular Role, Job Function or Line of Business.
- Some line organizations support their own training functions, others partner with CL&PD.

Why This Model?

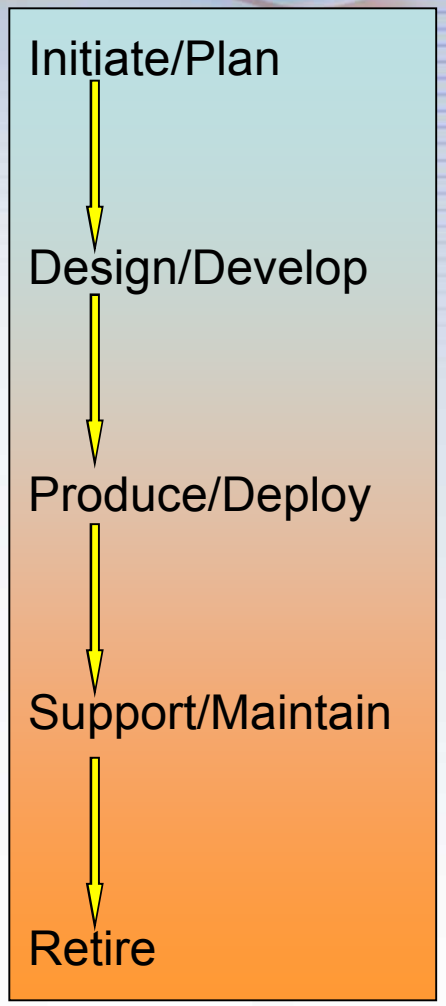
- Traditional corporate processes were the result of DOE nuclear weapons development. However, our non-DOE Customers have very different expectations and associated processes.
- We must develop and use processes and tools expected by
  - Department of Energy
  - Department of Defense
  - Department of Homeland Security
  - Department of Commerce
  - … and others

Education and Knowledge Management Must Align

Strategic Alignment: Strategic Education Committee

- Guides and oversees Sandia's education, professional development, and training programs.
- Assist Sandia in meeting its strategic goals for continuous improvement through education, professional development, and training.
- Partners with Corporate Learning and Professional Development (CL&PD) to ensure Sandia approaches learning from a strategic perspective.

Strategic Alignment: Product Lifecycle Management Program



- Product Lifecycle Management (PLM) is the process of managing the entire lifecycle of a product from conception, through design and manufacture, to service and disposal.
- The PLM Program Goal: To deploy scalable PLM solutions, including people, processes and tools for all Sandia
  - Integrate with and complement RPSS using pre-existing methodologies & successes
  - Development of processes and plans that will ensure qualification of robust talent pool at SNL
  - Deliver Enterprise Product Lifecycle Management System
- New Program - Long-term role yet to be defined.

Knowledge Management: Technology Symposiums

- The Technology Symposiums lunchtime series addresses current trends of technological significance and unique approaches to innovation technology.
- It provides an opportunity for technical staff to interact with others, both inside and outside their areas of expertise.
- Knowledge and experience can be shared across the Nuclear Weapons Complex.
- Offered by the NW Weapons Professional Development Program.

Professional Development: Strategic Educational Initiative

- The Strategic Education Initiative goals:
  - Create a culture that is passionate about and supportive of continuous learning,
  - Initially increase the number of internally provided technical and leadership/management development classes or courses completed by and delivered by Sandians, and
  - In the future, increase the number of internally provided professional development courses.
  - Promote professional development by providing Sandians with corporate funding for up to 32 hours of training within a fiscal year.
- Intended to enhance or significantly expand an individuals' current and new knowledge base. This knowledge must relate to or enable the mission of the Laboratories.

Professional Development: Memberships in Professional Organizations

- Sandia Corporation supports employee participation in professional association activities as a means of fulfilling its strategic endeavor to develop its workforce.
- Professional memberships and participation in outside professional organizations provide employees with opportunities in training, information exchange, and networking, while building professionalism and projecting the quality of Sandia National Laboratories workforce.
- Sandians are members and board members at the International and Local (State) levels:
  - INCOSE – International Council on Systems Engineering (Sandia is a Corporate Member)
  - PMI – Project Management Institute
  - ASQ - American Society for Quality
  - LMC Systems Engineering Steering Council

Line Specific Training – An Example: Realize Product SubSystem

- How Sandia National Laboratories (SNL) realize NW products to achieve Engineering Excellence.
- RPSS, a subsystem of the Nuclear Weapons Management System, includes five processes to consistently realize product.
- RPSS Awareness Training
  - Overview of PRT Responsibilities/Processes
  - Overview of Product Acceptance
  - Overview of Supplier Quality Management System
  - Overview of Engineering Authorization