Process Engineering

A Systems Approach to Process Improvement

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A funny thing happened on the way to the briefing…

- Realization that “process engineering” is only part of the answer
  - Puts process development in a systems development context
  - Inferred and supported by the CMMI^{SM} Model Suite
  - But - omits other functions that are critical to the development of engineering capability
- Decision to integrate “process engineering” into a larger systems context

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~~Process Engineering~~

~~A Systems Approach to Process Improvement~~

Engineering Systems Development

A Systems Approach to Engineering Capability

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Engineering Systems Development

A Systems Approach to Engineering Capability

Some Reasonable Questions

- What do we mean by an “engineering system”?
- Why would we go to the trouble of looking at engineering capability in this way?
- How do we go about building or improving an engineering system?

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What is an Engineering System?

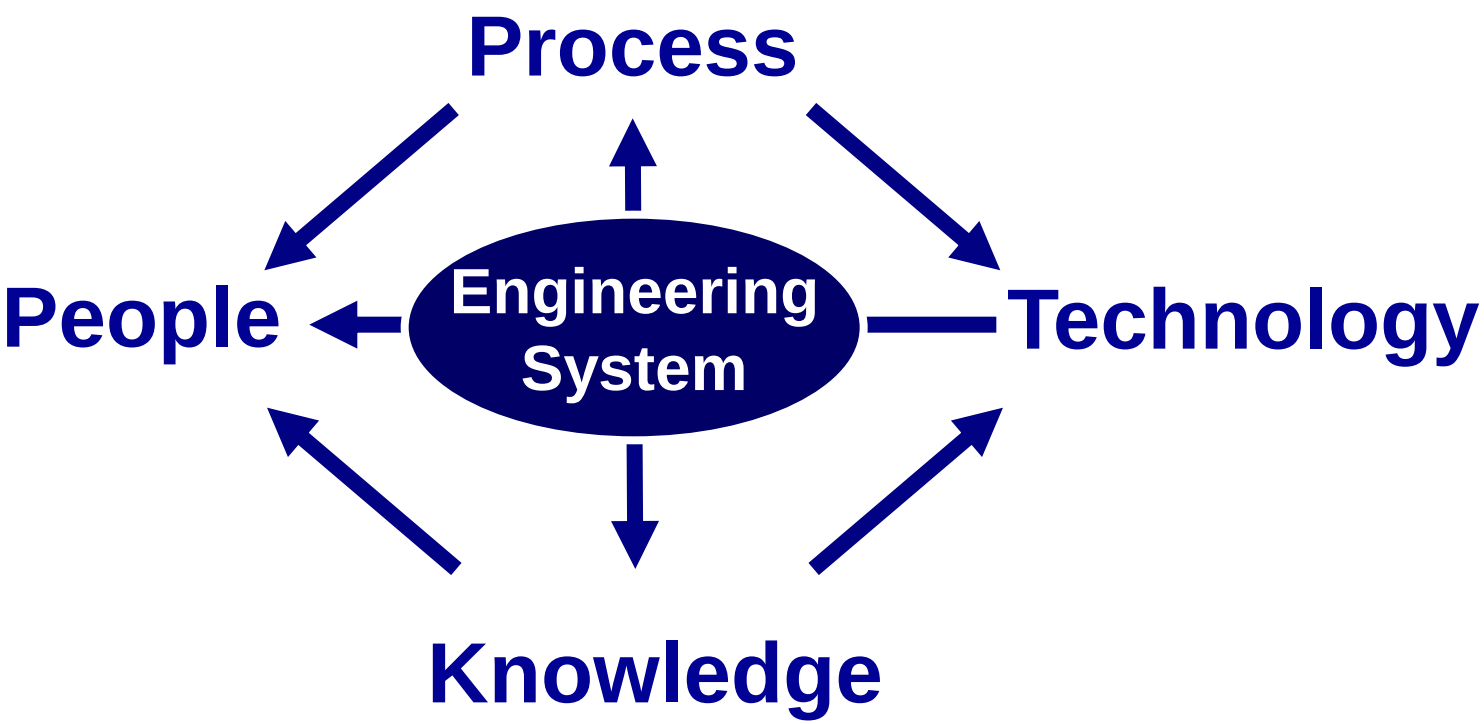
- Engineering system = capability for the development of systems, hardware, or software
- Components:
  - People
  - Process
  - Technology
  - Knowledge
- Interfaces:
  - Internal (among components)
  - External (to stakeholders and customers)

What do these terms mean?

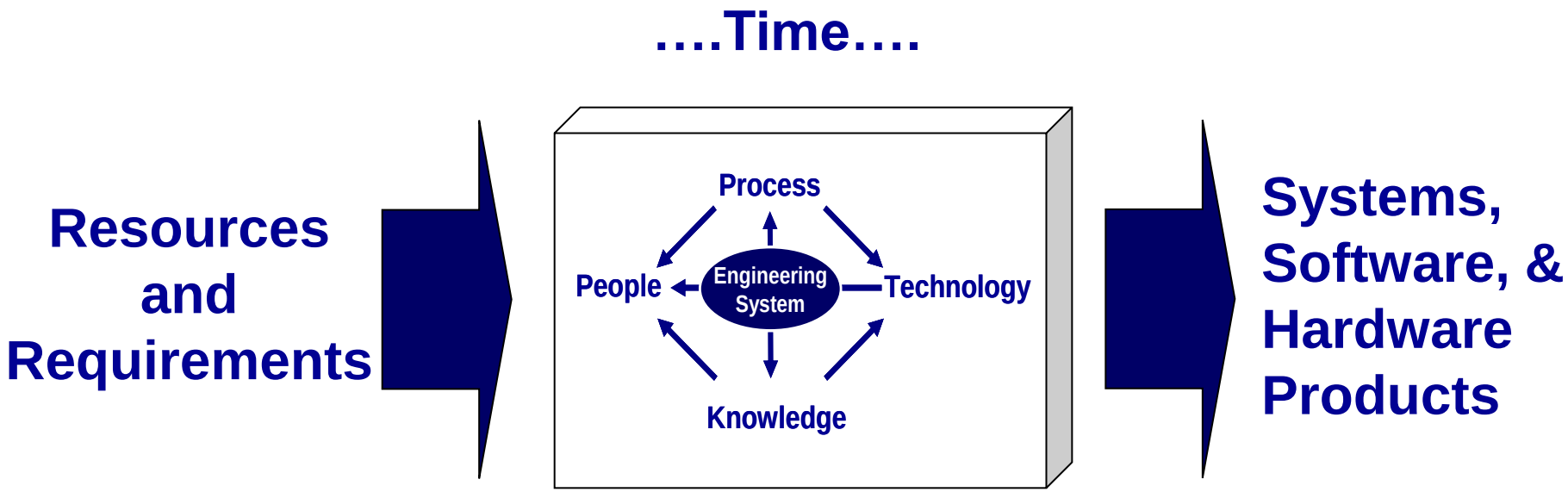
(Components of an engineering system)

- People: the people who are part of the engineering system
  - Engineers
  - Infrastructure support personnel
  - Managers
- Process: the processes used by the people or technology to accomplish the functions of the engineering system
- Technology: the tools and mechanisms of the engineering system
- Knowledge: value-added contextual information necessary to the development and operation of the engineering system

Primary Relationship Diagram



Engineering System Capability



Some Reasonable Questions

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- How do we go about building or improving an engineering system?

Why go to the trouble?

- Clear requirements leading to clear capability
- Ability to make functional trades
- Ability to clearly define, develop, and manage interfaces
- Ability to define and improve performance of the engineering system
- Knowledge and predictability of what it would take to make the engineering system do something new, different, or better
- Ability to make informed investment decisions

Ability to define and improve performance

(of the engineering system)

- Technical Performance Parameters (system level)
  - Throughput
  - Efficiency
  - Productivity
  - Product defect rates
  - Domain migration ability
  - Maintenance cost
  - Availability and reliability
- Configuration Item level
  - Process capability
  - Technology capability
  - Personnel skills and education
  - Knowledge base
- Interface level
  - Ability to carry information
  - Ability to support functional relationships

Predictability of system changes

- Adopting more rigorous or new performance parameters
- Migrating to new domains (producing something different)
- Taking advantage of new technologies
- Migrating to new processes (like the CMMI^{SM})
- Increasing capacity of the engineering system
- Integrating engineering systems for software and hardware
- Configuration management of system

Some Reasonable Questions

- Why would we go to the trouble of looking at engineering capability in this way?
- What is different, unique, or value-added in this approach?
- How do we go about building or improving an engineering system?

Engineering System Development

- Elicit customer and stakeholder needs
- Define requirements
- Allocate and validate requirements
- Design engineering system
- Verify and implement design
- Deploy and transition system or system components

Elicitation of Customer and Stakeholder Needs

- External customer and stakeholder needs
  - Domain requirements
  - Product specification performance impacts
  - Product complexity expectations
  - Customer communications requirements
  - Delivery and transition requirements
- Internal customer and stakeholder needs
  - Business policies and rules
  - System performance goals
  - Infrastructure stakeholder needs

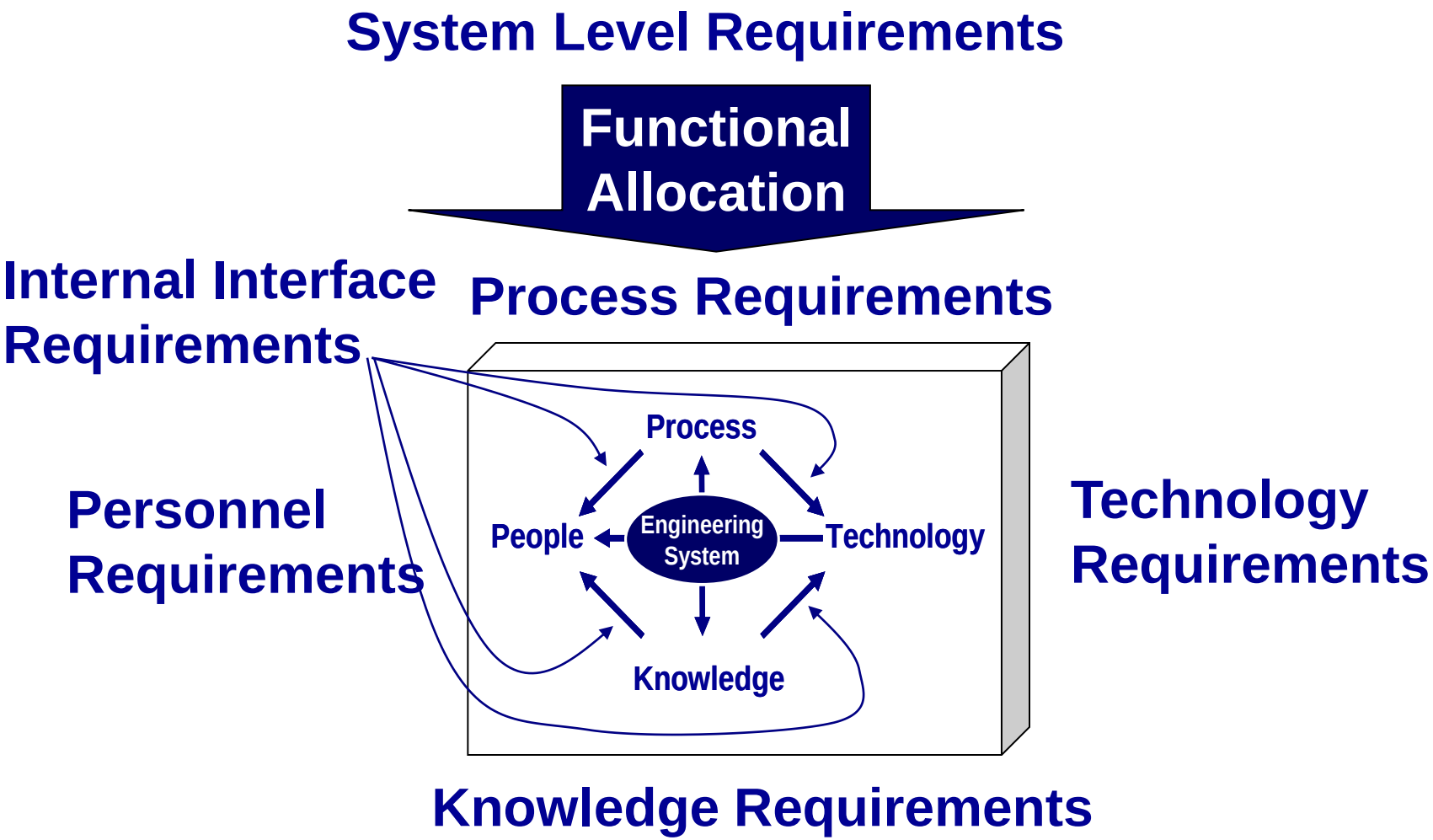
Operational Architecture

Engineering Systems requirements analysis

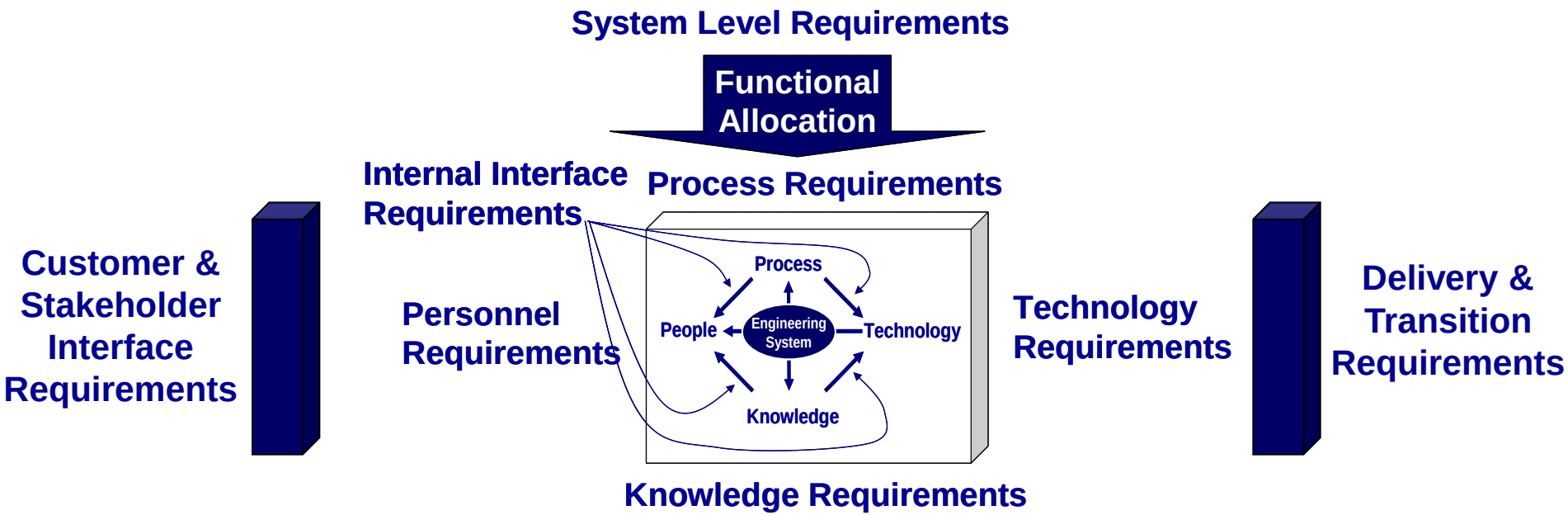
- Functional requirements
  - Program Management capability
  - System, hardware, and software development capability
  - Systems analysis and control capability
  - Domain migration ability
- Performance requirements
  - Throughput, efficiency, and productivity
  - Product defect rate goals
  - Develop system level Technical Performance Measures
- Design constraints
  - CMMI Model Suite requirements
  - Business/ technology domain(s)
  - Project size and complexity (nominal and spread)
  - Business and quality goals
  - State of current engineering culture
  - State of process culture and best practices
- Security and trust requirements
- Availability and Maintainability requirements

Technical Architecture

Requirements allocation for an Engineering System



Requirements allocation for an Engineering System



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Engineering System Design

- Define System Architecture
- Identify and track system technical performance parameters
- Design components and interfaces in response to allocated requirements
  - Process design
  - Technology design
  - Personnel skills and educational criteria
  - Knowledge system design
  - Interface designs

System Architecture

Verify and Implement Design

- Implement Processes
  - Process implementation may be in technology
- Implement Technology
- Implement Knowledge Assets
  - Build knowledge assets over time
  - Build in strategic phases to match system evolution
- Implement People approach
  - Affect hiring, training, job assignment, and knowledge assimilation
- Implement internal and external interfaces
- Continuously verify design integrity

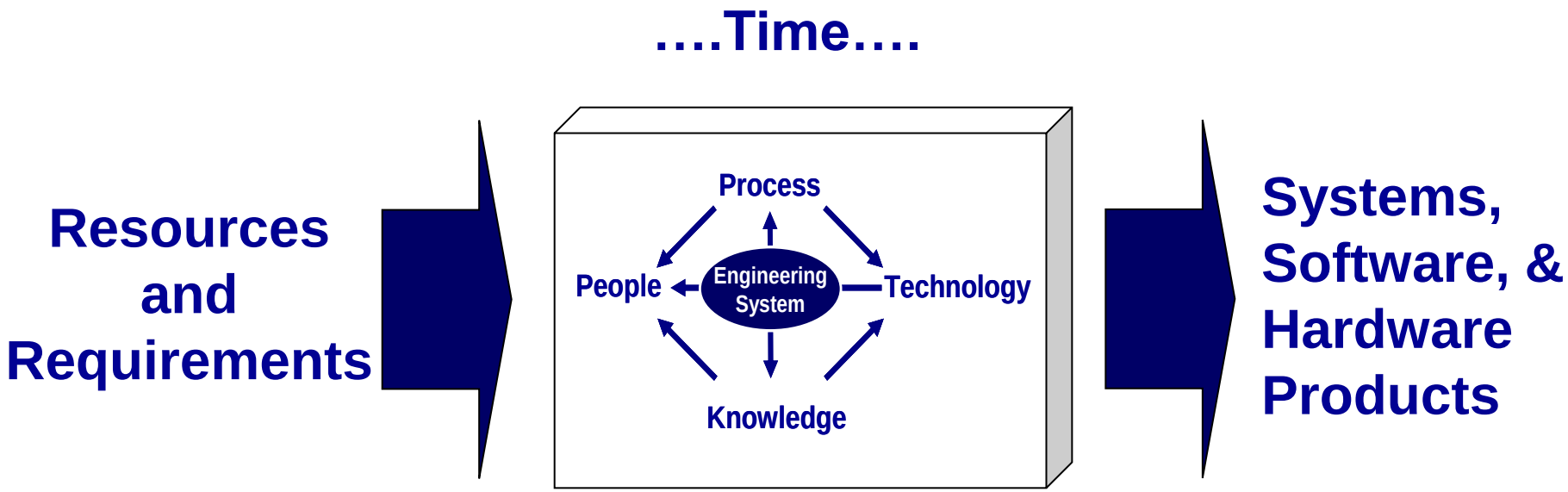
Deploy Engineering System builds

- Ensure Engineering System baselines are internally congruent (design verification and configuration audit)
- Deploy in increments that provide system level capabilities
- Precede deployment with training and knowledge dissemination
- Practice configuration management of components and baseline control of engineering system

Summary

- Introduced the idea that the capability to develop systems, software, or hardware can be treated as an Engineering System
- Provided summary of the systems life cycle for a notional Engineering System
- The Engineering System approach provides the abilities to:
  - Make functional trades among system components
  - Clearly define, develop, and manage interfaces
  - Define and improve performance of the engineering system
  - Predict what it would take to make the engineering system do something new, different, or better
  - Adopt more rigorous or new performance parameters
  - Migrate to new domains (producing something different)
  - Take advantage of new technologies
  - Migrate to new processes (like the CMMI^{SM})
  - Increase capacity of the engineering system
  - Integrate engineering systems for software and hardware
  - Apply configuration management principals to engineering capability

Engineering System Capability



Questions?

BACK UP SLIDES

Requirements Development Slides

Notional Process Requirements

- Satisfy accepted requirements of CMMI Model(s)
- Support development of products in identified technical domains (life cycle)
- Optimize process for predicted project size
- Accommodate alternative project sizes
- Optimize process for predicted project complexity
- Support accomplishment of business and quality goals
- Support transition of engineering, management, and process cultures
- Integrate current best practices and identify appropriate targets for improvement
- Define People and Technology interfaces
- Define interfaces to business infrastructure

Notional Technology Requirements

- Implement processes in a cost effective manner
- Make knowledge accessible in a timely manner in accordance with Knowledge interface requirements
- Integrate Knowledge into technology where appropriate
- Provide appropriate human interfaces to People
- In C4ISR Terminology, define the Technical Architecture
- Define technical interfaces to business infrastructure

Notional Knowledge Requirements

- Define knowledge domains or assets that support and enable process and technology implementation
- Define knowledge creation requirements for future growth and evolution of the business base
- Provide Knowledge Integration and Knowledge Access requirements to Process, Technology, and People

Notional People Requirements

- Define skill sets that take advantage of Knowledge assets, Technology, and Process
- Define appropriate educational requirements
- Define Knowledge that must be assimilated as a function of job execution
- Define interface requirements for Process, Technology, and Knowledge
- Define interfaces to Human Resources

Design Slides

Notional Process Design

- Design the Process Architecture
  - Primary processes
  - Process relationships
  - Process fidelity
- Define interface to the Technology Architecture
- Define tailoring approach and criteria
- Define structure of standard process(es)
- Define component processes and internal interfaces

Notional Technology Design

- In C4ISR Architecture Framework terminology, implement the Technical Architecture and allocated portion of System Architecture
- Design process implementation
- Design the interface to existing and future business systems
- Design the interfaces to existing and future product design and implementation systems
- Design the interfaces to Knowledge assets
- Design the interfaces to People

Notional Design of Knowledge Assets

- Design the Knowledge Architecture
- Design knowledge gathering and creation functions
- Design knowledge assimilation functions
- Design knowledge assessment functions
- Design interfaces to Process assets, Technology base, and People

Notional Design of People Assets

- Match target skills and education to job functions
- Match job functions to processes, technology, and knowledge assets
- Design interfaces to processes, technology, and knowledge assets
- Design interfaces to Human Resources functions
- Design risk mitigation approach to mis-match of skill and educational sets with job functions