SAND2007-0882C

Science and Engineering Information Systems (SEIS)

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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.

S&E IS Information Engineering (4510)

We partner with and support all Strategic Management Units (SMUs)

Integrated Technologies and Systems
Three Management Units

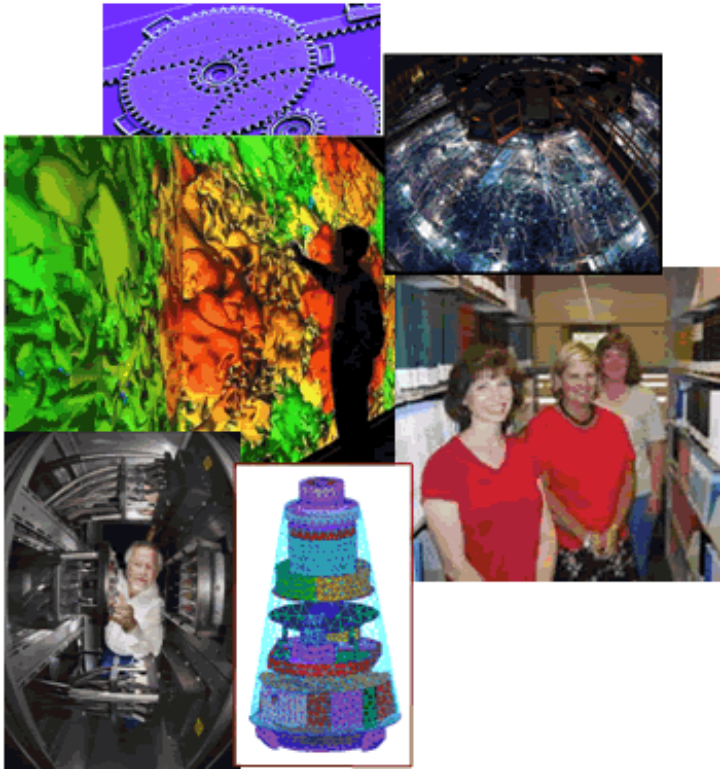
- *Energy, Resources, and Nonproliferation*
- *Homeland Security & Defense*
- *Defense Systems & Assessments*

Nuclear Weapons
One Management Unit

- *Nuclear Weapons*

Laboratory Transformation
Two Management Units

- *Science, Technology, and Engineering*
- *Integrated Enabling Services*



Common Initiatives Between SMUs

- Transform how business is executed
- Develop common, integrated business processes
- Utilize data to make effective decisions, using one source of truth
- Share information securely across enterprises
- Pool knowledge together for better understanding
- Gain wisdom to guide decisions and actions

Develop Information Infrastructure

What We Do

- **Information Engineering** is a rigorous architectural approach to planning, analyzing, designing, and implementing applications within an enterprise. Information Engineering is useful in:
  - business engineering
  - organization planning
  - systems engineering
  - information and systems architectures
  - application development

SEIS Vision

Be the partner of choice
for information engineering
to deliver high-impact
products and services
that support Sandia's missions.

SEIS Capabilities

- Enterprise Architecture
- Business Process Analysis
- Requirements Engineering
- Software Engineering
- Software Aggressive Testing
- Human Computer Interaction (HCI)
- Data Warehousing
- Data & Text Mining
- Natural Language Processing
- Pattern Recognition
- Machine Learning
- Business, System, and Application Integration

Certifications of People in SEIS

- Project Management Institute Certification
- System Engineering Certification
- Information Architecture Certifications
  - OMG[1] UML Certification
  - CMU/SEI[2] Professional Software Architect Certification
  - CMU/SEI Architecture Trade-Off Analysis Method Evaluator Certification
  - ICCP[3] Business Intelligence – Data Management and Data Warehousing Certification
- Process Certifications
  - CMU/SEI SCAMPI Certification (CMMI Assessors)
  - CMU/SEI Personal/Team Software Process Certification
  - Scrum Mastery Certification (agile software methodology)
  - Hammer Process Mastery Certification (process re-engineering)
  - Lean Six Sigma Certification

1 – Object Management Group
2 – Carnegie Mellon University/Software Engineering Institute
3 – Institute for Certification of Computing Professionals

Lead Transformation

- Challenges
  - Rapid business development
  - Applying a systems approach
  - Enabling culture change
- Strategy
  - Create a clear vision
  - Establish values that support vision
  - Use Enterprise Architecture

Information Engineering (4510)

Enabling an Enterprise to Implement Strategy

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National Nuclear Security Administration

Sandia National Laboratories

en·ter·prise *n.* **1.** An undertaking, especially one of some scope, complication and risk.

Emphasis is on helping implement strategy, because…

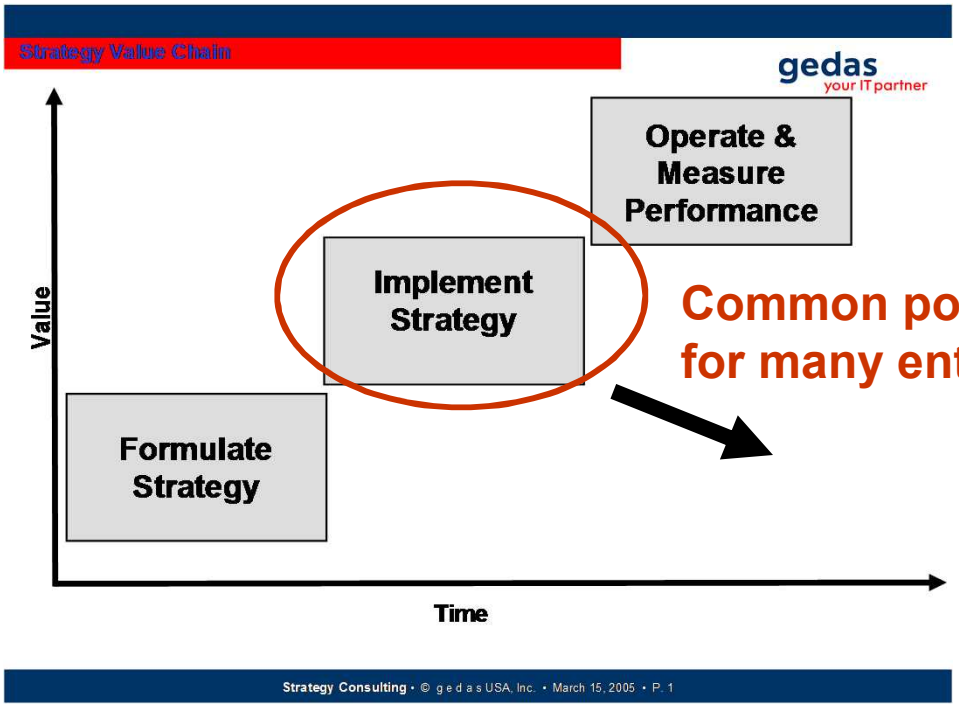
FAA Goals

- Financial accountability
- Align R&D better with future of flight
- Put the “T” back into Technical Center

…Strategy enables Goals

Acknowledge the Pitfalls

VW strategist advised Sandia at Exec Leadership Forum



Common point of failure for many enterprises!

Implementers not properly provisioned to succeed.

What Drives Failure?

- **Wicked problems** (Conklin & Weil)
  - No definitive problem statement, broad disagreement on what the problem is
  - A search for solutions that is open ended, competing stakeholders frame the problem to lobby for a solution specific to their interests
  - The problem-solving process is complicated by continual changes in resources, constraints, ground rules
  - Stakeholders that come and go, change their minds, fail to communicate
- **Business units loosely tied by ineffective understanding and uncommon purpose—whole is not even the sum of its parts**
- **Organization and socio-cultural factors (e.g., funding model, reward system, leadership, process, etc.)**

Evidence is Staggering

Organizations are not good at implementing change.
1991-2000, 49 Studies, 43,000+ organizations

Culture Change—19% Success Rate
Business Expansion—20%
Reengineering/BPI—30%
Mergers/Acquisitions—33%
New Technology—40%
Restructuring—46%
New Strategic Direction—58%

M. E. Smith, ISPI, 2002

Evidence is Staggering

Productivity surveys reveal common problems across the business world.

Less than 50% Productivity

Members of your team would say they are focused on the company's most important objectives less than half of the working day.

Only 14% Contribute to Company Success

Just one in seven people think the team he or she works on is doing all it can to contribute to company success.

Less than Half Know Company's Goals

Only 44% can identify the company's goals. How can the other 56% help you achieve what they can't identify?

FranklinCovey Brochure 2006

Survey data from xQ surveys by Harris Interactive in December 2003

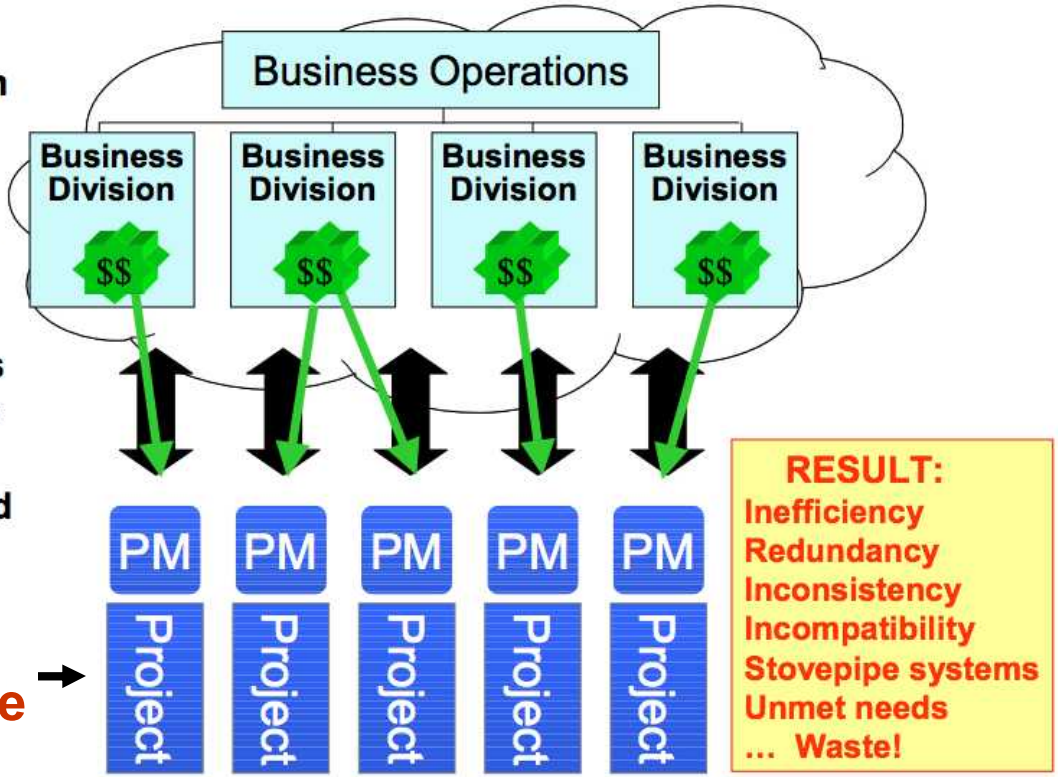
Your Architecture is a Direct Result of Your Funding Model

Why Do You Need an EA?

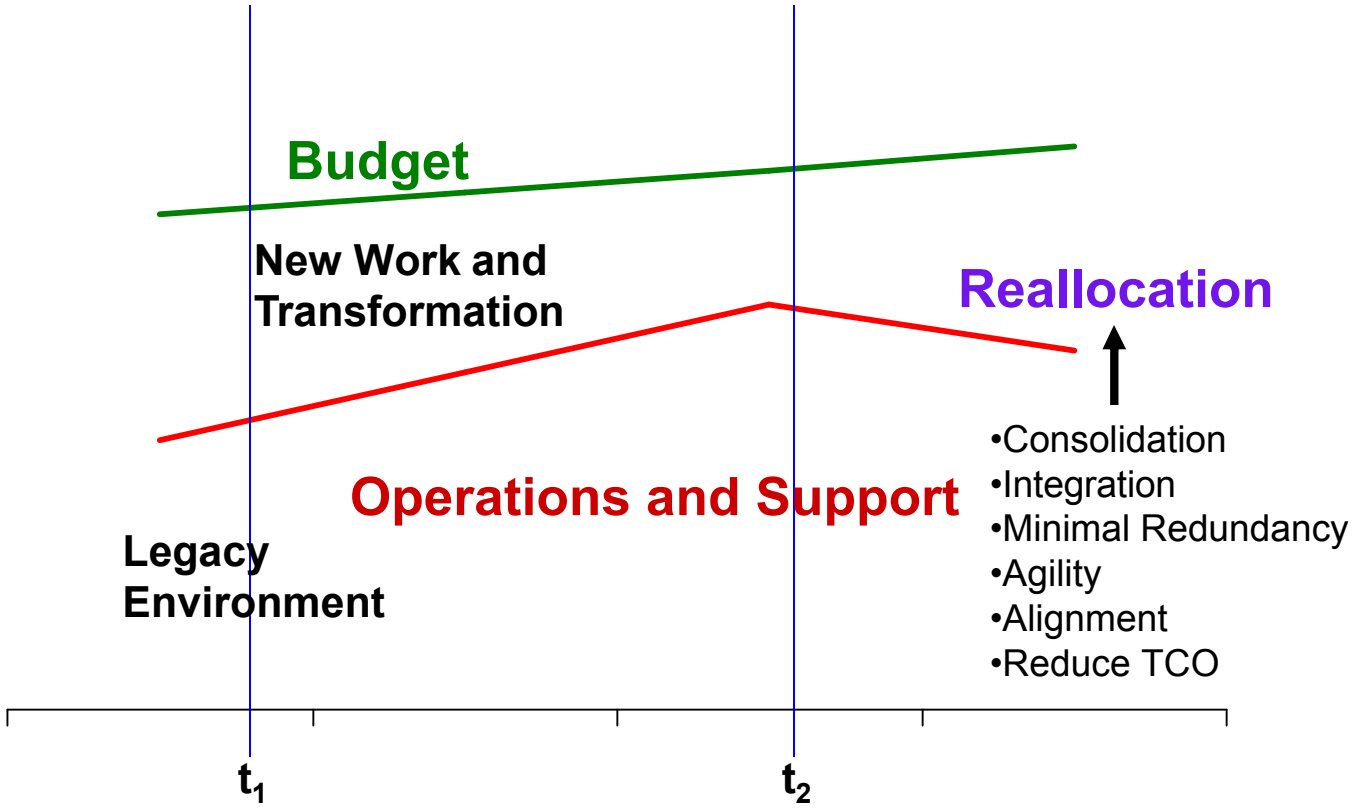
MITRE

- initiatives often justified on their own merits
- Autonomous management of budgets
- Interface to SMEs and operations is project driven
- Projects managed individually

Architecture Happened Here →



Tough Choices



We are having to solve a new class of problems—*wicked problems*—using thinking, tools, and methods that are useful only for simpler problems…

> Wicked Problems: Naming the Pain in Organizations
> Conklin & Weil.

Most companies are captives to their way of thinking.

> Steve Jobs

Enterprise Architecture

The art and science of capturing, designing, and making explicit, an enterprise's operating framework.

PURPOSE, GOALS, CONCERNS, STRATEGIES, POLICIES, PROCESSES, APPLICATIONS, DATA, EVENTS, CYCLES, NORMS, VALUES, RULES, SPONSORS, CUSTOMERS, CONSTRAINTS, ETC.

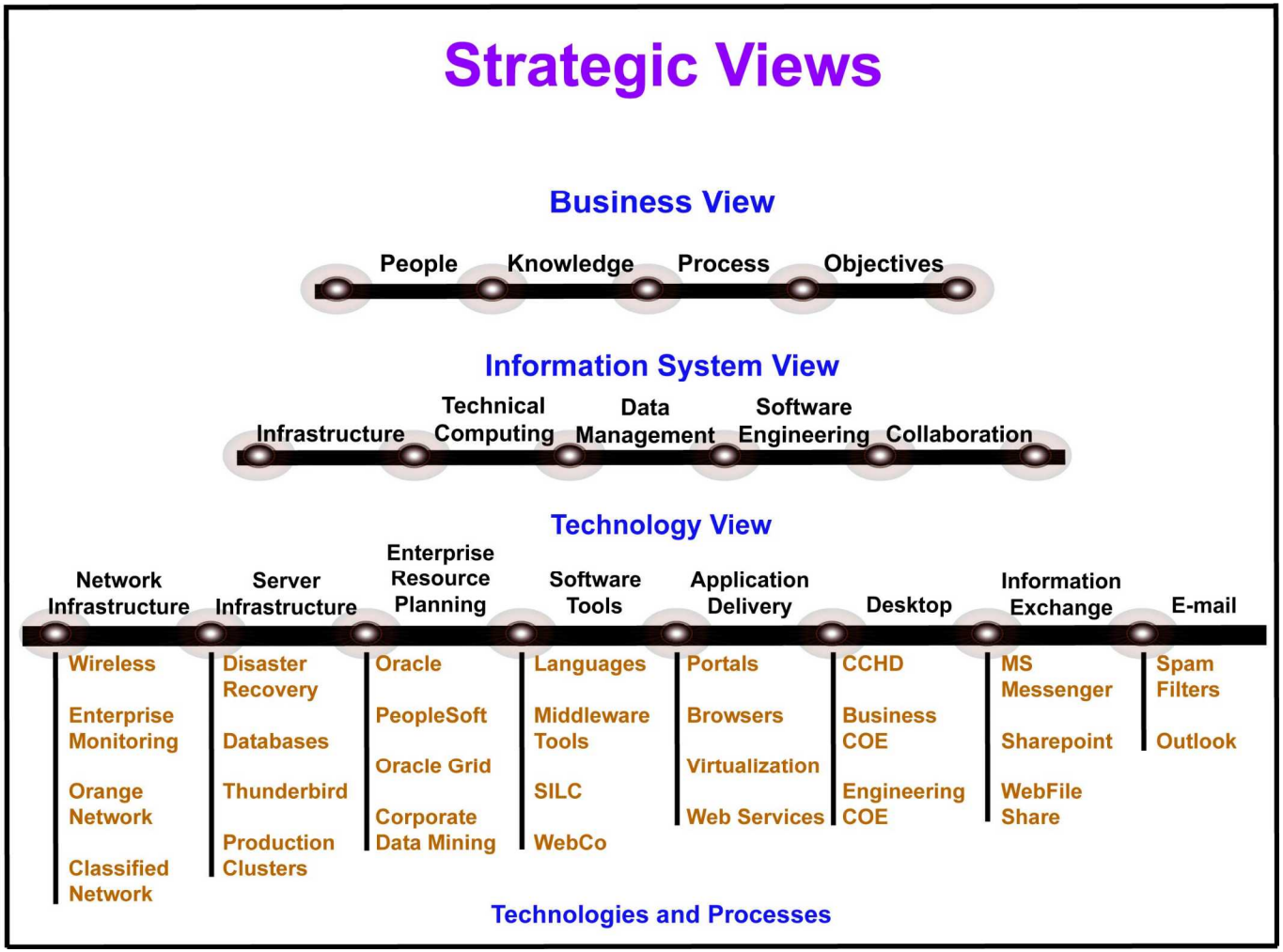
The goal of EA is to ensure that decision-making within the enterprise is based on explicit knowledge about the enterprise rather than 'folklore.'

Principles:

- It's about the business—scoped appropriately
- Simple as possible, but no simpler
- EA is an enabling discipline, nothing more nor less
- Agility is expected

Enterprise Architecture

Decision-makers have different “perspectives” within an operating framework—it is a complex “social network”



Social Impact is Huge

…the really difficult problems to solve in an enterprise architecture effort usually involve people issues…related to corporate culture, executive support, organizational change, policy, office politics, and other matters far removed from questions of hardware or software standards. Even dialog with stakeholders concerning basic business and architectural principles, such as "data is shared," can be contentious. Inevitably, multiple, sometimes-painful, and often ongoing discussions…are necessary both to resolve and to build consensus in support of the vision and implementation of an enterprise architecture.

—Software Productivity Consortium, July 2004

An Example

Enabling the CIO; A longstanding partner

Enabling the CIO

Sandia, 58 yrs and counting

As the *infrastructure matures*, the companies that succeed will not be those that reflexively pursue innovation…but rather those that are pragmatic in planning and competent in execution.

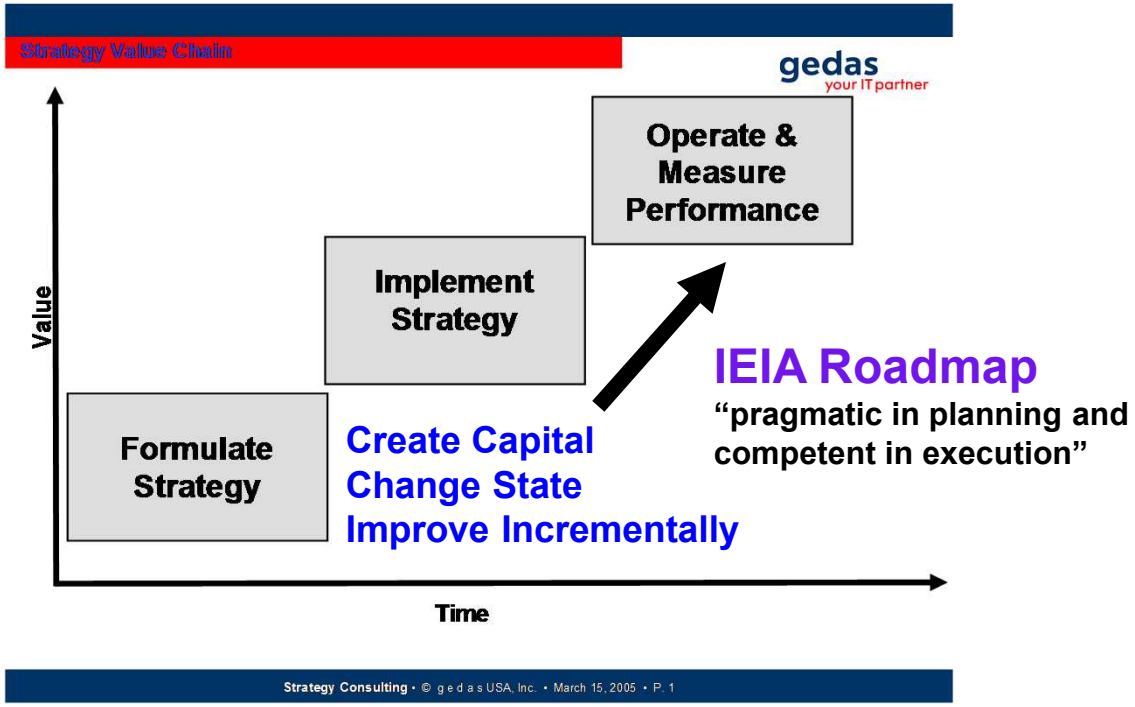
—Nicholas Carr, Does IT Matter?

Enabling the CIO

- Hackett Group Survey
  Key IT-specific actions for Sandia
  - Invest in Governance structure for IT
    - Execs must know that IT understands the business
    - that IT is proactive in providing business solutions
  - Reduce complexity…
  - Achieve flexibility…ensure cost efficiency and effectiveness
- Lab Transformation based on ILMS

Enabling the CIO

Vision: Mission and Operational Excellence Through Information Mastery



IEIA—Integrated Enterprise Information Architecture

Enabling the CIO

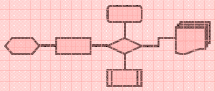
Major Roadmap Elements

Given

- **knowledge of the customer,**
- **enterprise's motivations and intents**

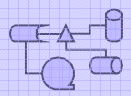
define an *optimal enterprise structure*
(the architecture of the enterprise)

Business Architecture: fundamental organization of work (people, processes, work products, facilities) that **enables motivations and intents**



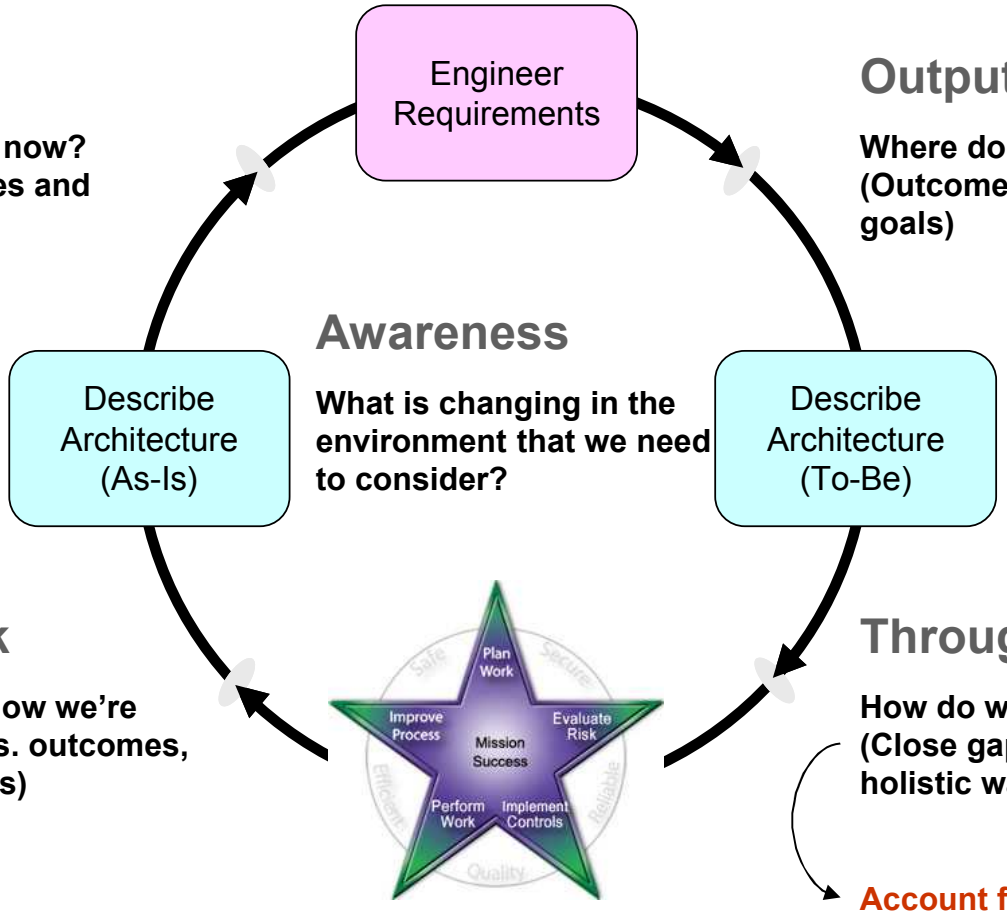
Information Systems Architecture: fundamental organization of applications and data that **enables work of the enterprise**

Technology Architecture: fundamental organization of communications, platform and software infrastructures that **enables information systems**



Realization Model

Roadmap Addresses "Work Planning"; Work Management Completes the Cycle—Iterate



Input

Where are we now? (Today's issues and problems)

Output

Where do we want to be? (Outcomes, purpose, goals)

Feedback

How do we know we're there? (V/V vs. outcomes, purpose, goals)

Throughput

How do we get there? (Close gap in a complete holistic way)

Account for social factors

Manage Work

Architecting can be tedious; match resolution with value.

The Work of Architecting

- **As-Is Architecture**
  - Background, Objectives and Scope
  - Operational Policies and Constraints
  - The Business (why, how, who, with what, where, when)
  - Information Systems
  - Supporting Technology
  - Modes of Operation
  - Stakeholder Roles
  - Support Environment

The Work of Architecting

- **To-Be Architecture** (same list from As-Is *plus…*)
  - The Rationale for the Target Architecture
    - Usage Scenarios
    - Summary of Impacts (during development, operational, and organizational)
    - Summary of Improvements
    - Disadvantages and Limitations
    - Alternatives and Trade-offs Considered
    - Screening and Selection Criteria
    - Make / Buy / Reuse Analysis
  - The Requirements Met by Each Component in the Target Architecture

Architecture of the Enterprise

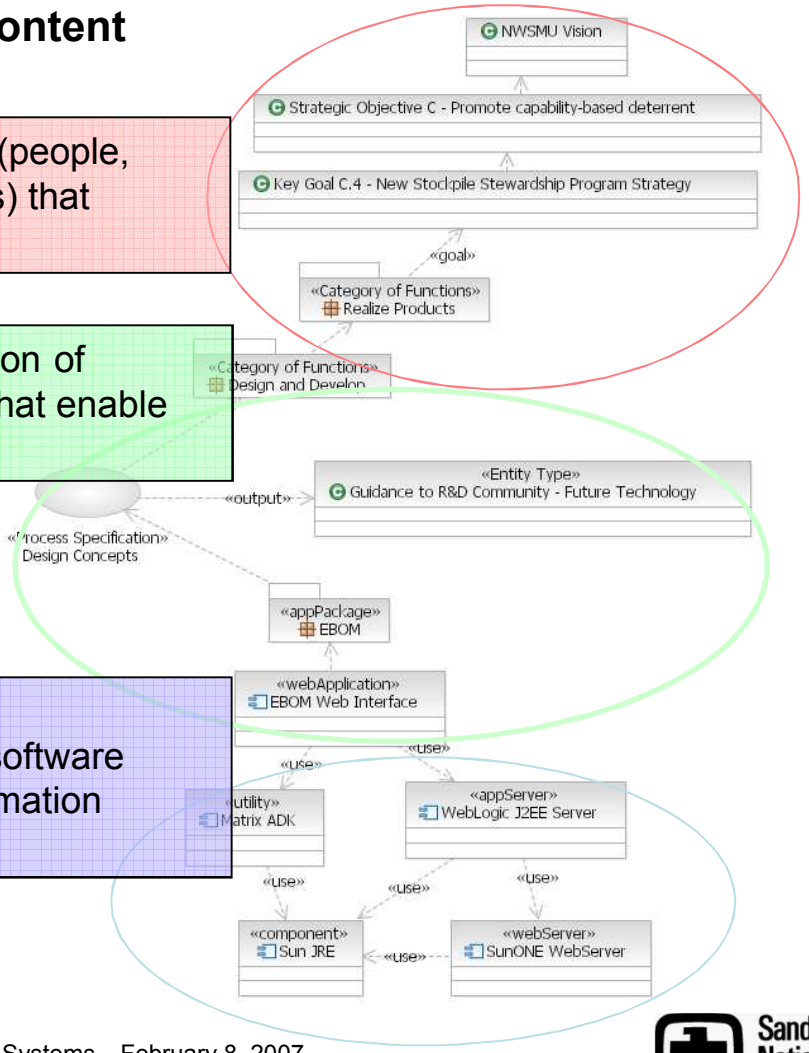
Models provide detail, where required

Example description of aligned NW SMU content

Business Architecture: fundamental organization of work (people, processes, work products, facilities) that enables motivations and intents

Information Systems Architecture: fundamental organization of applications and data that enable work of the enterprise

Technology Architecture: fundamental organization of communications, platform and software infrastructures that enable information systems



Architecture of the Enterprise

Model detail is helpful for analysis of dependencies

Example description of aligned NW SMU content

- credible deterrence
  - a safe, secure and reliable nuclear weapons stockpile
  - meets all military requirements
- science-based engineering infrastructure
- anticipates and responds to national security needs

- promote capability-based deterrent

- stockpile stewardship program strategy

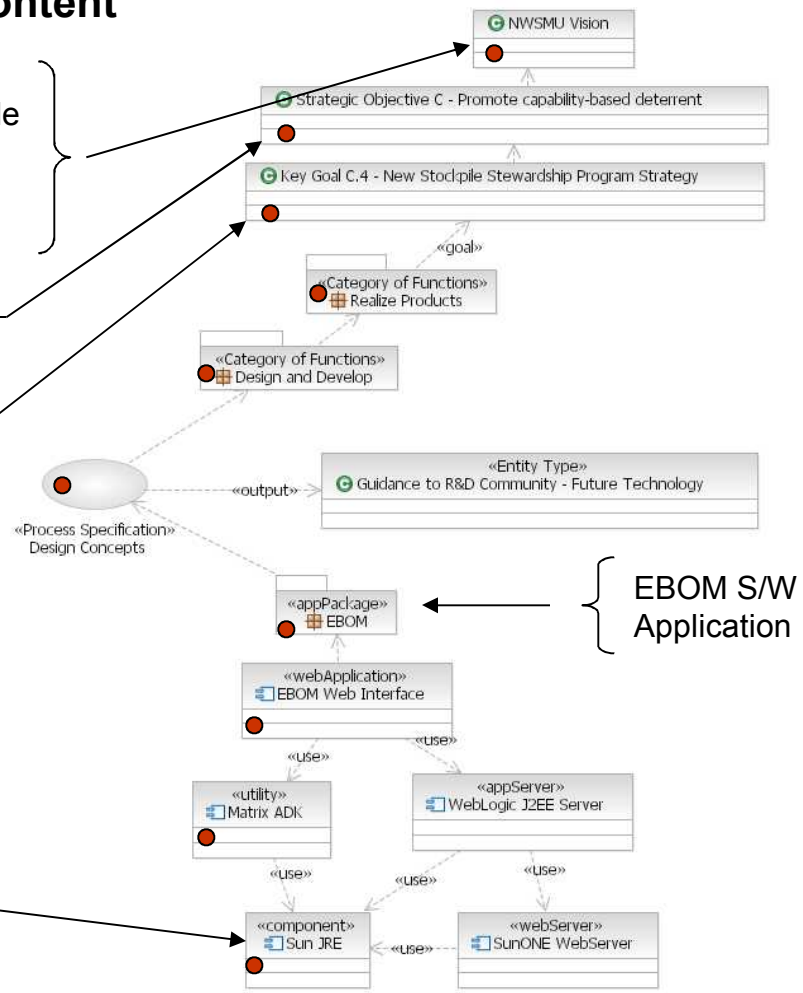
CONNECTS THE DOTS…

PROVIDES CONTEXT AND STRUCTURE…

HELPS ANSWER Qs LIKE:

- **WHICH FUNCTIONS ARE INVOLVED?**
- **WHAT PROCESS DO THEY SUPPORT?**
- **ARE THERE GAPS?**
- **WHICH APPLICATIONS SUPPORT STRATEGY?**
- **WHAT IS AFFECTED BY REPLACING THE SUN JRE?**

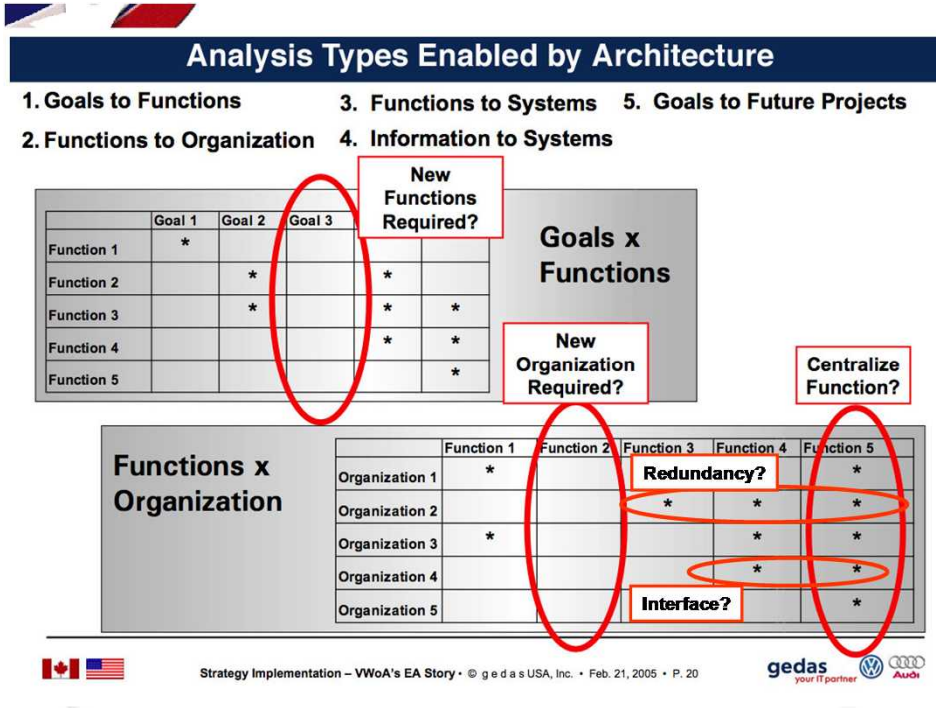
- Sun Microsystems Java Runtime Engine



Architecture of the Enterprise

Affinity matrices can also be used for analysis

Generic Analysis Types



Actions taken: Consolidation, Staffing Plan, Organization Design

IT Dependency Matrix

	IT DEPENDENCY	Business Applications: EBOM	IMS	LLCE	ROA	SSDMS
Infrastructure Software	Cold Fusion	X				
	DCE/Kerberos	X	X	X	X	X
	IIS Web Server					X
Database Management Systems	Oracle	X			X	X
	Sybase			X		
	DB2		X			
Machines	ds09sainf			X		
	sahp137	X		X		
	sahp860		X	X	X	X
Networks	SCN	X	X	X	X	X
	SRN			X		
	SON					

integrated information services

Sandia National Laboratories

Issues: DBMSs, Machine SLA (many apps on one)

EA is not just for the CIO; EA is not IT.

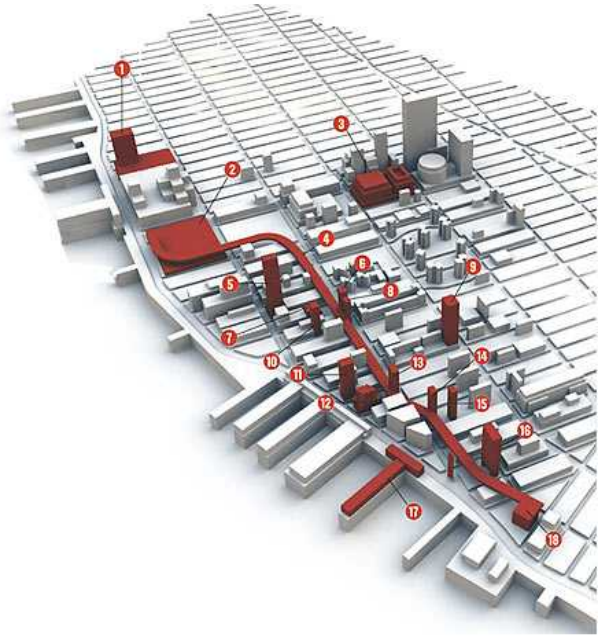
The noblest pleasure is the joy of understanding.
—Leonardo da Vinci

Urban Plan::Enterprise Model

Best available metaphor for comparison

Public, Zoning, Code, Planner, Developer, Builder, Transport, Commission, Plans, Waste, etc.

Business Units, Policy, Stds, Portfolio, Process Owner, Program Manager, Governance, Technologies, etc.

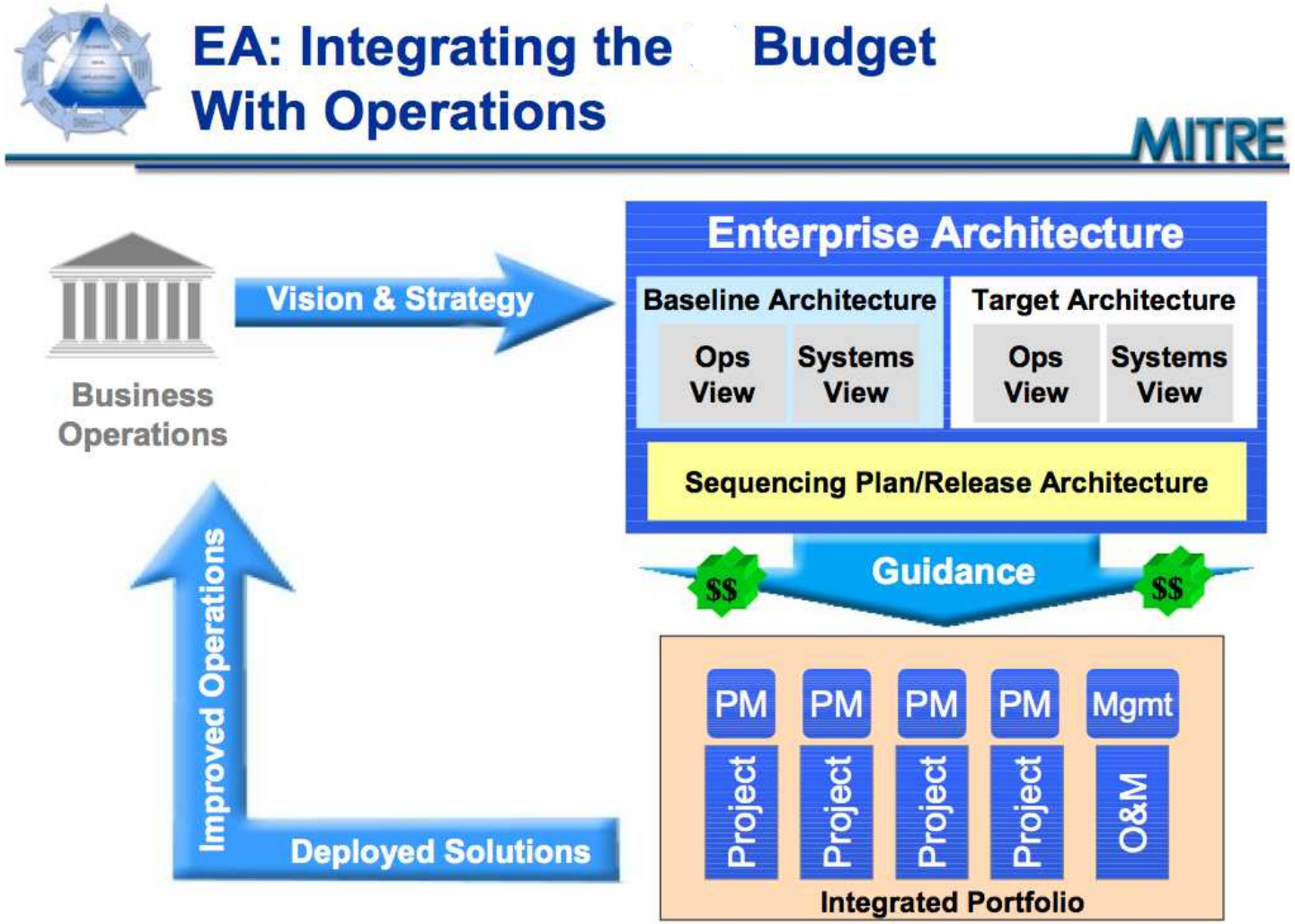


?

Have one, need one, want one

Follow the Architecture

The money is allocated to achieve outcomes



Critical Success Factors

From a people capability perspective

(By 2010), the most effective workforce will be outward-focused, business-driven competency centers…people in IT might be involved in information integration and systems integration, customer service…where companies can leverage scarce and high-value talent…

—Diane Morello, Gartner Group

…the hot jobs in 2010 will be these enabler jobs: business enterprise architects, business technologists, systems analysts and project managers…

—David Foote, CEO, Foote Partners LLC

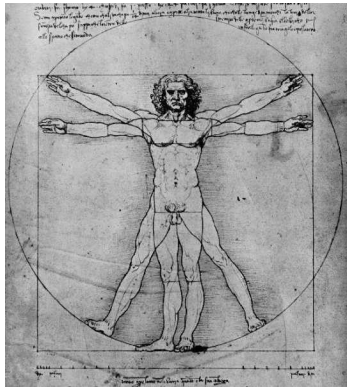
There is much more emphasis on the business domain and on project management skills…it's not that you don't need technical skills, but there's much more of a need for the business skills…

—Kate Kaiser, Marquette University

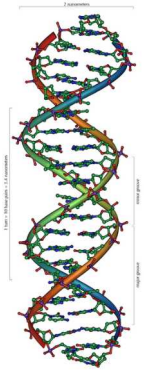
As reported in Computerworld July 2006

To create a new standard, it takes something that's not just a little bit different, it takes something that's really new and really captures people's imagination…

—Bill Gates



HUMAN MODEL

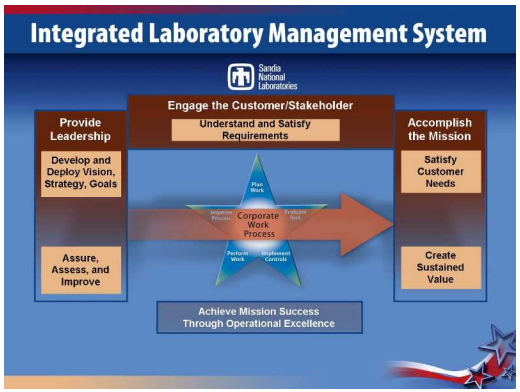


DNA

Consider the evolution of the forensics of the human system.

A New Standard?

Are we capable of (re)engineering an enterprise?



Consists of

Describes

Architecture

Enterprise

"DNA"

Optimizes

Enterprise Engineering
(Roadmaps, Business Plans)

Defines

A Final Word

To create a new standard, it takes something that's not just a little bit different, it takes something that's really new and really captures people's imagination and the Macintosh, of all the machines I've ever seen, is the only one that meets that standard.

—Bill Gates 1984

The creature that survives is not the smartest or the strongest but the one most adaptable to change.

—Darwin

Data Transformation at SNL

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Running a Business

- Simple Problems
  - Usually already have the data
  - If not, can get the data
  - Usually low to medium impact to the business
- Wicked Problems
  - Typically high impact to the business
  - Many aspects to the problem
  - Need validation

Solving a Wicked Problem

- Need data
  - Can't get all of the data
  - Some or all data is not in the right format
  - Can't make sense of the data
  - Data is not integrated
  - Don't have analysis tool(s)
- Result for the business
  - Analysis is too slow to meet needs
  - Make decisions without the analyses

Solving a Wicked Problem

- Need an existing infrastructure
  - Integrated data (data warehouse)
    - Subject oriented, formatted, non-volatile, time variant, accessible, process-oriented
  - Suite of analysis tools
  - Know which tool(s) to use
- Result
  - Analyses can provide validation
  - Good decisions for the business!

Sandia is No Different: One Example

- 50 plus years of Nuclear Weapons information
  - Stove piped systems
  - Couldn't get to all of the data
  - Some or all data was not in the right format
  - Couldn't make sense of the data
  - Data was not integrated
  - Didn't have analysis tool(s)

Neutron Generator Mfg

- Moved manufacturing from Pinellas, Florida to Albuquerque
- Many different issues to solve
  - First find the data (paper, electronic, many different systems)
  - Combine the data (some scanning, some re-entry, some manual eyeballing to integrate, figuring out who could define it)
  - Getting the data together took **months**!!!

Neutron Generator Mfg

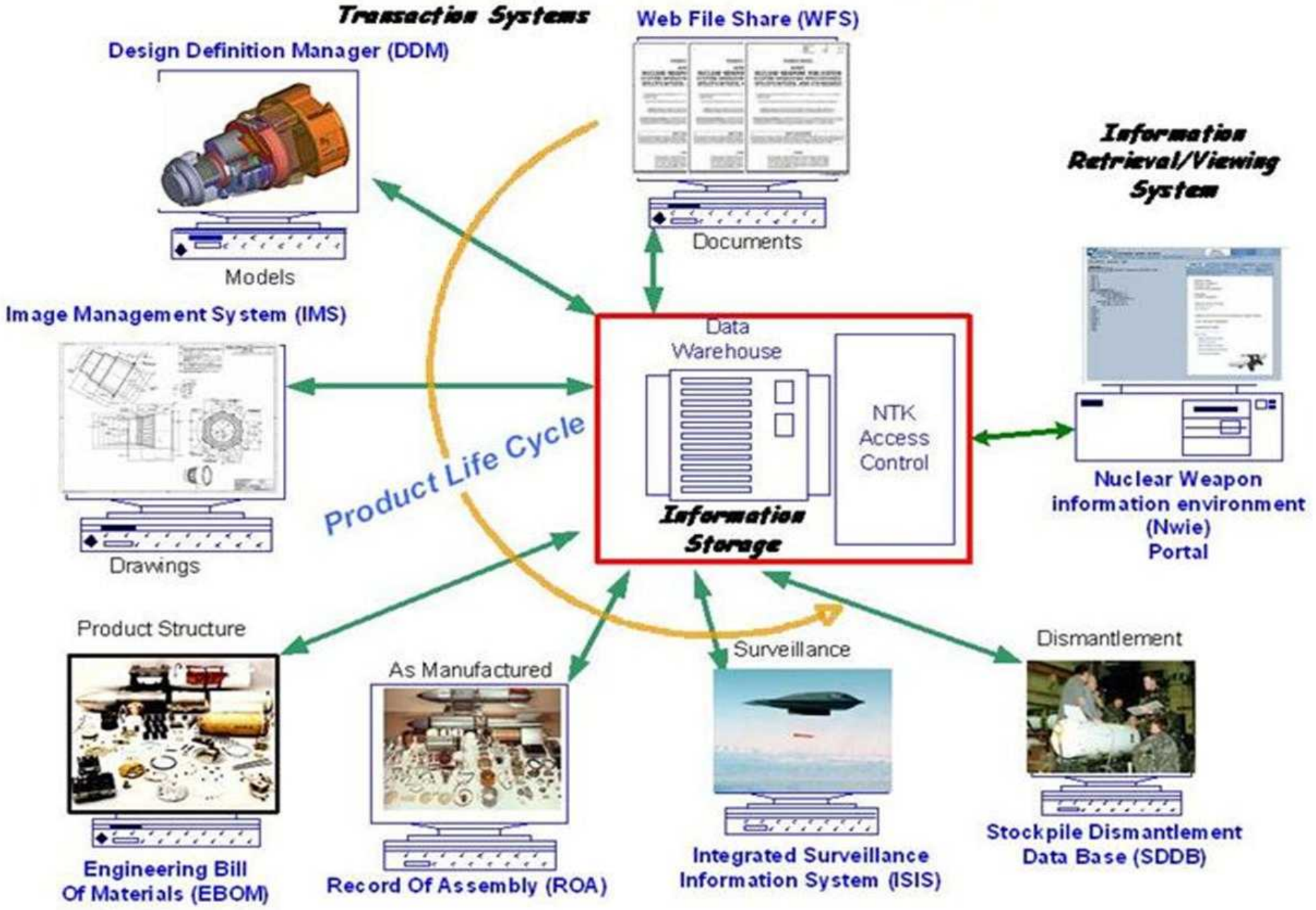
- Had to have integrated data
- Used our Data Warehouse
  - Defined the data (data dictionary, schemas, etc.)
  - Unclassified BOM data
  - Classified testing data, ROA data, etc.
  - Built in flexibility – data changes over time
  - Can accept new data sources
  - Combine data in many different ways

Neutron Generator Mfg

- Large investment in
  - Infrastructure
  - Business processes
  - Data cleansing
  - Maintenance

- Return On Investment
  - Data analyses difference from months to **minutes**!!!!

Engineering Information Systems



Access to Information

- Within Nuclear Weapon Complex (NWC), must share data regardless of where data resides
- The NWC is comprised of many sites:
  - Kansas City Plant (KCP)
  - Lawrence Livermore National Laboratory (LLNL)
  - Los Alamos National Laboratory (LANL)
  - Oakridge Y-12 Plant (Y-12)
  - Pantex Plant (PX)
  - Sandia National Laboratory (SNL)
  - Savannah River Site (SRS)
  - *NNSA Site Offices and Headquarters*
- All sites must work together to meet mission and objectives of the NWC

A Responsive Nuclear Weapons Infrastructure is Enabled by *Information*

Information Engineering (4510)

Design & Analysis → **Manufacturing** → **Maintenance & Surveillance** → **Dismantlement**

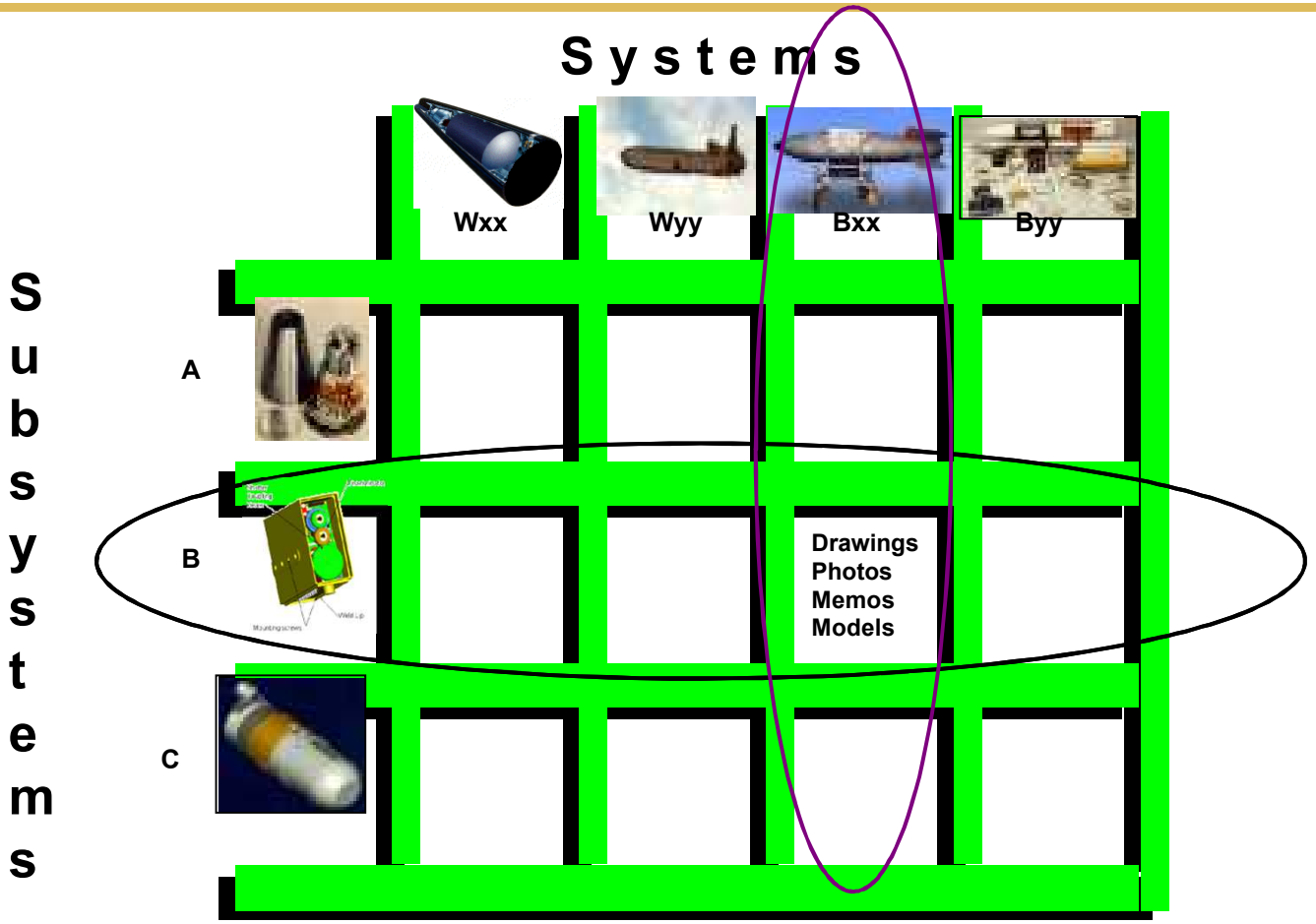
The Nuclear weapons product realization process spans our geographically dispersed Nuclear Weapons Complex

Without the secure flow of information the Nuclear Weapons Complex will not function.

What is Need-to-Know?

- **EXECUTIVE ORDER #13292 issued March 25, 2003**
  - **A determination made by an authorized holder of classified information that a prospective recipient requires access to specific classified information in order to perform or assist in a lawful and authorized governmental function.**
  - **URL: http://www.whitehouse.gov/news/releases/2003/03/20030325-11.html**

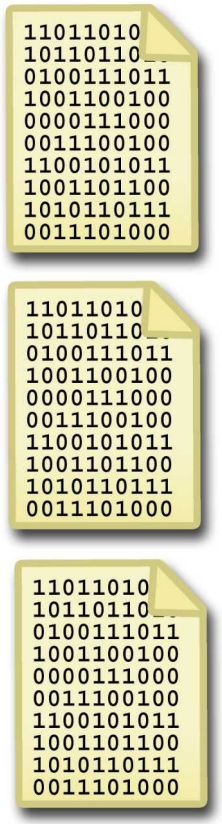
Providing Secure Access



Yucca Mountain Project High Level Waste Repository

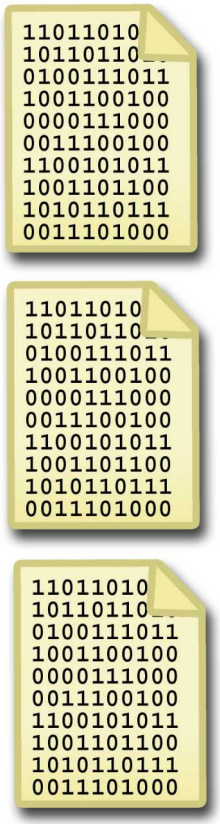
- Switched Lead Lab from BSC to SNL
- Many different issues to solve
  - First find the data (paper, electronic, many different systems)
  - Combine the data (some scanning, some re-entry, some manual eyeballing to integrate, figuring out who could define it)
  - Getting the data together is difficult!!!
  - Added issue of pedigree of data

Data



Decision

Data



observing,
describing

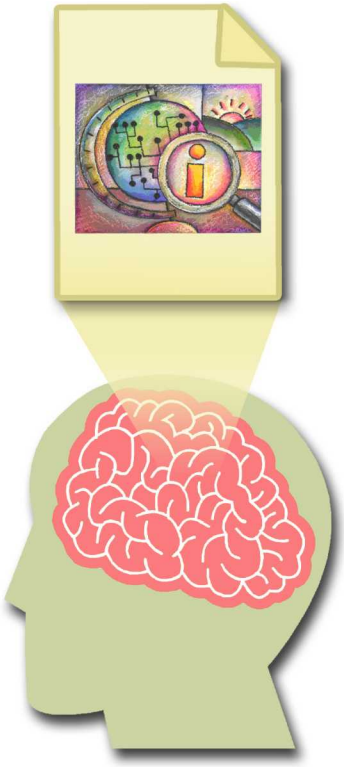
understand

Information

defining,
contextualizing

retain

Knowledge



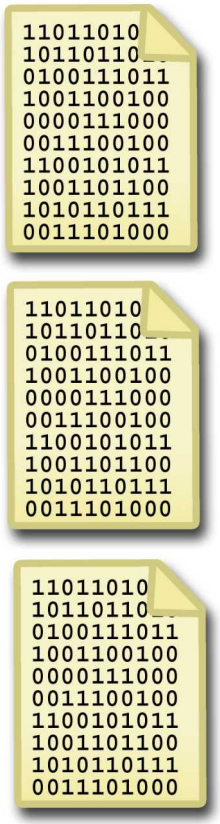
assimilating,
organizing

apply

Wisdom

deciding,
acting

Data



observing, describing

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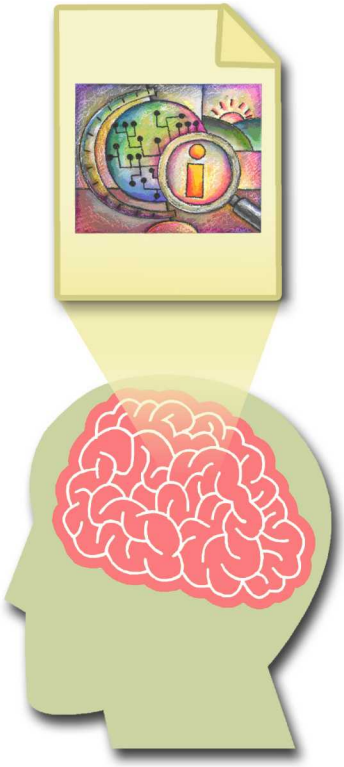

assimilating, organizing

apply

Wisdom

deciding, acting

SEIS Shift in Culture

- Change in Management
  - Stopped research element of work
  - Focused on production element only
  - Became disassociated w/solving wicked problem – focused on simple solutions
- Customers wanted focus on system engineering again

SEIS Shift in Culture

- Using Business Architecture to enable culture change
  - Re-building research element of work
  - New foci
    - System Engineering
    - Solving wicked problems
      - Applied Research
      - Collaboration across SNL w/many different groups
      - Strong tie to production
    - Back to SNL culture “we are problem solvers”

Sandia Mission

To be the provider of innovative, science-based, systems-engineering solutions to our nation's most challenging national security problems

National Security Threats

- Proliferation of Weapons of Mass Destruction
- Terrorist threats within the US
  - Harm people (bombs, viruses, chemicals, etc.)
  - Shut down
    - Water supply
    - Food supply
    - Transportation
    - Energy supply
    - Cyber infrastructure
- Lack of good intelligence

Knowledge to Wisdom

- Wicked problems aren't answered easily
  - Includes layers of questions
  - Integrated data is only one step
  - Need a portfolio of methodologies/tools
  - Need to be able to pick the right tool(s) for the right problem(s)
  - Need validation in order to trust data and make a timely decision
  - Need systems that learn and adapt to dynamic situations

Capabilities in Development

- 80% of data is unstructured
  - Data and Text Mining
    - Develop new functionality
    - Use new tools against real problems
    - Mine the internet
  - Data Fusion
    - How can we combine disparate data types & convert to something meaningful
  - Natural Language Processing
    - Capture concepts, ideas
    - Understand what's changing, what's new

Current LDRD Work

- Cross-language Information Retrieval
  - Using native language internet sites identifying new concepts that are developing and gathering momentum/converts
- Internet Mining Toolkit
  - Cluster analysis to sort out what's relevant
  - Use multiple tools developed at SNL

Summary

- Enterprise Architecture helps to structure and understand the enterprise
- Information is a critical enabler for making effective and timely decisions
- Implementing a strategy requires good information
- EA can enable successful implementation of strategy

Dialogue