

Session 3.0

SE/Systems Principles



Systems Principles

- **The purpose for identifying systems principles is to have a sound basis for application**
- **These principles are helpful to apply to SMC work since we work systems at many levels**
- **Four Systems Principles have been identified , ... but there may be other principles**
- **Each systems principle carries a specific implication when adapted to each Government Team member's job**

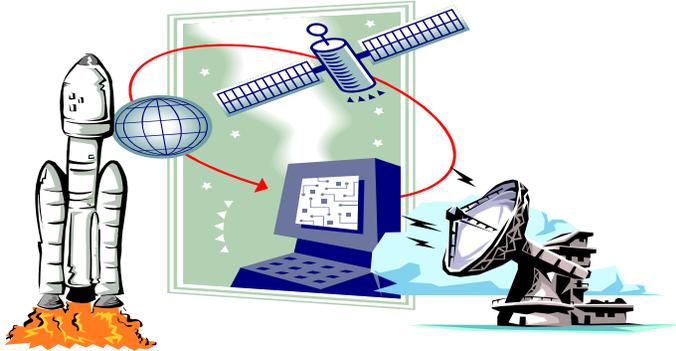


4 Systems Principles

- | | |
|---|---|
| 1 | • Every system is/yields a product supplied to a customer |
| 2 | • Every system has boundaries and elements external to it |
| 3 | • Complex systems require disciplined and communicable methodologies |
| 4 | • Every set of system objectives must be compatible with the the bigger environment of which it is a part |



A Product Can Be



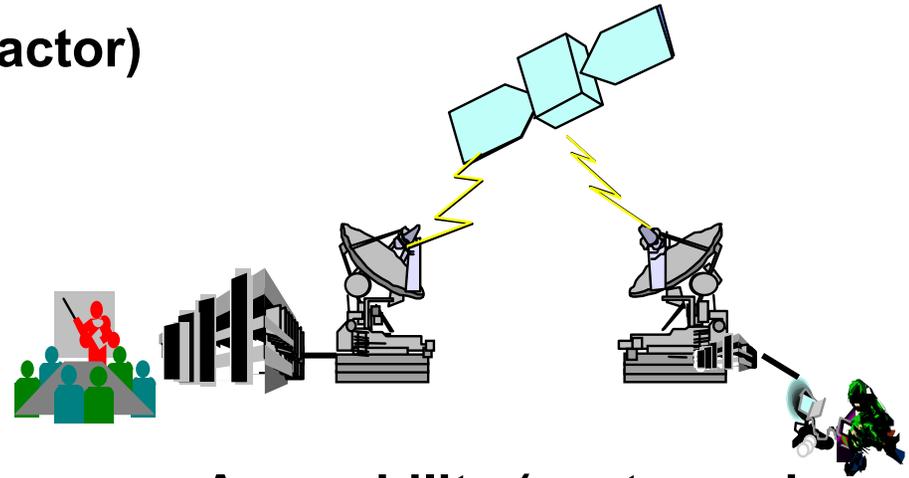
**A hardware/software system
(customer is SMC, supplier is a contractor)**



**A decision
(e.g. contract award)**



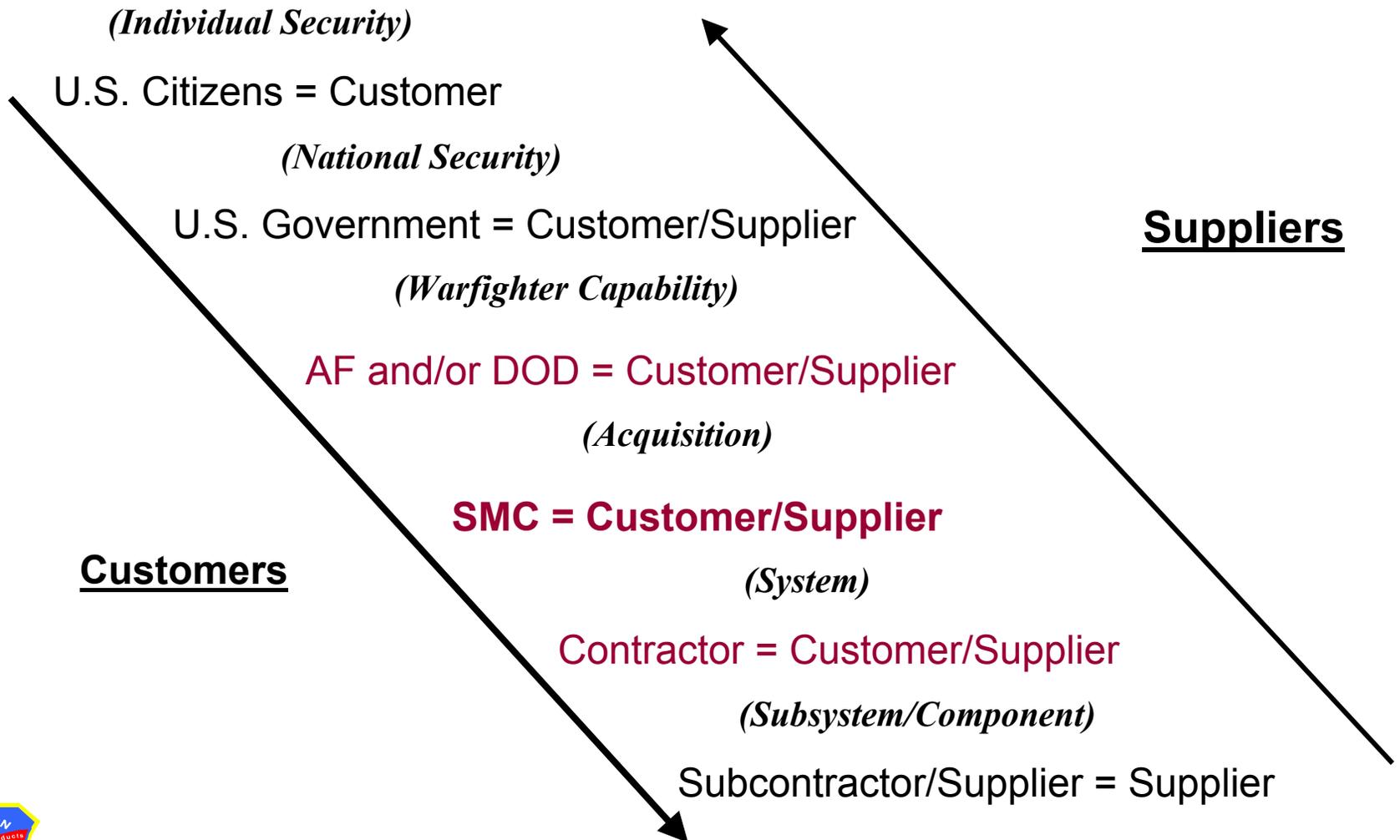
**A document (e.g. System
Requirements Document)**



**A capability (customer is
DoD, supplier is SMC)**



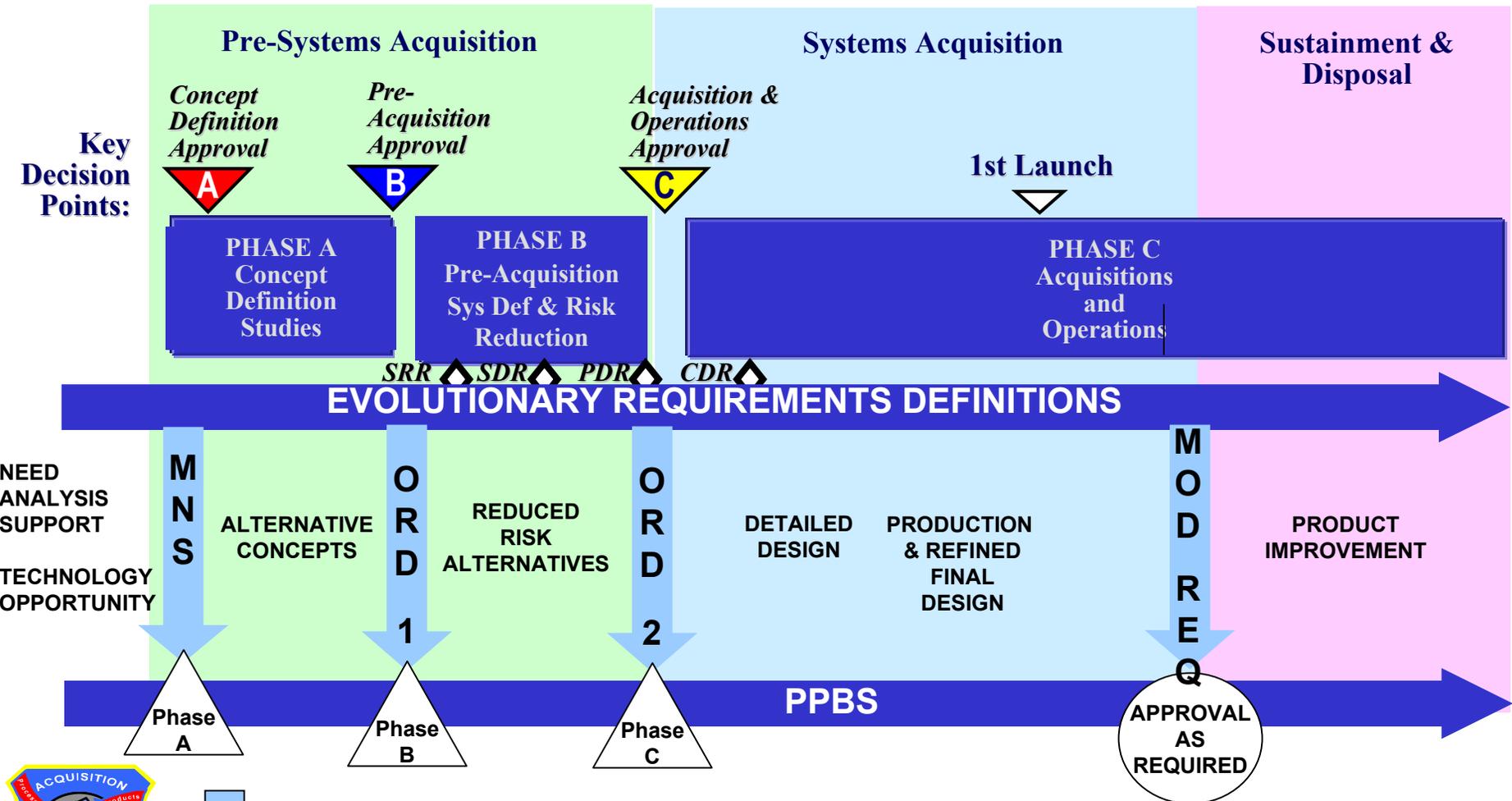
Customer- Supplier Relationships Drive the Application of SE



AFSPC- SMC

“Customer-Supplier”

Draft USECAF Space Acq Policy 02-1

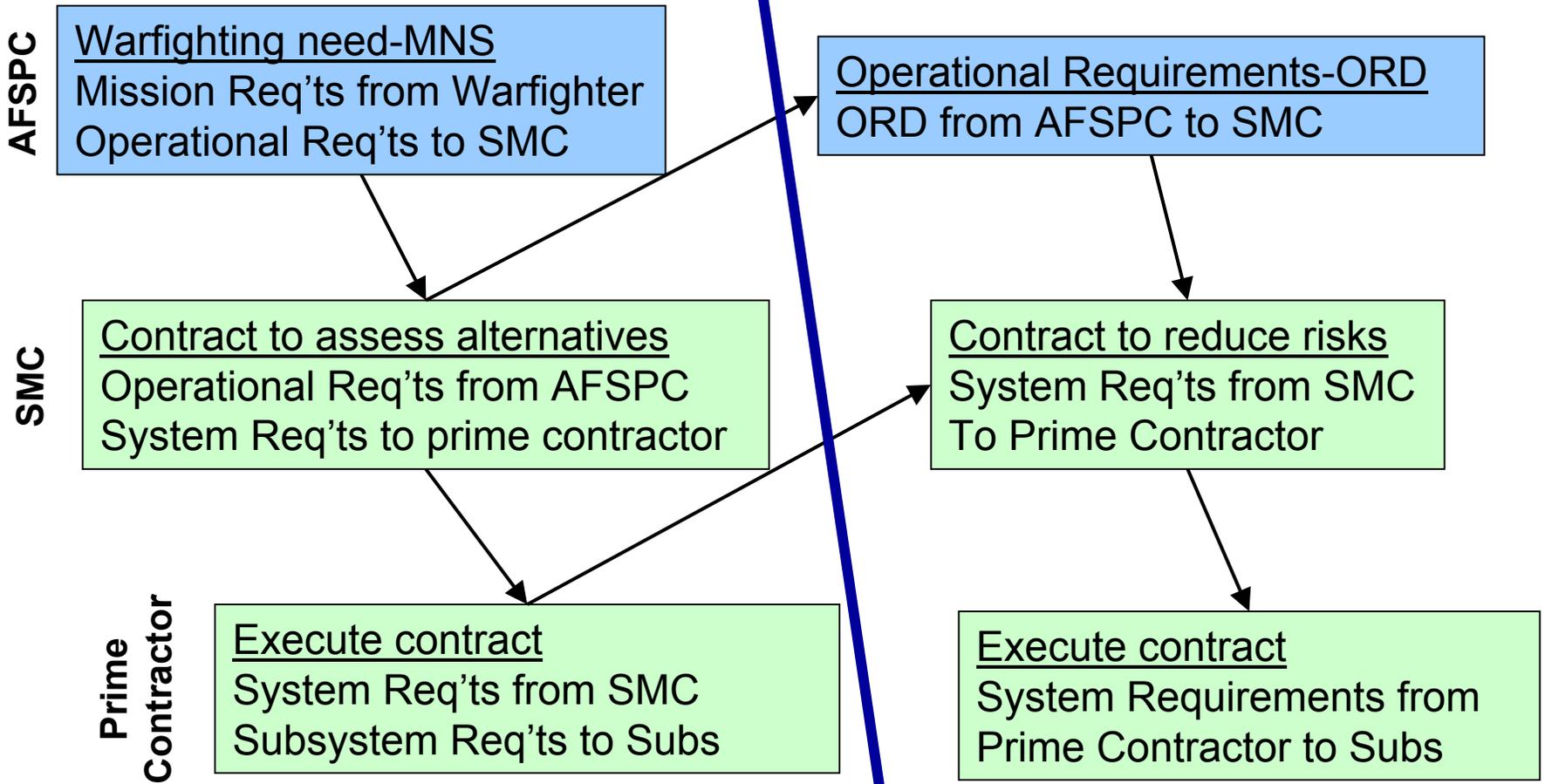


- Responsibility of AF/DoD/AFSPC
- Responsibility of SMC and any contractor



AFSPC- SMC-Prime Contractor “Customer-Supplier” Products

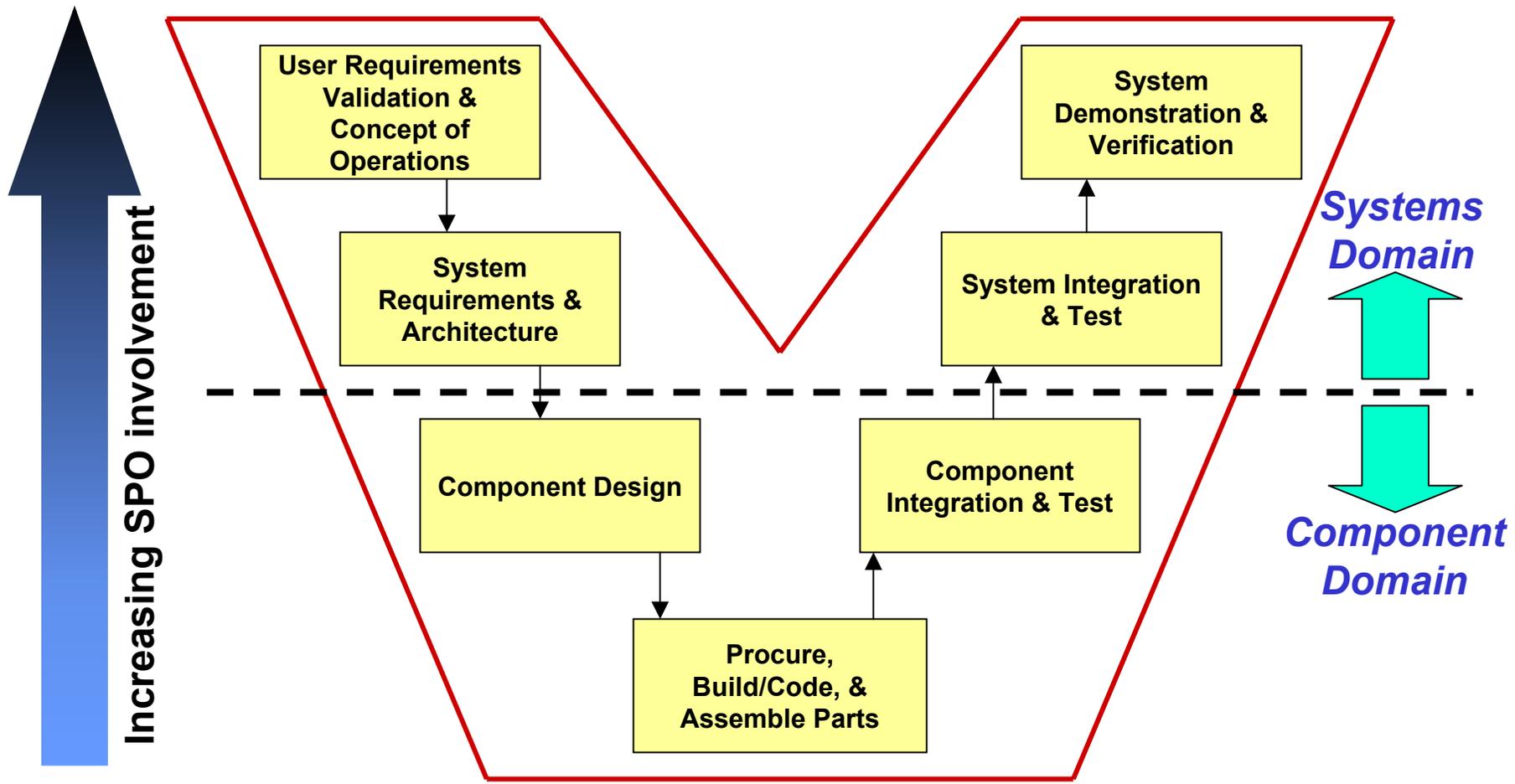
Phase B Key Decision Point



Sequential Activities within an organization



SMC-Contractor Customer-Supplier



“Vee” Model of System Development

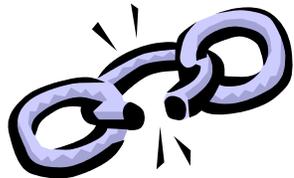


Principle 1: Every System is/yields a Product Supplied to a Customer



Consequences of Ignoring this Principle

- Disconnects in requirements flow down
- Inability to verify the requirements were met
- Proceed with work ... going at risk!
- Unplanned delays in arriving at a stable, executable program



Implications for YOU

- Continuously check requirement flow and verification up/down the C/S chain
 - Ensure quality, consistency and **completeness** (yours and your contractors')
- Agree on the documentation needed (up and down the C/S chain)
 - Their contents and their approval
 - Conditions under which they might change
- Ensure your “ultimate” customer approves of the system
 - Continually ask along the way ... “are we all on track here”?



4 Systems Principles Identified

- | | |
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| 1 | • Every system is/yields a product supplied to a customer |
| 2 | • Every system has boundaries and elements external to it |
| 3 | • Complex systems require disciplined and communicable methodologies |
| 4 | • Every set of system objectives must be compatible with the the bigger environment of which it is a part |



Principle 2: Every System has Boundaries and Elements External to it

The Definition of (“System”)

- **General¹**
 - A set of different elements so connected or related as to perform a unique function not performable by the elements alone
- **Industry**
 - The end product requested by the customer
- **SMC “Working Definition”**
 - The **space system** end product(s) needed, required, budgeted, designed, developed, and delivered

¹Rechtin, E., Systems Architecting, 1991



Constructing Your View of the System

- **What is in your system?** (Hint: look at paper, people, decisions, deliverables, etc.)
- **What is the environment of your system?** (Hint: you are influenced by them but you have no control over them)
- **What are the internal processes?** (Hint: What do you and the people you work with do during the day?)
- **What are the products?** (Hint: What do you produce that ends up part of the system?)
- **Who is the customer for the system?** (Hint: who controls the money or wants your product?)
- **Who is the supplier for the system?** (Hint: who gets the money or the tasking to supply a product?)
- **What is the next bigger system containing your system?** (Hint: same as defining your system above, may be your customer's system)





Principle 2: Every system has boundaries and elements external to it



Consequences of Not Having a Clear System Boundaries

- **Can't effectively plan an acquisition or contract a "fuzzy" system**
 - confused roles and responsibilities inability to implement them ...
 - Can't develop a stable approach
- **Incomplete systems picture**
- **Duplication of efforts**

Implication for YOU ...

- **Know all the elements that define your system**
 - Boundaries
 - Inputs, Outputs, Processes
 - Associated information and support systems
- **Define total team roles/responsibilities with respect to the system**
- **Know the elements external to the system that can influence your system.**
- **Understand how the system satisfies mission needs, operational, system, and contractual requirements**

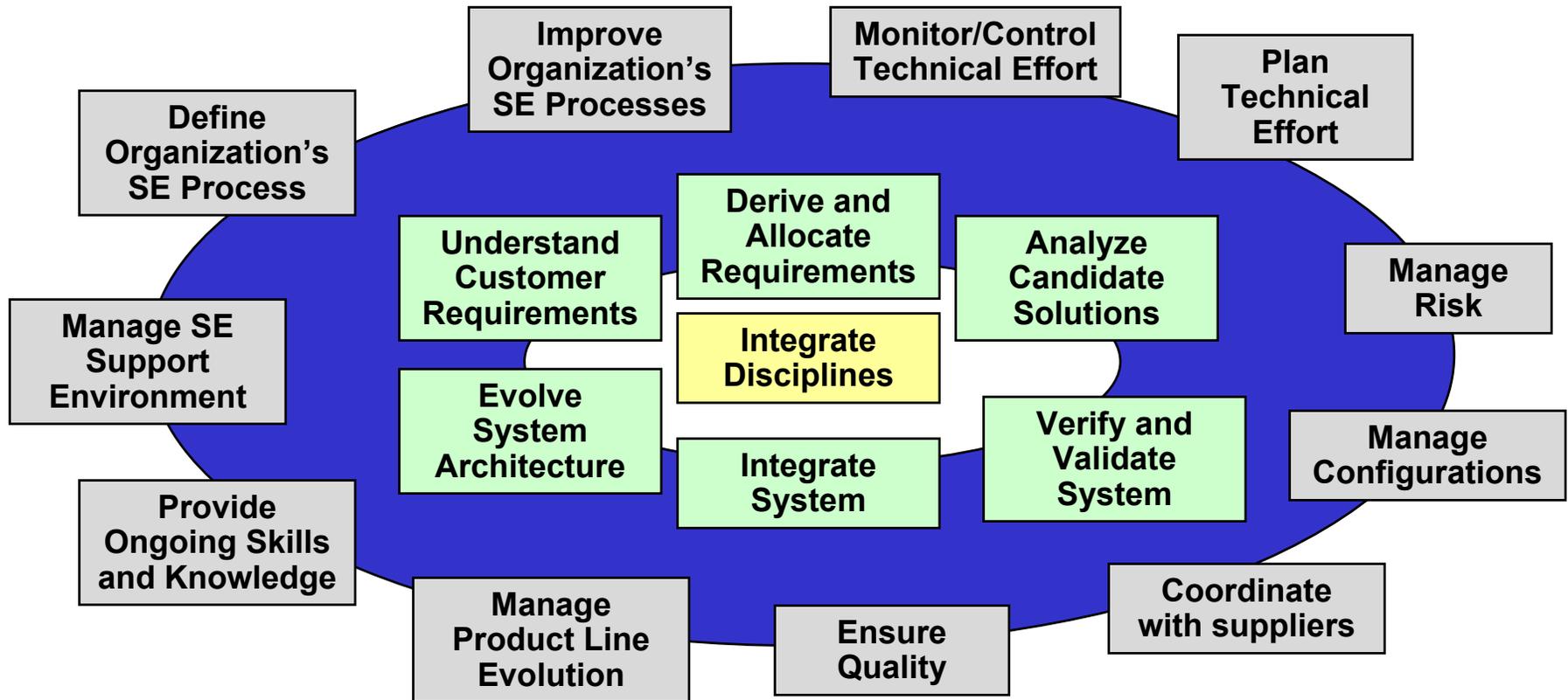


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A View of SE-Complexity

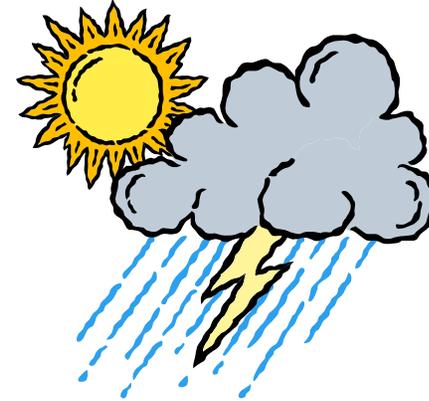
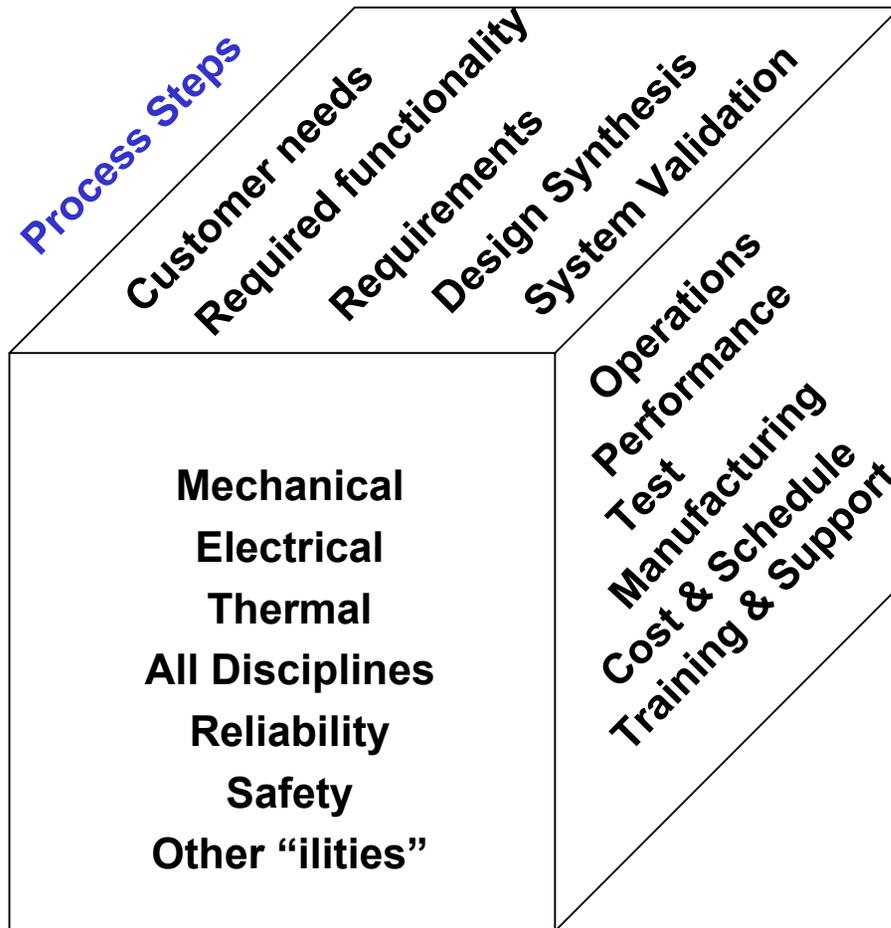


Look at the process areas on each ring.

We must understand which Process Area applies to what specific part of the the system and it's life cycle, and what organization is responsible for working each Process Area



The High Complexity of Systems



Environment

The practice of SE is multi-dimensional



Principle 3: Complex Systems Require Disciplined and Communicable Methodologies



Consequences of Ignoring this Principle

- Unstable baselines – acquisition, people, performance, requirements, cost, schedule, agreements, etc.
- Can't balance the competing requirements
- Lots of confusion and lack of credibility of results



Implications for YOU



- Apply sound SE processes consistently
 - Avoid expedient shortcuts
- Accept alternative SE process implementations
 - Principles shouldn't change
- Used disciplined and communicable methods
 - You
 - Total team

Deal with System Complexity in a Disciplined Way

For your responsibilities know:

- **System definition**
 - System Spec, MNS, ORD, Conops, etc.
- **Approval Authorities**
 - E.g., CC, PEO, DAB, DSAB
- **Reviews**
 - IBR, PDR, CDR, etc.
- **Documents: program and system**
 - IPS, SAMP, Contract, etc.
- **Processes**
 - Requirements, Test, Risk, Change control, EVM, etc.
- **Information**
 - Deliverables, trends, metrics, etc.
- **Analysis techniques**
 - Models, simulations, etc.

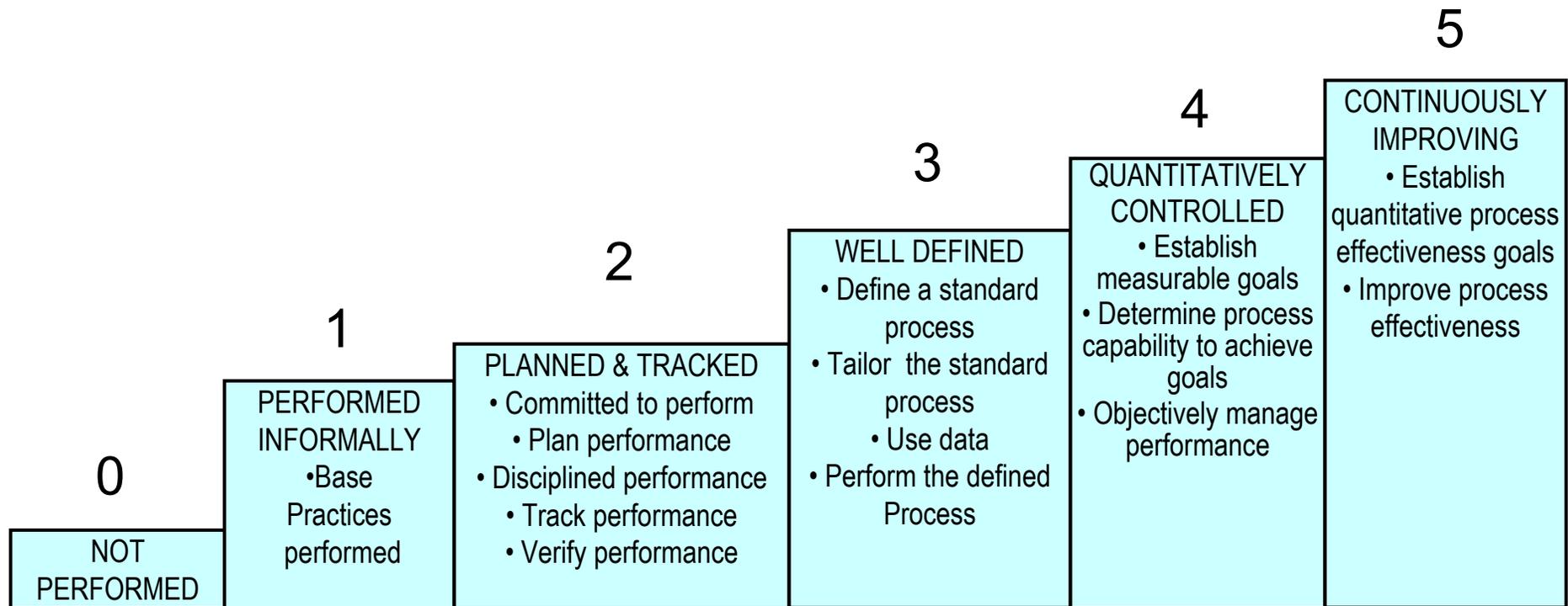
For your responsibilities do:

- **Identify all the items that apply to your assignment**
 - They aren't handed to you, they need to be found
 - Use references to tools and methodologies, like CMMI, or an SE "Engine" definition to identify areas of concern/focus
- **Ensure they are integrated to provide the right product**
 - Take responsibility to keep them aligned
- **Integrate them in a systematic way to track them**
 - Be able to status their maturity
- **Set up your own means to assess them**
 - Identify the circumstances where you need to take action
- **Take action when needed**



Deal with System Complexity in a Disciplined Way

References to Tools and Methods Can Help You Identify a Path to Improve the Discipline



The Carnegie-Mellon Capability Maturity Model Integration (CMMI)* is a reference that can be used to assess organizational SE capability

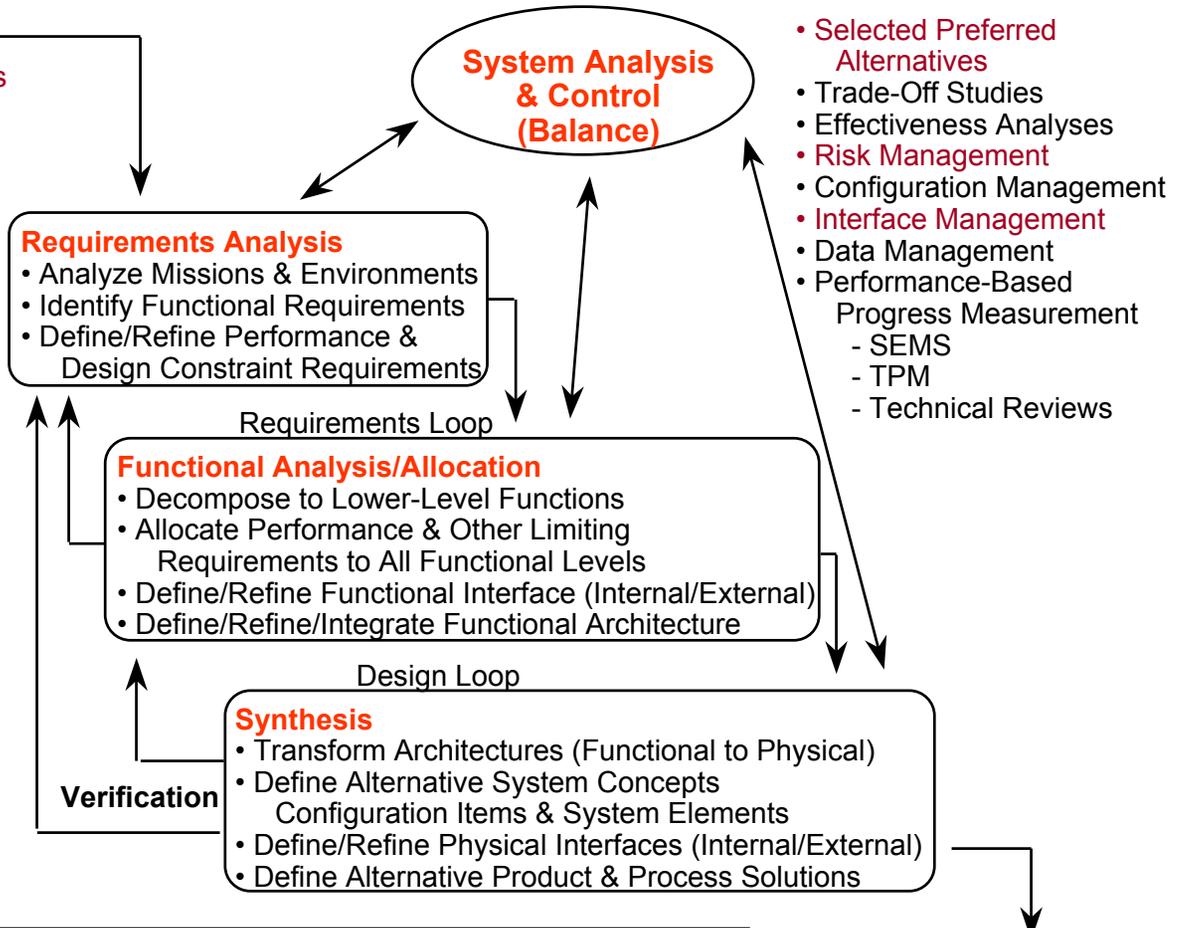


Deal with System Complexity in a Disciplined Way

References, like the SE Engine*, Help Identify Areas of Concern/Focus

PROCESS INPUT

- Customer Needs/Objectives/Requirements
 - Missions
 - Measures of Effectiveness
 - Environments
 - Constraints
- Technology Base
- Prior Outputs
- Program Decision Requirements
- Requirements From Tailored Specifications and Standards



*“SE Engine” from MIL-STD 499B.

MIL-STD-499B was never officially released,
a casualty of Specs and Standards Reform
It still contains a lot of wisdom, as do most Mil Stds

PROCESS OUTPUT

- Decision Data Base
 - Decision Support Data
 - System Functional & Physical Architecture
 - Specification & Baselines
- Balanced System Solutions

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Principle 4: Every set of System Objectives must be Compatible with the the Bigger Environment of which it is a Part

Use the System and Program Objectives, yours and your customer's to select an executable and stable acquisition approach

Potential Program and System Objectives (What)

- **Field some capability quickly**
 - Shake out user requirements
 - Learn how to use the system
- **Field modular system and add capabilities**
 - Pre-planned improvements
 - Un-planned improvements
- **Field “all capable” single system**
 - vs. many “less capable” systems
- **Redundancy**
- **Failure modes**
 - Safe, semi-operational

Acquisition Approaches (How)

- **Prototypes, Demo's, LRIP***
- **Current Acquisition Paradigms**
 - Waterfall
 - Evolutionary Acquisition
 - Spiral Development
- **New Acquisition Paradigms**
 - Capability based
 - Effects based
 - Simulation based
 - Agile acquisition



*Low rate initial production

Principle 4: Every Set of System Objectives Must Be Compatible With the the Bigger Environment of Which It Is a Part

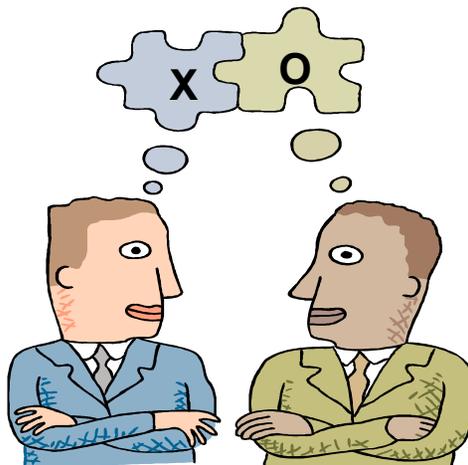


Consequences of Ignoring this Principle

- Acquisition rework, termination, or a deficient product
- Un-executable objectives, agreements, or contracts
- Customer-supplier due to misunderstandings related to the “bigger” environment

Implications for YOU

- Plan for changes driven by the external environment
- Achieve EARLY customer-supplier acceptance of system objectives
- Ensure executability - adequate SE at all customer-supplier levels
- Understand your customer’s customer and your supplier’s supplier



Points to Remember for Systems Principles



- **We've provided 4 Systems Principles**
 1. Every system is/yields a product supplied to a customer
 - Clarify your products
 2. Every system has boundaries and elements external to it
 - Know your systems, what's inside and outside
 3. Complex systems require disciplined and communicable methodologies
 - Otherwise there is chaos and the program is unmanageable
 4. Every set of system objectives must be compatible with the the bigger environment of which it is a part
 - Don't forget your customer's customer

- **The Systems Principles can help you manage **your work product** within a systems context**
 - If used to, they contribute to a system accepted by the customer
 - There are implications if they are not used or ignored
 - Application requires action on your part
 - References to tools and methods exist to assist you

