SAND2016-0463PE

Briefing to Steve Hughes (AWE)

1/20/2015 10:30 – 12:00

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Objectives

Production Development Quality and the Role of 420/NQT

10:30 – Introductions
10:40 – QMS
10:50 – Cost of Quality
11:00 – Tools and Methods of Defect Prevention
11:15 – NQT
11:50 Wrap up / Questions / Discussion

Introductions

A Little About Me

- Designed, developed, built, and deployed various high consequence HW/SW systems (avionics, radars, ground systems, satellites)
- Developed a personal bias against fixing the same problems repeatedly – became a defect prevention advocate
- Moved into management then to the Quality Group, and became aggravated by watching resources being diverted from interesting new work to fixing problems, meetings, new vendor qualifications, etc.

Quality Management System (QMS)

- A QMS is a set of ***policies***, ***processes,*** and ***procedures*** required for ***planning*** and ***execution*** in the core business area of an organization
- It integrates internal processes within the organization and provides a process approach for project execution
- It helps an organization identify, measure, control, and improve core business processes to lead to improved business performance
- It is necessary, yet insufficient to achieving the end goal of product quality

QMS Examples

- **Weapon Quality Policy (NAP-24)** describes the requirements and responsibilities for the QMS as well as for product quality – a contractual requirement for NW
- **ISO 9001:2008** is a standardized QMS used by many
- **AS9100:2008** is a standardized QMS with requirements for the aerospace industry

The requirements of NAP-24 have been flowed down to RMI's and incorporated into RPPs. By following the RPP's we meet the requirements of NAP-24

The Cost of Quality

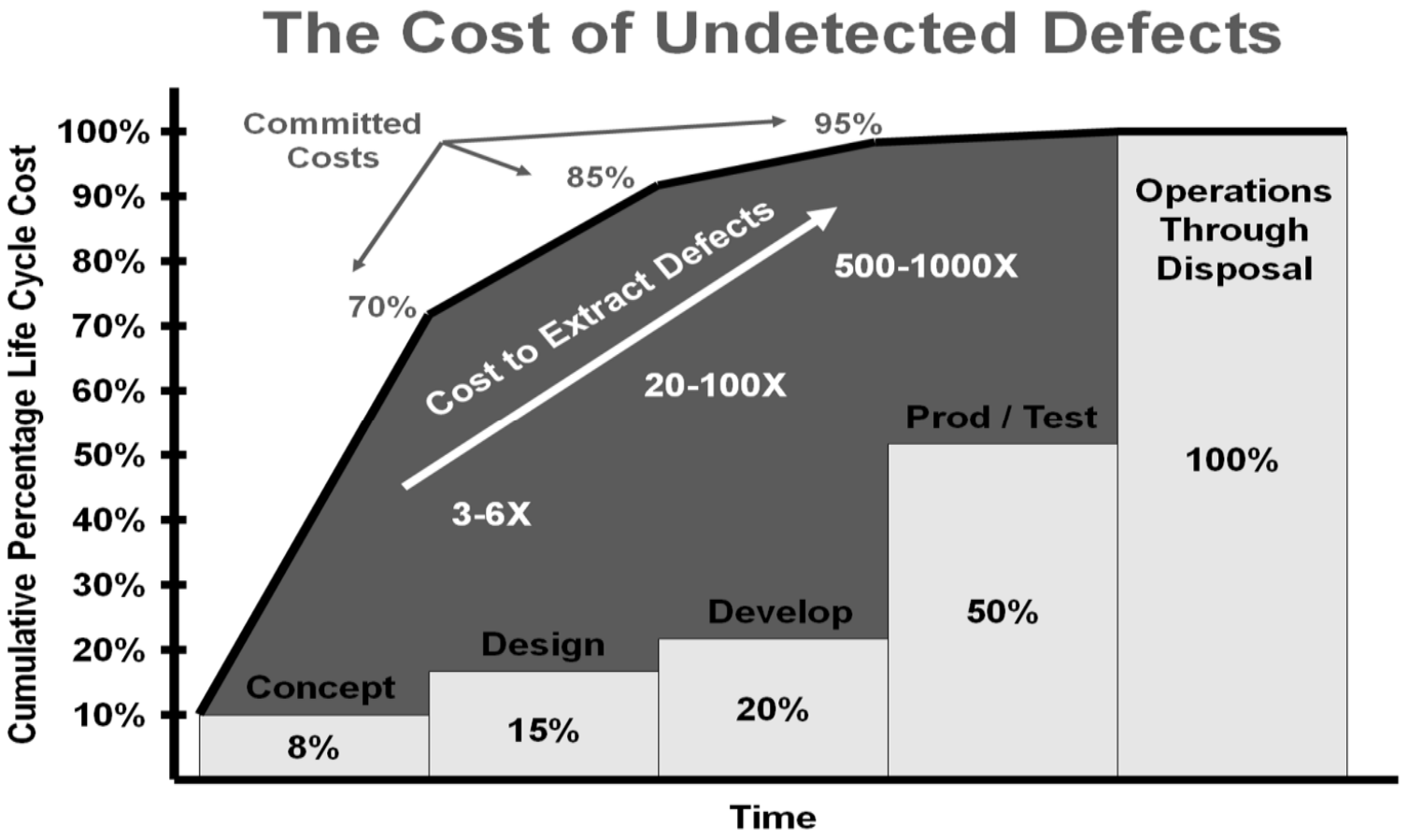
- **Prevention** – Routine activities that ensure scrap, rework, and corrective action are minimized later in the project. ***Your best opportunity to avoid wasted time and money***

- **Appraisal** – Activities that examine and measure how well the quality management system is performing (e.g., assessments, audits, inspections)

- **Internal Failure:** Costs to SNL for "in-house" failure (e.g. scrap, rework, re-testing, corrective actions, schedule delays, lost weekends . . .)

- **External Failure:** Costs that occur when your customer finds the failure:
  - Loss of reputation and customer confidence,
  - Increased oversight and reporting,
  - Loss of follow-on business,
  - Product recalls / returns / replacements
  - Lost weekends, overtime, stressed out people, increase turnover, …

The Cost of Quality



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Roles and Responsibilities

- Use Defect Prevention Tools and Methodologies to Enable PRT Success
- Examples / Specifics
  - Works with PRT to develop a qualification strategy
  - Provide system-level design architecture analysis and innovative approaches in the product realization
  - Develop and assist with the implementation of overarching frameworks, quality plans/strategies, requirements engineering infrastructure, configuration management, and documentation architecture
  - Define requirements and develop acceptance criteria
  - Ensures traceability of system to lower level requirements
  - Participate in design and drawing reviews, and ensure evidence is Collected and configuration managed
  - Develop and maintain quality plans, qualification and acceptance documents, and evaluation/qualification status releases
- Your Examples?

What a Technical Quality Engineer Does and Doesn't Do

Quality For Design, Development, & Qualification

1. Manage requirements
2. Ensure configuration management
3. Verify and validate requirements
4. Optimize manufacturability transition
5. Begin with product acceptance in mind

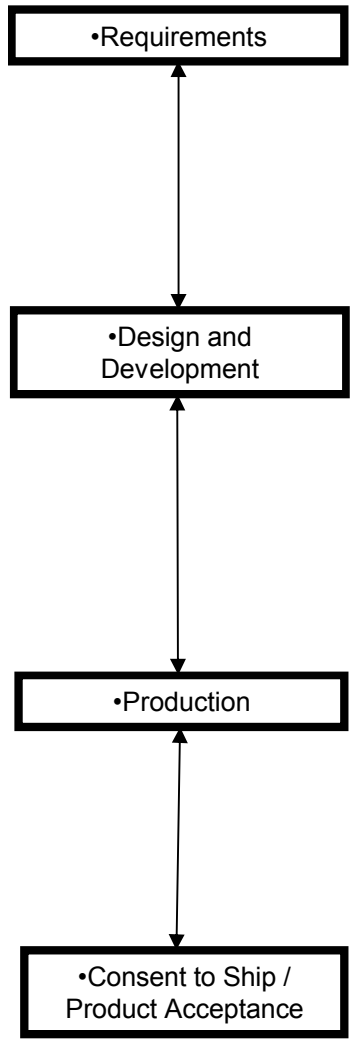
Quality For Fabrication & Manufacture

6. Ensure predictable manufacturing
7. Control non-conforming product and its disposition
8. Ensure product acceptance success
9. Ensure sustainable manufacturing

Quality Assurance & Evidence

10. Ensure that 1-9 are executed
11. Prove you did what you said you would do in 1-10

Tools and Methods of Defect Prevention vs. Phases



- Concept of Operations
- Fagan Inspection
- Requirements:
- Manage traceability of requirements (e.g. customer to product, system to subsystem)
- Systems modeling
- Initiate requirements verification (verification matrix)

•Design and Development:

- Modeling and Simulation
- Mistake Proofing
- Fagan Inspection
- Ensure traceability from requirements to design
- Test Planning
- Prototyping
- Accelerated Testing (HALT)
- Supplier Quality
- Failure Mode and Effects Analysis (FMEA)

•Production:

- Checklists and procedures
- Accelerated Screening (HASS)
- Ensure traceability from design to production
- Supplier Quality
- Qualified tools/testers

•Consent to Ship / Product Acceptance:

- Requirements compliance (Verification Matrix)

•Concurrent Engineering

•Quality Management System (Record Control, Configuration Management, Corrective Action, Reviews, etc.)

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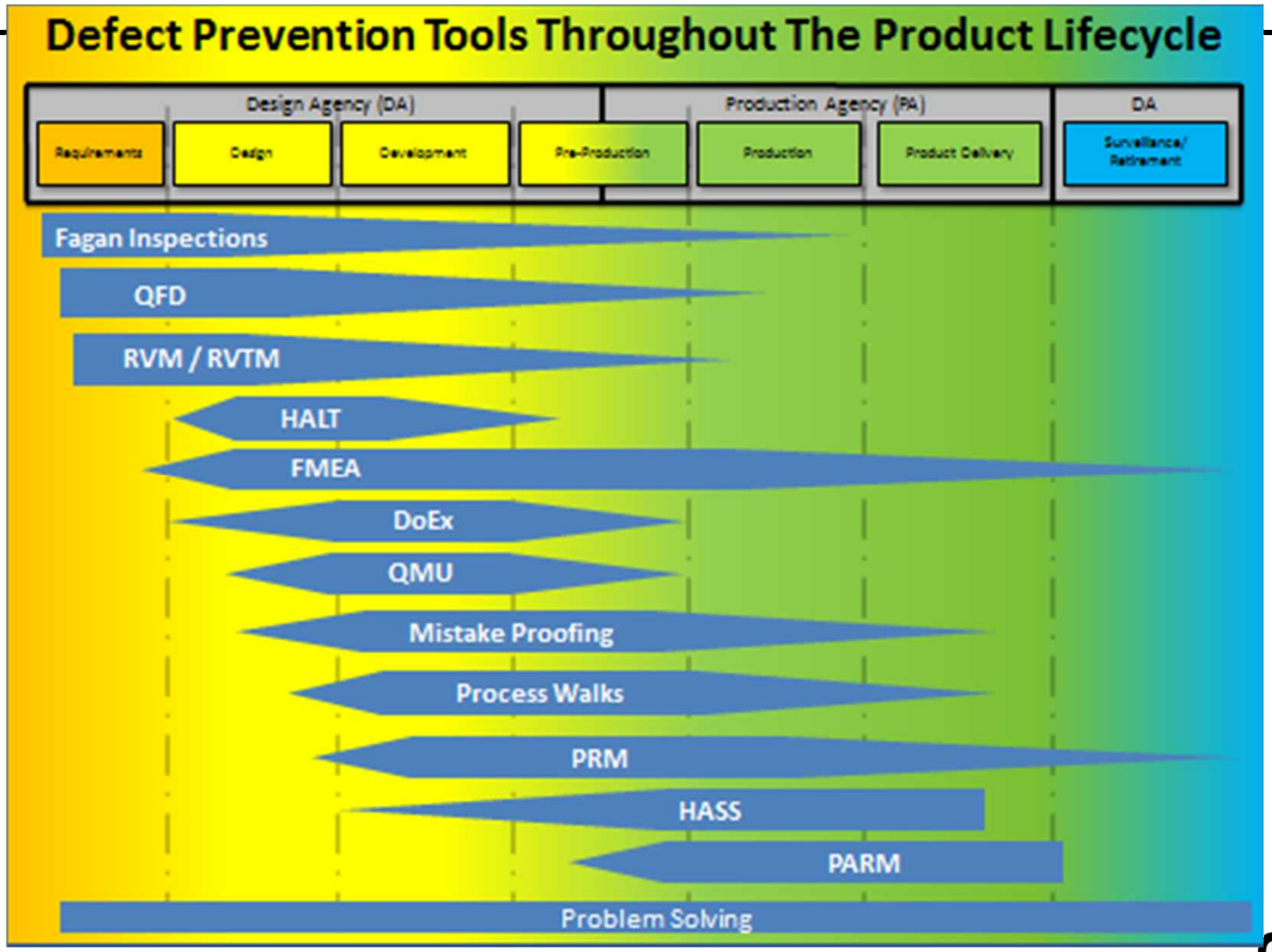
Point 3 – We are advocating an increased use of preventive approaches



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NQT fit to Corporate Strategic Plan

Strategic Objectives

- Amplify our national security impact
- Strengthen our Laboratories' foundation to maximize mission impact
- Advance an exceptional work environment that enables and inspires our people in service to our nation

Crosscuts

- Trusted Partnerships
- Exceptional Performance

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NQT Program supports Strategic Objective #2:

Strengthen our Laboratories' foundation to maximize mission impact

•Our Laboratories' foundation gives our institution its vitality and uniqueness. Using advanced facilities and tools, our talented people build upon an enduring research base by advancing the frontiers of science and engineering. They create Sandia's rich technical capabilities that give our institution its identity and uniqueness within the laboratory system. Deeply committed to national service, our people seek internal and external partnerships to achieve best results in service to the nation. Our facilities and tools foster and enable innovative thinking and outstanding operational expertise, which define Sandia's own brand of mission delivery. Our broad, multidisciplinary research base is forward-looking, and it encourages bold technical outcomes that can qualitatively advance the Laboratories' capabilities. With these resources, Sandia is well prepared to anticipate emerging threats to national security and apply deep scientific understanding to demonstrated engineering solutions.

•Intentionally anticipatory and agile, our Laboratories' foundation uses a successful framework, which enables focused decisions about capabilities. These decisions are driven by our mission area strategies and our responsibility to steward and sustain our competencies now and in the future. To fulfill this responsibility, **we will elevate the practice of engineering through partnerships with universities, industry, other national labs, and other institutions.** We will stimulate the growth of visionary, principle-based leaders who can assure exceptional operational performance and mission execution. With a workforce united in purpose, the integrated facets of our foundation will bring the full power of the Laboratories to solving our nation's most-critical national security challenges.

- "… we will elevate the practice of engineering through partnerships with universities, industry, other national labs, and other institutions."

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Definition of Quality & Our Challenges

Traditional Definition of Quality

- American Society for Quality (ASQ): a product or service free of deficiencies that meets all stated or implied needs
- 10 C.F.R. § 830.3 and DOE O414.1D - The condition achieved when an item, service, or process meets or exceeds the user's requirements and expectations

Our Broader Definition of Quality

- A product or service free of deficiencies that meets all stated or implied needs that was designed, developed, and delivered in a reliable, consistent, and efficient manner

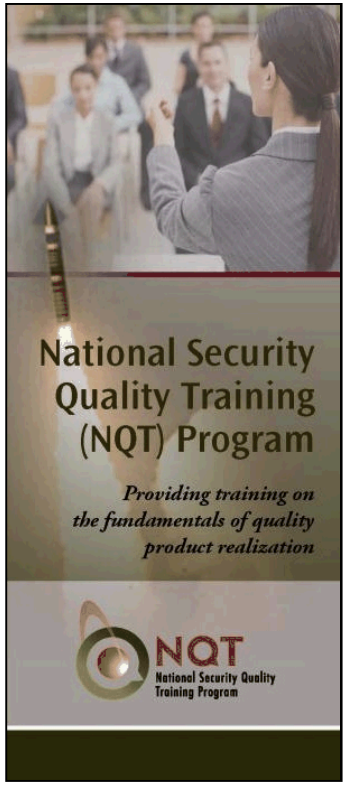
Our challenge extends beyond delivering high performance, highly reliable products to delivering:

- On budget
- On schedule
- With engineering excellence

Description of NQT Program

NQT is a corporate-wide "quality" training program intended teach techniques and practices that enable a disciplined approach for the engineering of products and services with assured quality

- ***In FY15, over 1300 attendees for 11 different courses.***
- ***80% of attendees from outside the quality organization.***



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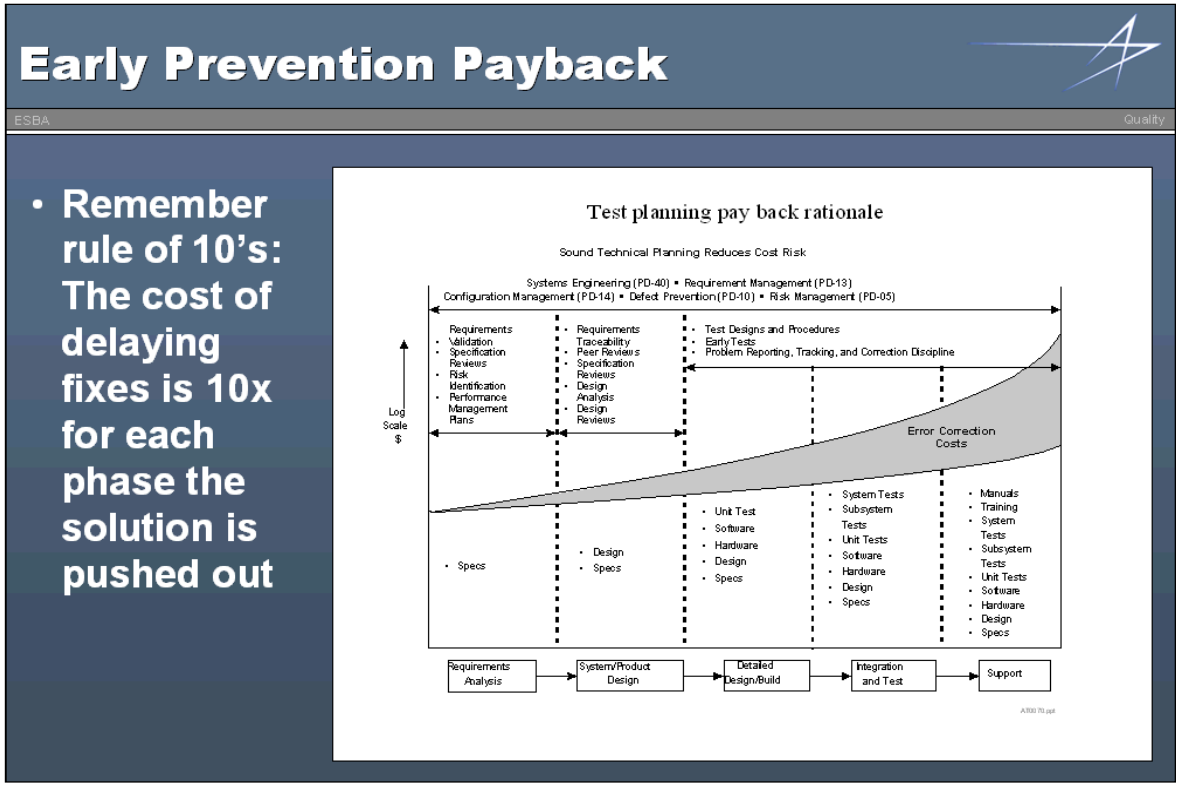
NQT Program Advocates Prevention

•The more phases the defect is carried through undetected, the more costly its removal will be when it is finally detected.

•The courses that comprise the NQT program are specifically designed to focus on preventing defects early in the product realization process, providing multilayered strategies to promote quality at every stage of product engineering.



•Courtesy: Lockheed-Martin parent company reach back program to Sandia National Labs

NQT Provides A Strategy for Prevention at Every Phase of the Product Realization Process

A Strategy for Prevention at Every Phase of the Product Realization Process

Requirements

- **NQT101 - Requirements Lifecycle**
  Prevents ill-formed requirements
- **NQT102 - Fagan Inspections**
  Detects inconsistent, ambiguous, or misplaced requirements

Design and Development

- **NQT008 - Product Realization Essentials**
  Prevents ineffective execution of the NW product realization process
- **NQT400, 401 & 420 - Product and Tester Qualification**
  Prevents common pitfalls in nuclear weapon qualification
- **NQT5xx - Accelerated Testing and Other Preventive Methods**
  Detects design, supply chain, and manufacturing defects through best practice engineering techniques
- **NQT600 - Mistake-Proofing**
  Prevents manufacturing and assembly mistakes
- **NQT650 - Problem Solving**
  Prevents problems from recurring by tackling them at the root
- **NQT800 & 801 - Supplier Quality Management**
  Prevents supplier quality issues

Production

- **NQT200 - Product Acceptance**
  Detects inconsistencies between as-built product, design definition, and the supplier contract

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NQT Courses Currently Offered

NQT008 – Product Realization Essentials
Dive deeply into the key Product Realization Process requirements and procedures that every nuclear weapon engineer needs to understand in order to execute multi-year, multi-billion dollar NW programs. (2-days)

NQT101 – Defect Prevention Through The Requirements Lifecycle
Clarify customer needs, develop product requirements addressing customer needs, and verify/validate needs and requirements. (1-day)

NQT102 – Using Fagan Inspections to Remove Defects from Product Definition
Detect and remove defects in documents, test plans, design definitions, and procedures. (2 ½-days)

NQT200 – Preparing for Successful Product Acceptance
Understand the product acceptance process and the tools to prepare a defect free evidence package. (1-day)

NQT400/401 – Preparing for Successful Qualification/Overview
Learn the overall process for qualifying nuclear weapon product and how to prepare for a successful qualification. (2-days/1-day)

NQT420 – Tester Equipment Qualification Overview
Understand the approach for planning, designing, qualifying and maintaining test equipment. (1/2 day)

NQT510 – Mastering HALT & HASS
Uncover and remove weaknesses in hardware designs and manufacturing processes. (2-days)

NQT600 – Using Systemic Mistake-Proofing to Prevent Defects
Reduce rework and schedule delays by applying mistake proofing concepts to product design, test equipment, and fixtures and tooling. (2-days)

NQT650 – Problem Solving
Learn a proven 7-step methodology to identify problems, develop solutions, and validate solution effectiveness, leading to a shortened schedule, lower cost, and reduced quality problems. (1-day)

NQT800 – Preventing Supplier Quality Problems
Effectively manage your supply chain over the product lifecyle from make/buy decisions, to accurate and complete statements of work, to supplier selection and supplier monitoring. (1/2-day with NQT801)

NQT801 – Supplier Management: A World of Myths, Mistakes, and Miracles
This online course provides an overview of the process Sandia uses to manufacture product off-site. Prerequisite to NQT800. (2-hours)

New NQT Courses Coming Soon

- **NQT430 -- software qualification**
  Qualification of firmware and software products for NW components and test equipment
- **NQT500 Series -- accelerated aging**
  An updated treatment of HALT, HASS and accelerated aging techniques as applied to nuclear weapons
- **NQT620 GD&T for QEs**
  A QE perspective on GD&T for drawing reviews and Fagan Inspections
- **NQT630 Statistical Analysis Techniques**
  Tools for QEs and PRT members to use during development and production

Take Home Points

- You Already Have a QMS
  - It Will Not Save You
- Cost of Quality Is Largely Determined by Defects – Prevent Them Early
  - "Hidden" costs include: Having to prepare briefings on why the failure occurred; Developing corrective actions and recovery plans; Providing status updates on how the corrective action implementations are going; and Retraining new people after those on the team "bail out"
- There Are Well Understood Tools To Prevent Defects
- You Are Responsible for Quality
- A Subject Matter Expert Can Make You Successful

BACKUP SLIDES

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Welcome to NQT101

Defect Prevention Through the Requirements Lifecycle

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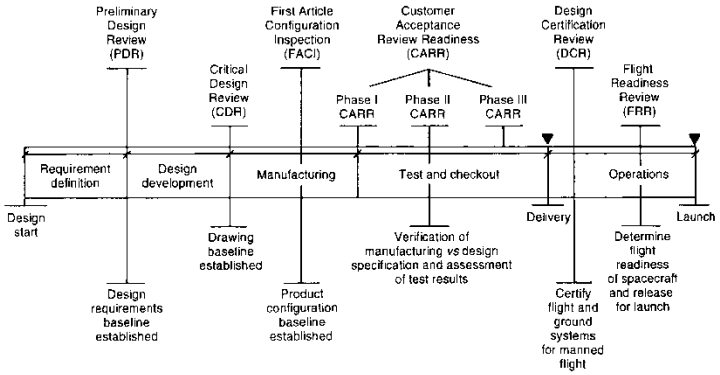
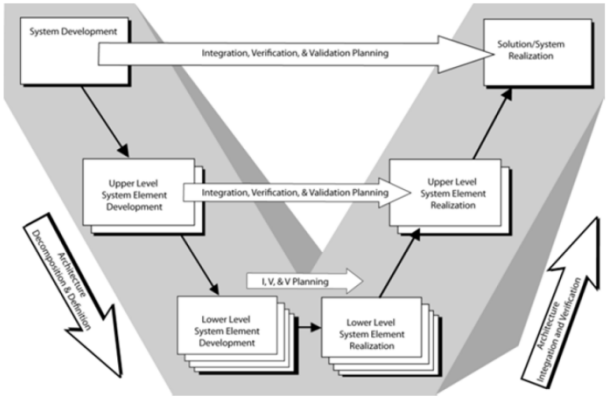
Course Objectives

- Understand how requirements flow through the product lifecycle
- Understand the difference between a customer need and a product requirement
- Understand how to create and identify defect-free requirements (and to correct defects)
- Trace product requirements to customer needs
- Understand how to verify and validate requirements
- Demonstrate your ability to trace requirements to evidence of compliance

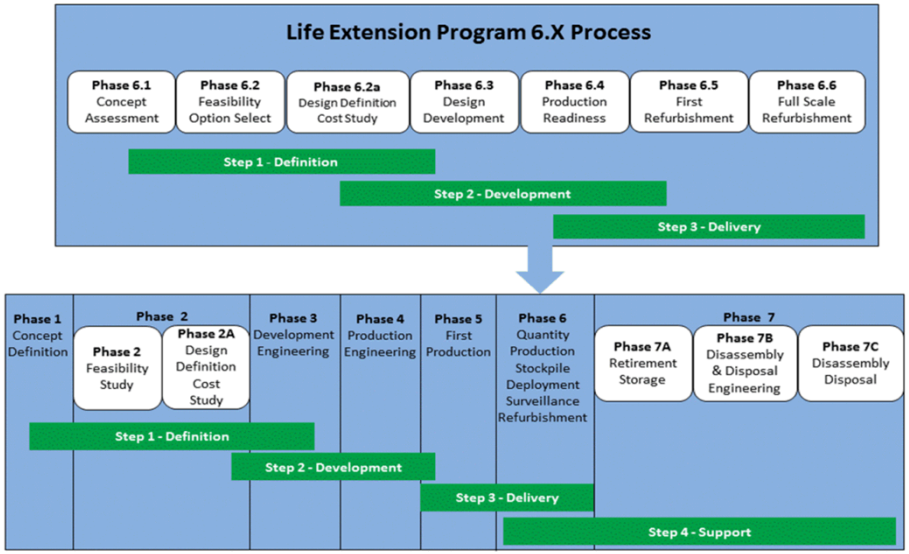
Examples of Product Life Cycles



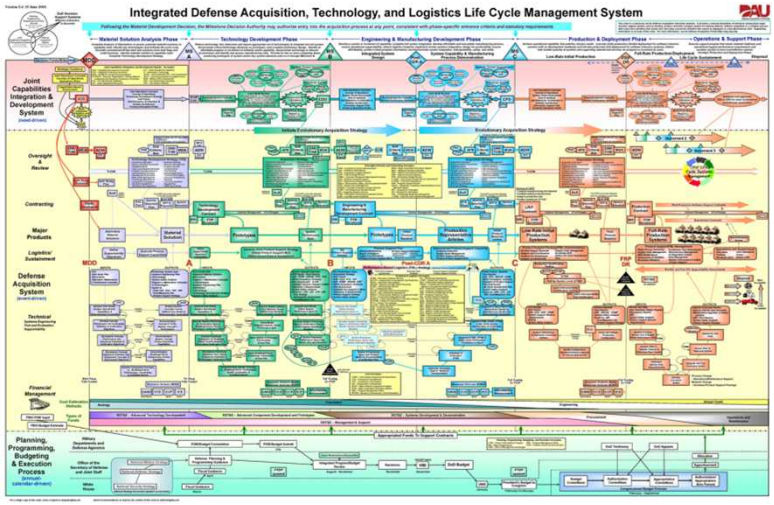
•NASA Life Cycle



•INCOSE Vee Model



•NW Product Realization Life Cycle



•DOD Life Cycle

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NQT102 Using Fagan Inspections to Remove Defects from Product Definition

Module 1: Welcome

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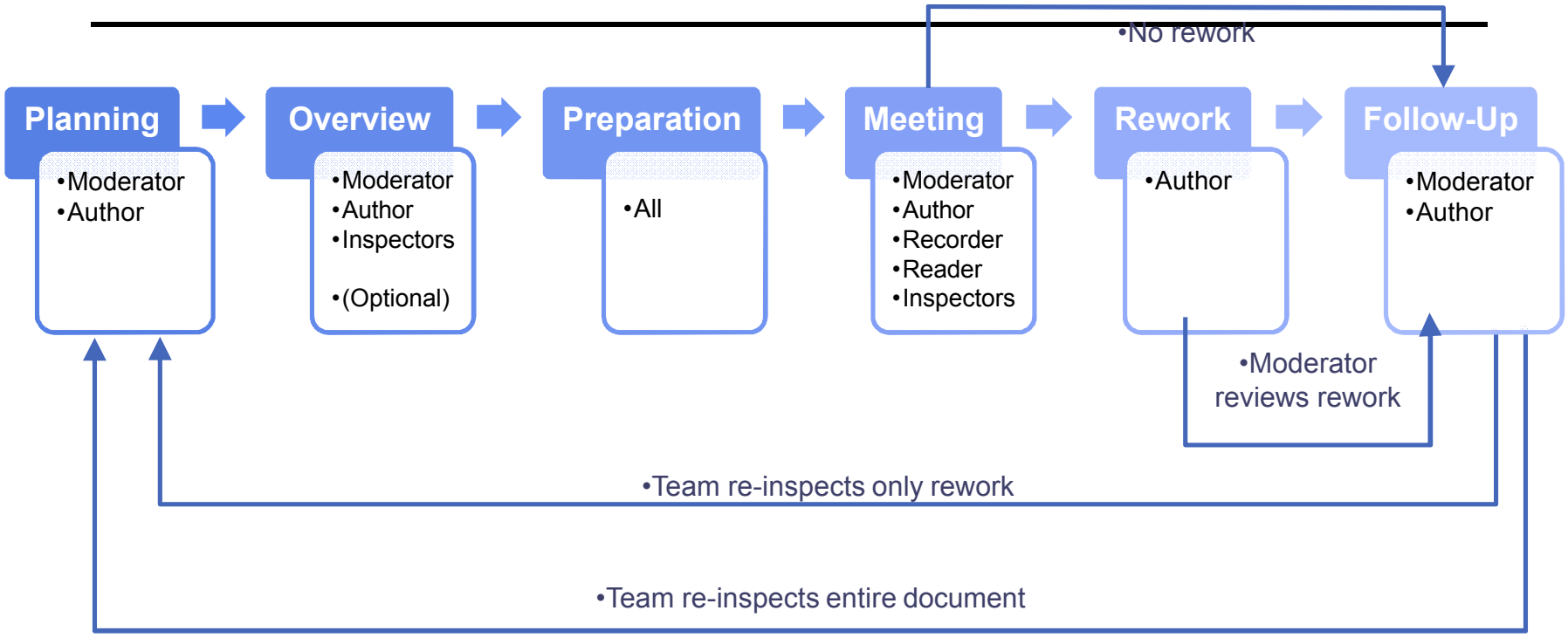
Course Goals

- Conduct effective Fagan Inspections
- Understand why Fagan Inspections are a cost-effective, defect prevention technique
- Understand the importance of key process elements
  - Small, knowledgeable group with specific roles
  - Preparation time
  - Inspection meeting ground rules
  - Re-work as part of the process
  - Criteria for defects for various document types

Fagan Inspection Roles & Process



•Meeting Outcomes

- No rework required
- Rework required, and only the moderator reviews the changes
- Rework required, and the team re-inspects only the rework
- Rework required, and the team re-inspects entire document

•Inspection Reports

1) Inspection Package
2) Inspection Defect List
3) Inspection Metric Summary
4) Inspection Summary Report

- *Store Inspection Reports in Project Database*

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NQT200
Preparing for a Successful Product Acceptance Introduction

February 19, 2016

Sandia National Laboratories

Course Purpose, Process and Payoff

- **Purpose:**
  - **NQT200, is designed to introduce participants to the basic concepts and principles associated with the SNL product acceptance process.**
  - **This class is targeted for Product Realization Team (PRT) comprised of PRT Leads Engineers, Quality Engineers, production agency and line organization.**

- **Process:**
  - **The course is taught in 10 steps organized into key milestones.**
  - **The steps build on each other to assist the PRT within their role, to effectively schedule, prepare, compile & verify quality evidence, and submit product for acceptance.**

- **Payoff:**
  - **These concepts and principles can be applied immediately to product acceptance preparation activities.**
  - **An ultimate payoff is a defect-free submittal.**

•Product acceptance training process steps build on each other, missing a section could have an adverse effect on understanding the process.

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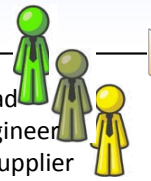
Step 5 - QAR to Perform SNL Acceptance

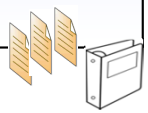
•Step 1
•PRT/PA to Schedule SNL Acceptance with Production Management Scheduler

•Production
•Scheduler

•Step 2
•PRT/PA to Prepare for SNL Acceptance: Compile & Verify •Quality Evidence



•PRT Lead
•Quality Engineer
•Supplier



•Quality Evidence/
•Lot Record Book

•Step 3
•QAR to Prepare for SNL Acceptance: Review •Product Definition

•Product
•Definition

•QAR

•Step 4
•PRT/PA to Submit Product & •Quality Evidence •to QAR for •SNL Acceptance

•PRT Lead
•QAR

•Step 5
•QAR to Perform SNL Acceptance: Verify •Quality Evidence & Inspect Physical Product

•QAR

•Step 6
•PRT/PA or QAR to Submit Product & Quality Evidence to NNSA/SFO for QAIP, •*as applicable*

•NNSA/SFO

•Step 7
•NNSA/SFO or QAR to Perform •Nuclear Weapon Stamping Activities

•Step 8
•Production Agency to Ship or Store 'Accepted' Product

•Controlled
•Storage

•Step 9
•QAR to •Distribute & Archive Records

•QAR

•Step 10
•QAR to Enter Rejectable Defects into SNL Assurance Information System (AIS), *as applicable*

•QAR

Assurance Information System

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•NQT400

Preparing for Successful Qualification

Course Summary

Ruben Muniz

Department 0425

Sandia National Laboratories

Course Summary

- **You should now comprehend the:**
  - Requirements for qualification
  - Principles of qualification
  - Basic process of qualification
  - Inputs and outputs of the stages of qualification
- **You should be able to:**
  - Apply the concepts of the Product Realization Process and REN qualification
  - Identify the minimum key personnel (or roles) that make this process work well
  - Recognize the tools that support qualification documentation

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NQT401
Preparing for Successful Qualification Overview

Rob Lundberg
Department 428

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Purpose of Module

Purpose

This Introduction Module provides an overview of Sandia's qualification principles and how Sandia's qualification process fits within our product realization lifecycle as compared to the rest of the world.

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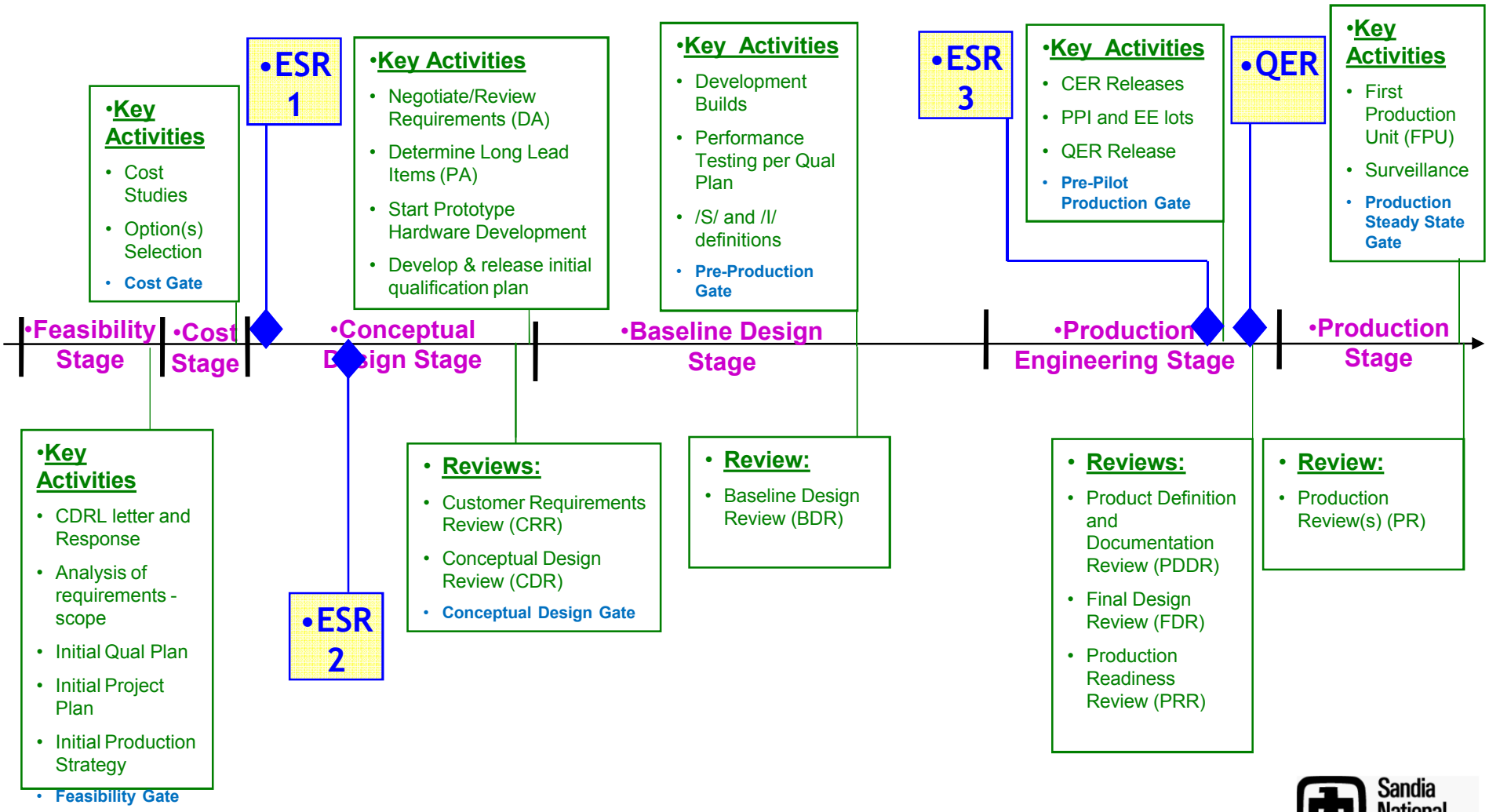
PRP Qualification Timeline



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•NQT420 TESTER EQUIPMENT •QUALIFICATION OVERVIEW

Ruben B. Muniz
Department 425

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Course Objectives

At the end of this course you will have an understanding of:

- ✓ The types of testers used and qualified for NW product testing
- ✓ The composition of a product tester PRT
- ✓ The roles and responsibilities of a PRT for tester qualification
- ✓ Tester design requirements and activities
- ✓ Tester qualification requirements and activities
- ✓ Qualification requirements unique to Nuclear Explosive Testers (NETs)
- ✓ Tester re-evaluation notices
- ✓ Lessons learned for previous tester qualifications
- ✓ Who to contact if you need guidance or assistance with
- tester qualification

Tester Realization Process in a Nut Shell

Phase	Major Activity
Requirements Determination	1. Product design information from product PRT becomes available which determines how product will be tested . . . what tests the tester must be designed to perform and to what fidelity.
Planning, Development & Design	2. DA issues AER (and revision thereafter) to authorize detail design, material/component procurement and/or fabrication of initial tester. 3. Tester PRT is formed, conducts meetings with SMEs, etc., prepares tester design proposals and presents at tester Conceptual Design Review. 4. Tester design reviews conducted, DA releases the acceptance equipment design definition by Complete Engineering Release (CER) at the time of design completion and approval. Initial tester qualification plan is developed. Tester fabrication is authorized to commence.
Fabrication & Qualification Prep	5. Tester is fabricated and checked out, qualification plan evolves/finalized and all qualification documents are generated in preparation of tester qualification activities.
Qualification	6. Tester qualification is conducted to verify the tester can accurately and repeatedly test the product for all production specification acceptance test requirements. Qualification Engineering Released (QER) is issued upon completion of all qualification activities and required documentation.
Post Qualification Re-evaluation	7. Post qualification tester re-evaluations for major/critical equipment or software updates or modes, repairs or when adding new products.

NQT430
Weapons-Related Software:
Product and Processes

Philip Huffman

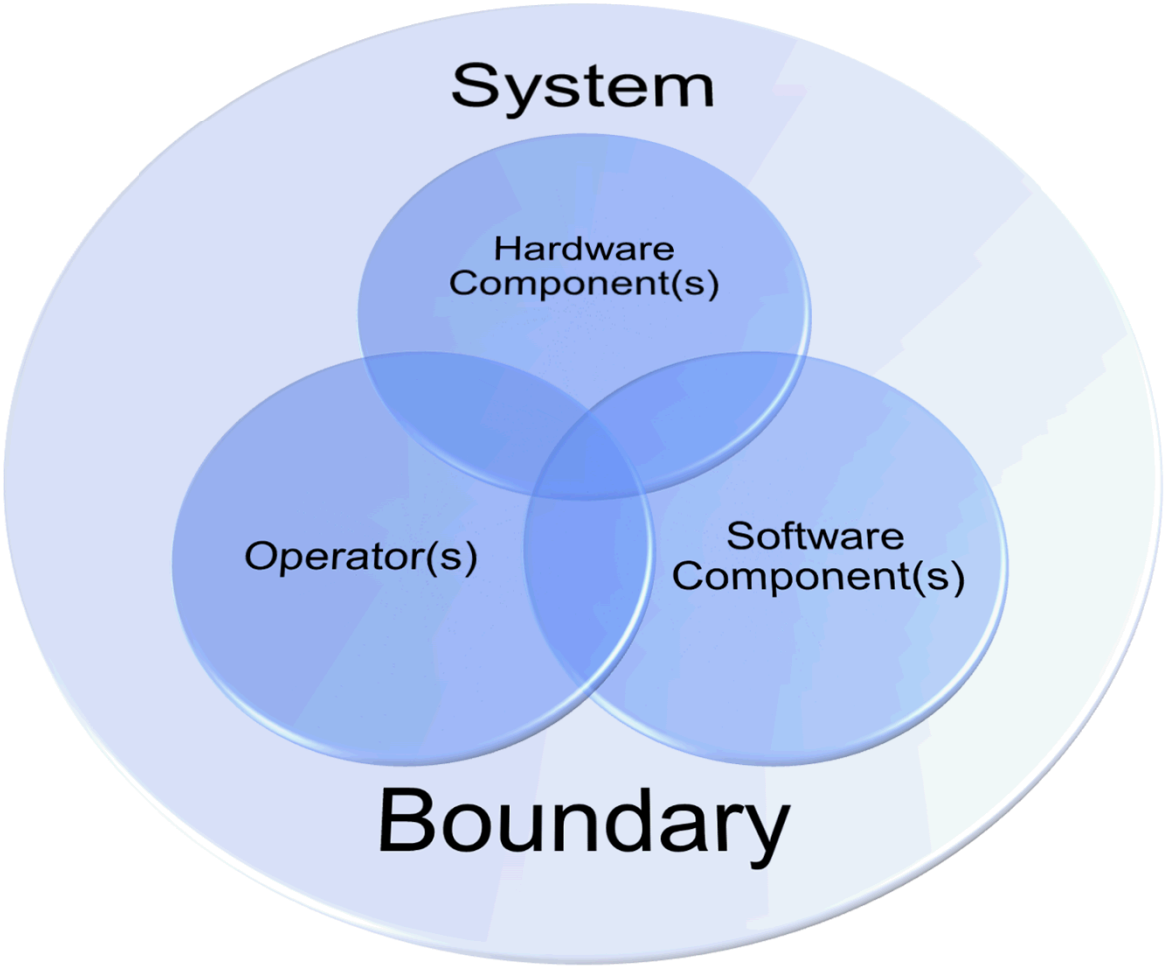
Sandia National Laboratories

Objectives

After this module, you will be able to answer:

- What?
  - Definitions of software and weapons-related Software
- Why?
  - Governing Criteria
- How?
  - The development process practices
  - Deliverable artifacts at each stage
  - The review and qualification process
  - Safety-related software
  - The change control process

•System Definition



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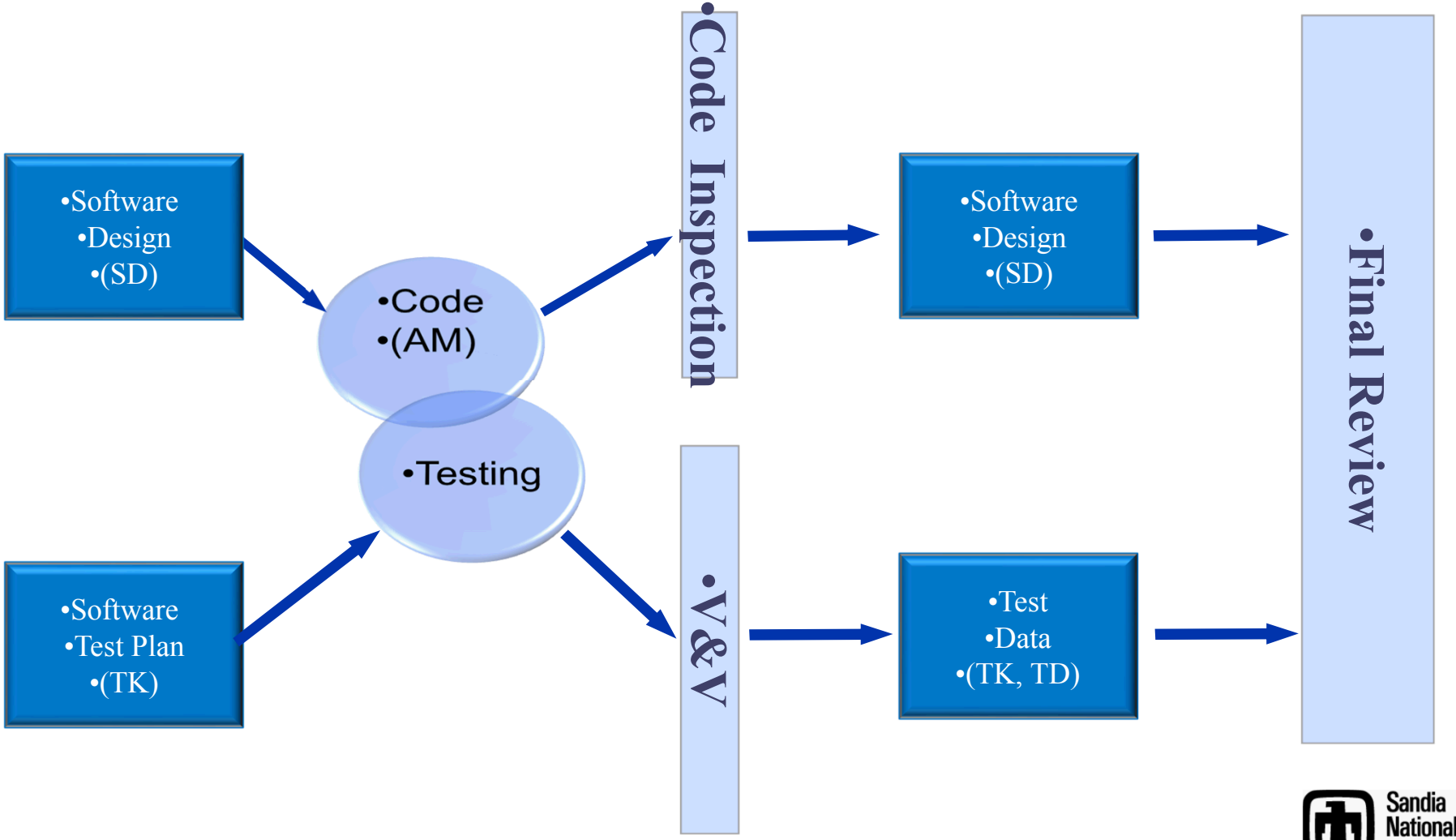
Software Development/Validation



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NQT 510

- National Security Quality Training (NQT) Classes HALT (Highly Accelerated Life Testing) is a preventive method that uncovers weaknesses in a hardware design early in development.
- HASS (Highly Accelerated Stress Screening) is a related process used during production to identify product weaknesses caused by changes in manufacturing processes or in the supply chain. Applicable for NW and WFO teams.

NQT
National Security Quality Training Program

NQT 650: Problem Solving Course

U.S. DEPARTMENT OF ENERGY
NNSA National Nuclear Security Administration

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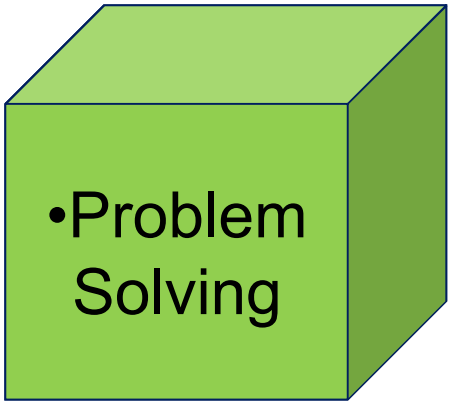
Course Objectives

- Describe the seven thinking elements of problem solving
- Explain the seven-step problem solving methodology
- Describe the importance of framing problems accurately and concisely
- Recognize several analysis tools for identifying a true problem
- Explain the importance of checking countermeasures
- Recognize the importance of problem communication
- Identify problems on the job which can benefit from this methodology
- Describe the three levels of certification in the SNL Problem Solving Program
- Recognize resources available to you for problem solving at SNL

7 Thinking Elements

1. Logical Thought Process
2. Objectivity
3. Balance Results and Process
4. Synthesis, Distillation, & Visualization
5. Alignment
6. Coherent and Consistent
7. Systems Viewpoint



NQT800: Preventing Supplier Quality Problems

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Goals of This Course

- Provide the knowledge necessary for you to effectively manage supplier relationships within Sandia's Product Realization 6.X process
- Provide an environment where product engineers, project leads, quality engineers and purchasing personnel can learn how to work together to create an effective Statement of Work
- Help you create an effective Statement of Work (SOW) to reduce supplier quality issues on your project

•A Preventive Mind: Think about unintended consequences

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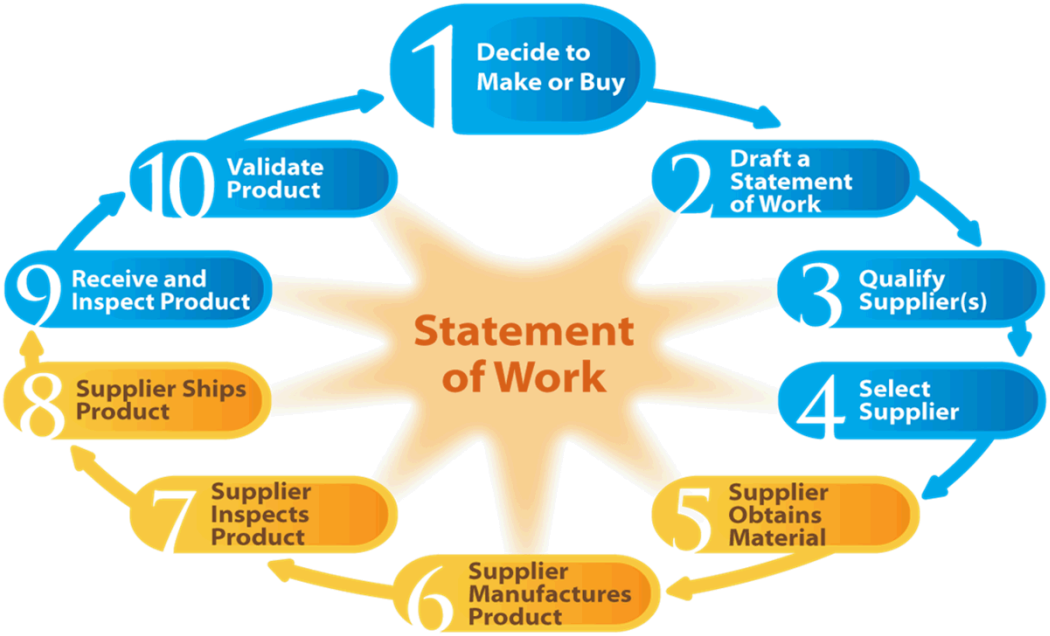
The Statement Of Work is Key

- Addresses possible risks at each stage of the process
- Ensures that all your requirements are accurately communicated
- Ensures that you get what you paid for!



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