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DEFINING THE FUTURE

The Challenge…

Going Beyond Systems Engineering

SI4000 Systems Engineering Seminar

Tom Williams
Sector Vice President, Program Integration
Integrated Systems Sector

What's Wanted – *"Major Concerns"*

- **On Time Delivery**
- **Within Budget**
- **High Reliability (Missions Success)**
- **Meet War Fighters' Needs**
- **Agile, Credible, Spiral Capable Development**

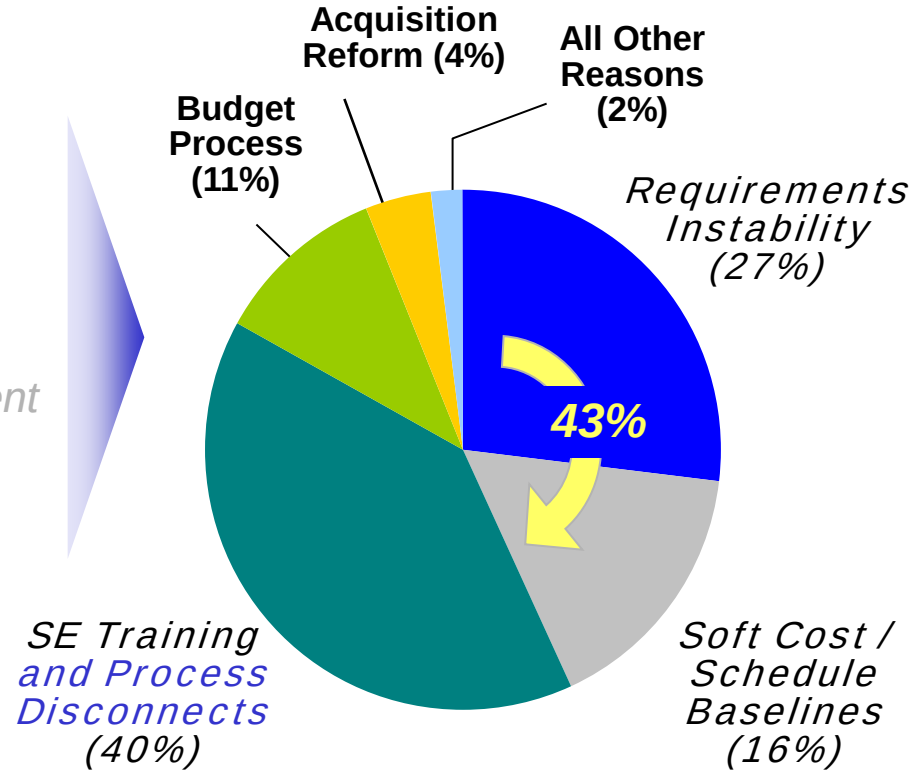
Deliver What Is Promised, When Promised!

Recent USAF ACAT-1C/D Program Experience

Actual Cost/Schedule vs Negotiated Contract

- 36% Cost Over-Runs
- 2 Year Schedule Increase
- ***2% Cost Over-Run When Compared to** the Cost Assessment Improvement Group **(CAIG) Estimate***

Development Growth Cause(s)



Source: *Space Systems Development Cost Growth Analysis* Conducted by Booz-Allen-Hamilton (83 Surveys of 67 Organizations)

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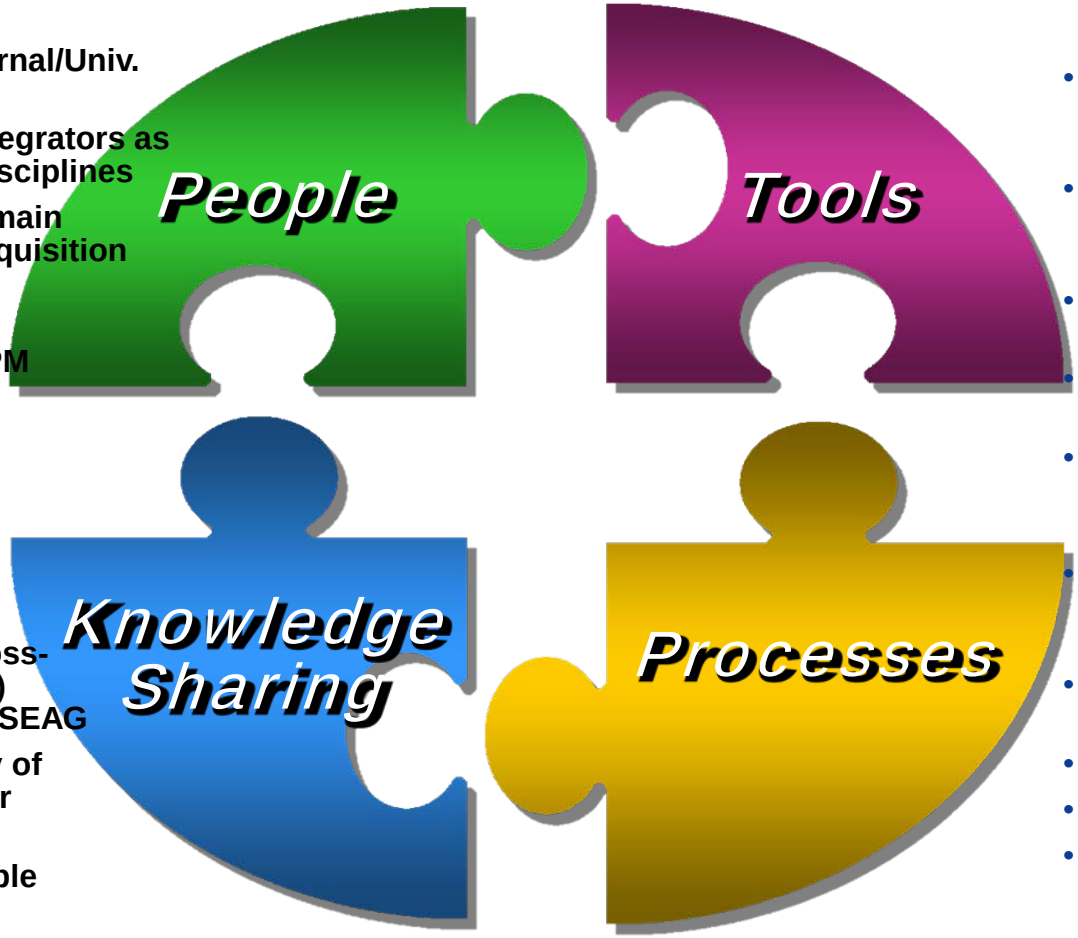
Enhancing Program Performance

- Program Manager SE Training
- SE/SI Training (Internal / External/Univ. Affiliations)
- Architects / Integrators as Recognized Disciplines
- Accelerate Domain Knowledge Acquisition
- Strengthening Material / Procurement PM Talent Pool



- Integrate Intermediate SE Work Products into End-to-End Business Systems (ERP Systems)
- *Willoughby-Like Program / Product / Process Templates*
- Integrated Analysis and Synthesis Tools (Early Simulation)
- Program Health Visibility Systems
- Enhanced Risk Mgmt Tools
- Extend Unified Modeling Language Tools to SE

- Corporate (Cross-Business Area) SE Councils – SEAG
- SE Community of Practice & User Groups
- People-to-People Contact Tools
- Embedding Processes/Knowledge in "Closed Loop" Workflows

- Cross-Program Peer Reviews Using Domain Experts
- SE Products Precede Downstream Design
- *CMMI (SW/SE/IPPD/SS)*
- Lean / 6σ
- Non-Advocate Reviews (NAR) / Independent Cost Evaluations (ICE) Prior to Proposal Submittals

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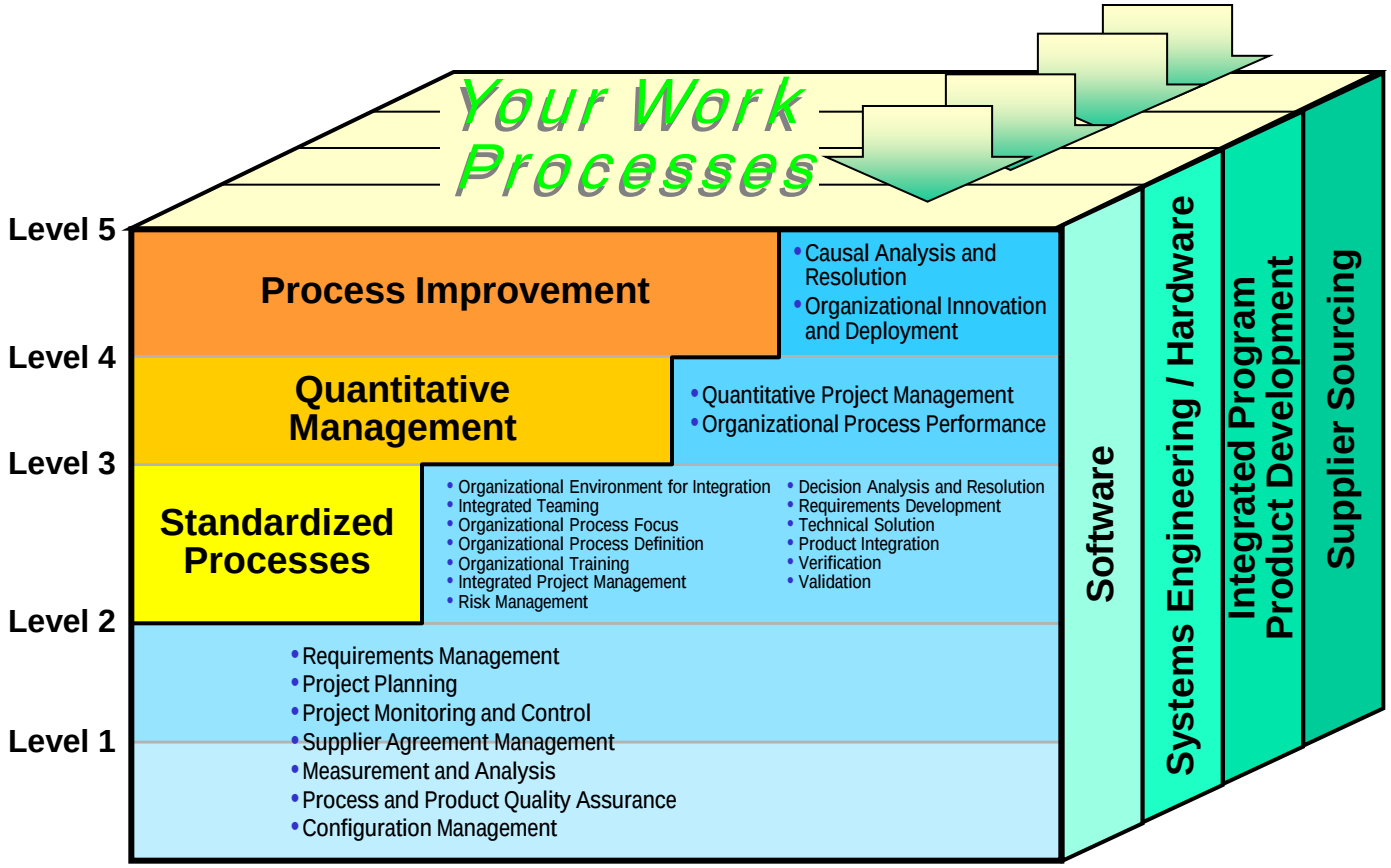
Capability Maturity Model "Integration" – *CMMI* ®



Four Discipline Models Address Different Parts of the Business

- *Provides Architecture for Linking/Integrating of Processes*
- *Provides a Measurement/Assessment Approach*
- *Does NOT Assess "Goodness" of the Processes Being Used or Number of Processes Under Control*

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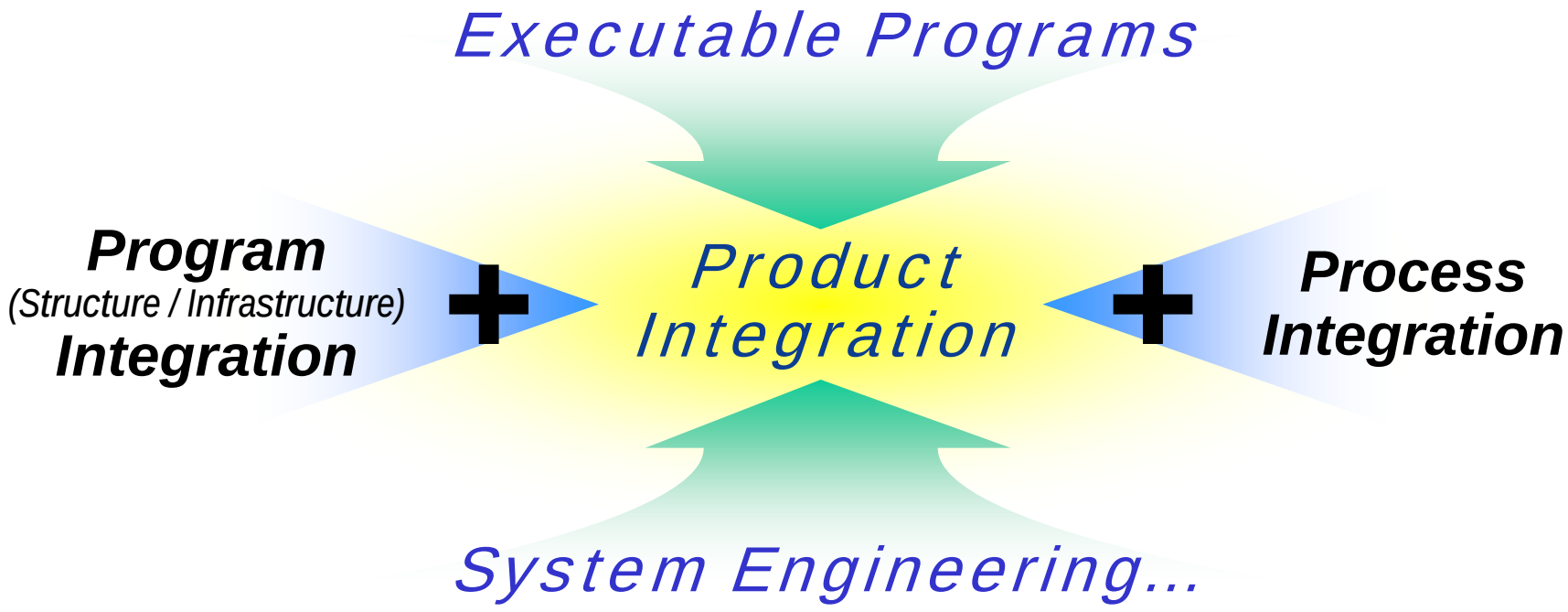
Expanding Our Focus



….Involves Structured Requirements Analysis Allocation and Design Syntehsis (Hierarchical Product Decomposition) DRM Associates

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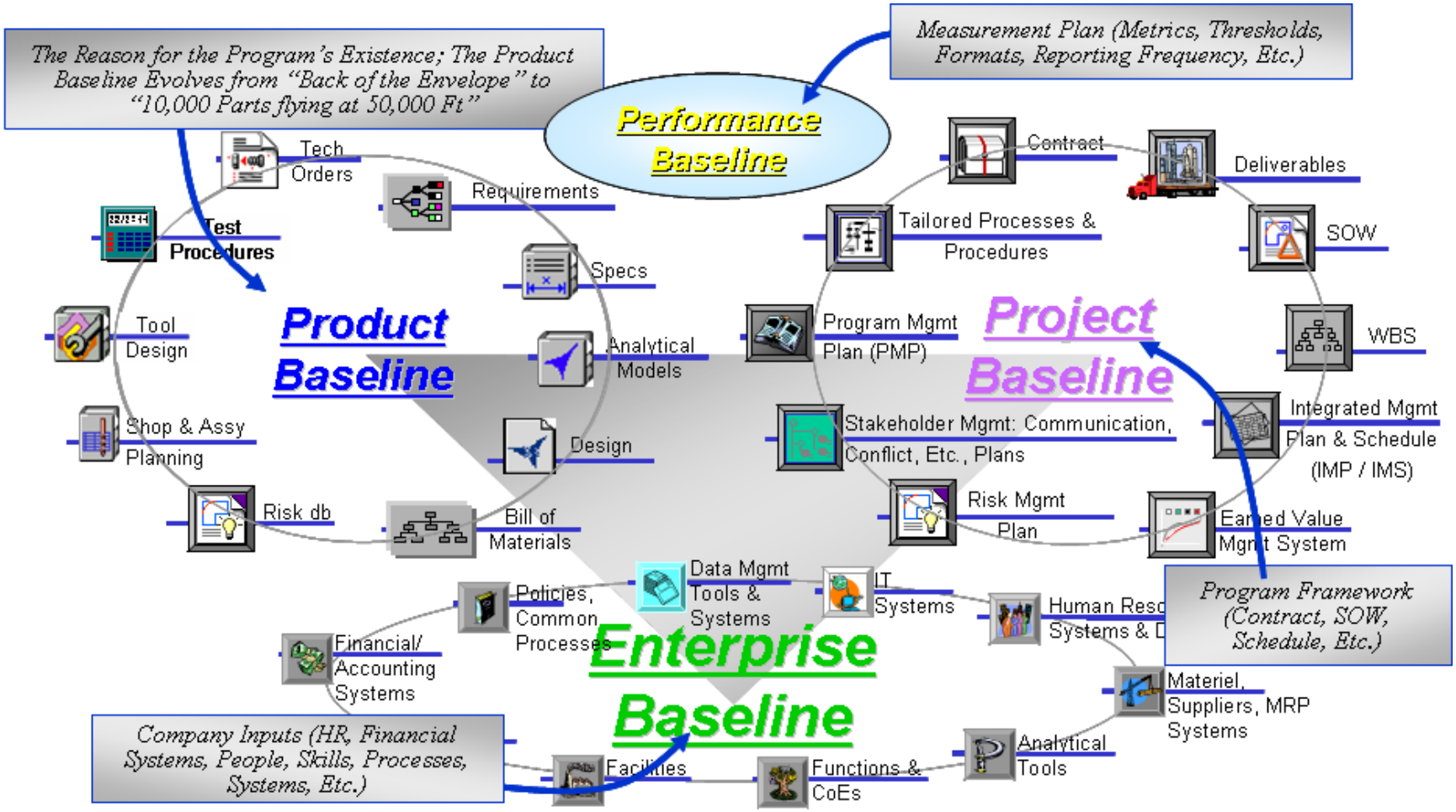
Going Beyond the "Product"



Manage and Integrate ALL Baselines

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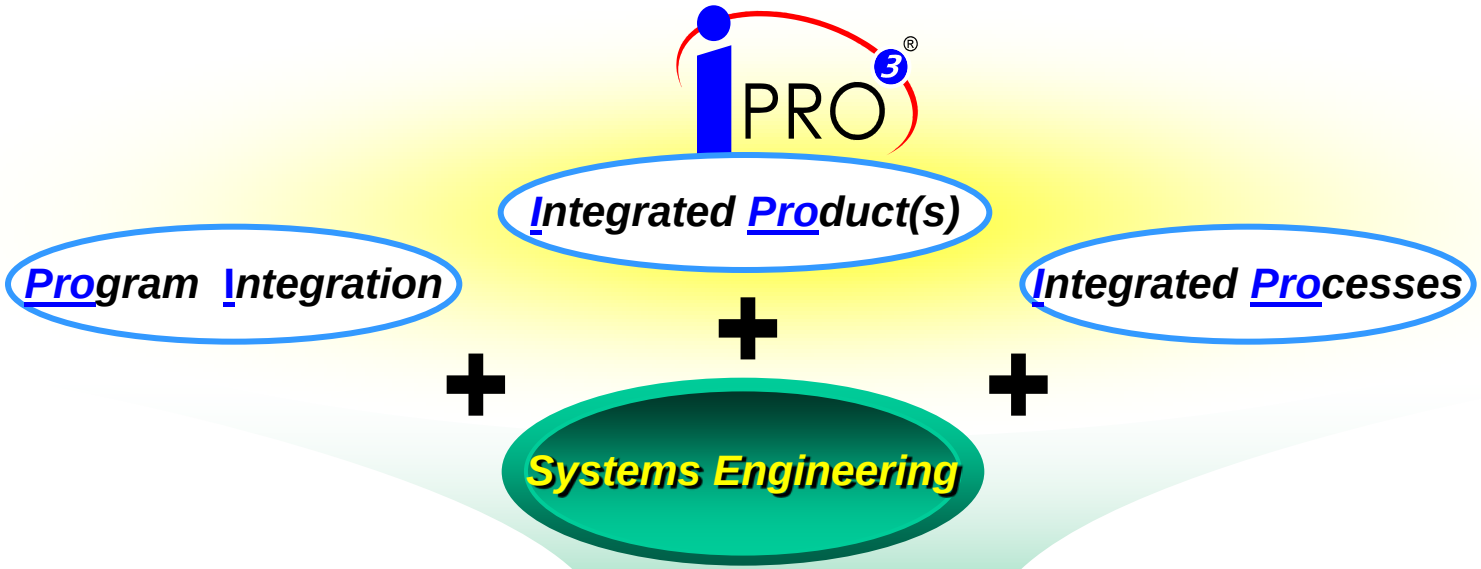
One Approach…



Executability Templates

- ***"Expert System"* Tailored to:**
  - Program Life Cycle
  - Program Size and Complexity
- **Similar in Format to Willoughby Templates**
  - Leverages Past Company/Industry Experience and Best Practices

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How Do You Measure Good Systems Engineering?

The Number of Successful Programs

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What Is System Engineering?

IEEE 1220:

An Interdisciplinary Collaborative Approach to Derive, Evolve, and Verify a Life Cycle Balanced System Solution that Satisfies Customer Expectations and Meets Public Acceptability

Mil-Std 499B:

An Interdisciplinary Approach Encompassing the Entire Technical Effort to Evolve and Verify an Integrated and Life-cycle Balanced set of system People, Product and Process Solutions that Satisfy Customer Needs

EIA/632 EIA 620 ISO/IEC 15288

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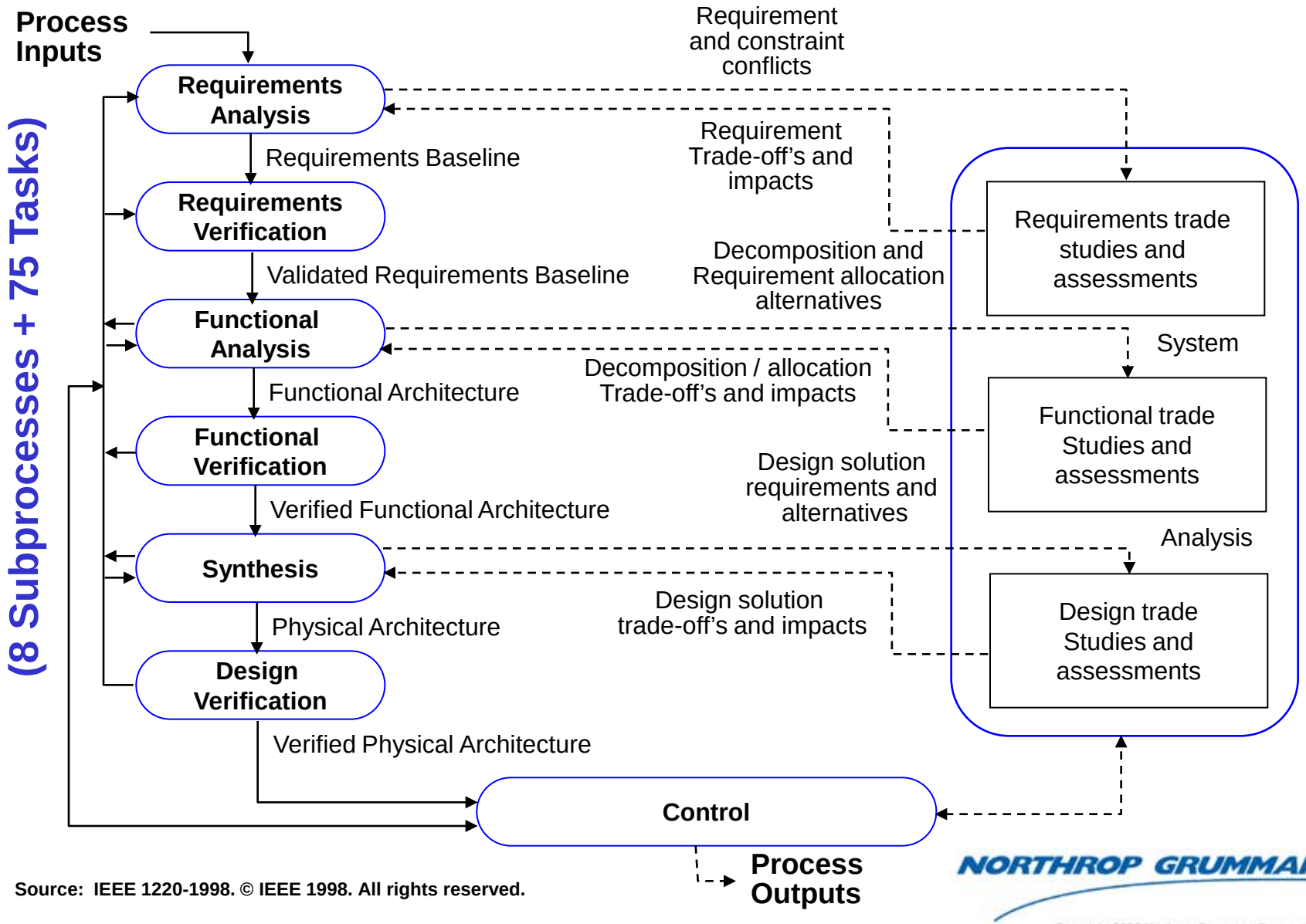
System Engineering Process



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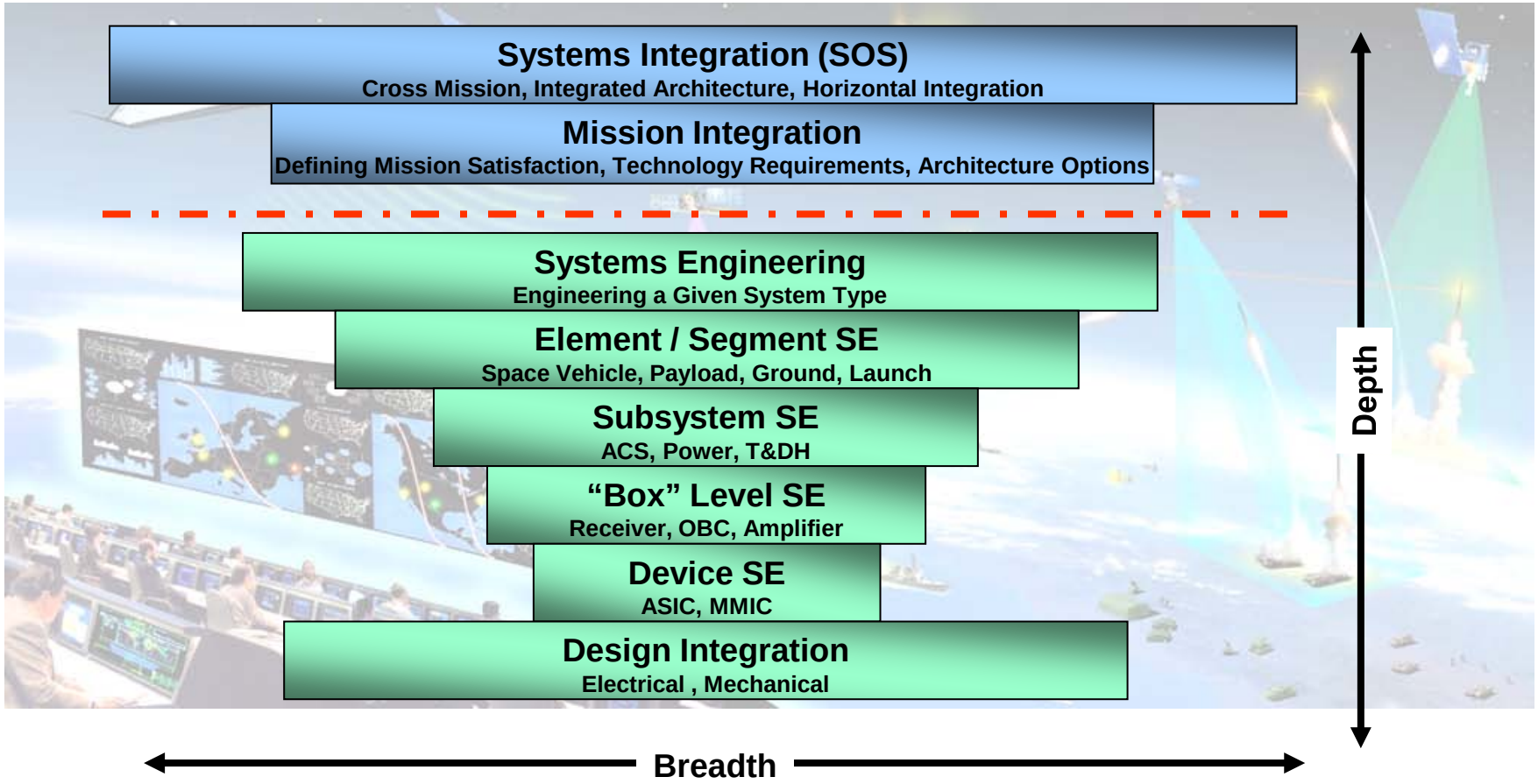
Is SE Training Enough?



Domain Expertise + Systems Engineering/Integration Expertise

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System(s) Complexity

- Net Ready
- Interoperable
- Spiral Capable

⋮

System(s) Complexity

- Net Ready
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- ⋮

- **Program Dependencies on Other GFP/GFE**

System(s) Complexity

- Net Ready
- Interoperable
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- Program Dependencies on Other GFP/GFE

- **Acquisition Approaches Which Drive Increased Concurrence and Number of Contract Elements**

System(s) Complexity

- Net Ready
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- Program Dependencies on Other GFP/GFE

- Acquisition Approaches Which Drive Increased Concurrence and Number of Contract Elements

- **Dominant Portion of Development Content and Occurs at the Suppliers**

System(s) Complexity

- Net Ready
- Interoperable
- Spiral Capable

- Program Dependencies on Other GFP/GFE

Systems Engineering Domain

- Acquisition Approaches Which Drive Increased Concurrence and Number of Contract Elements

- Dominant Portion of Development Content and Occurs at the Suppliers

Impact on the Cost of Integration?

(Mil Handbook 881)

Why Do Programs Get into Trouble?

"Best Value" Selection

DAU Training

SEPs

Budget to CAIG Should Cost Levels

SE Weighting in Source Selection Process

Back Loaded Award Fee Structures

Contract Go-Ahead

Strategy / Program Development → Sell / Propose → Negotiate Contract → Execute Program

SRR

- Requirements
- Unknowns
- Baselines

Competition **Desire to Win Can Drive Cost at the Expense of Program *Executability***

Cost and SOW Risk *Balance* Can be Unknowingly Changed

Lack of Breadth of Knowledge, Experience Tools and/or Capability

"Built Broke" → *"Negotiated Broke"* → *"Execution Problems"*

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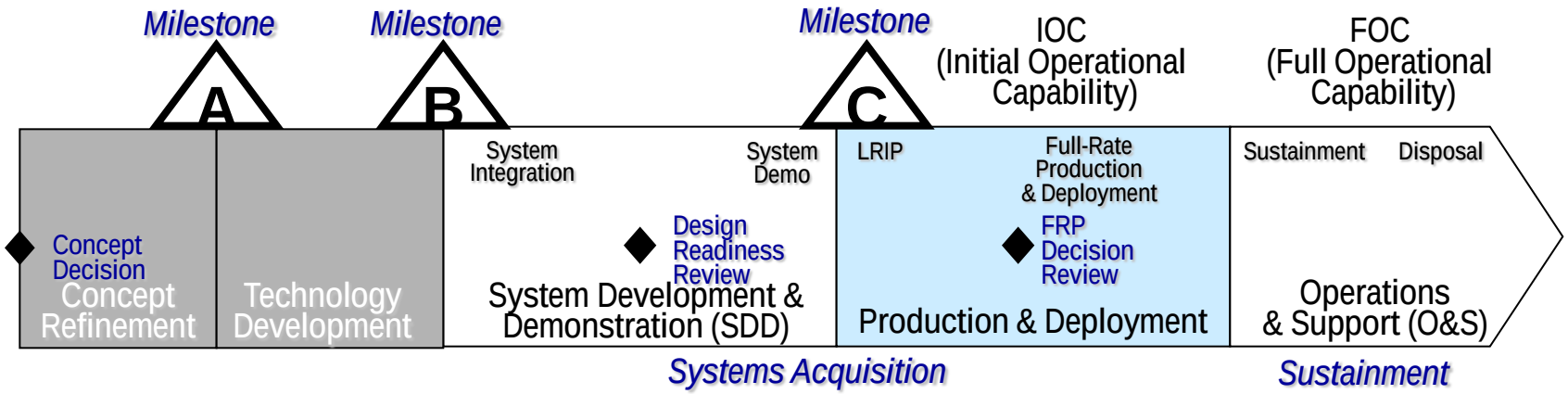
The Goal and the Trap

5000 Acquisition Model:



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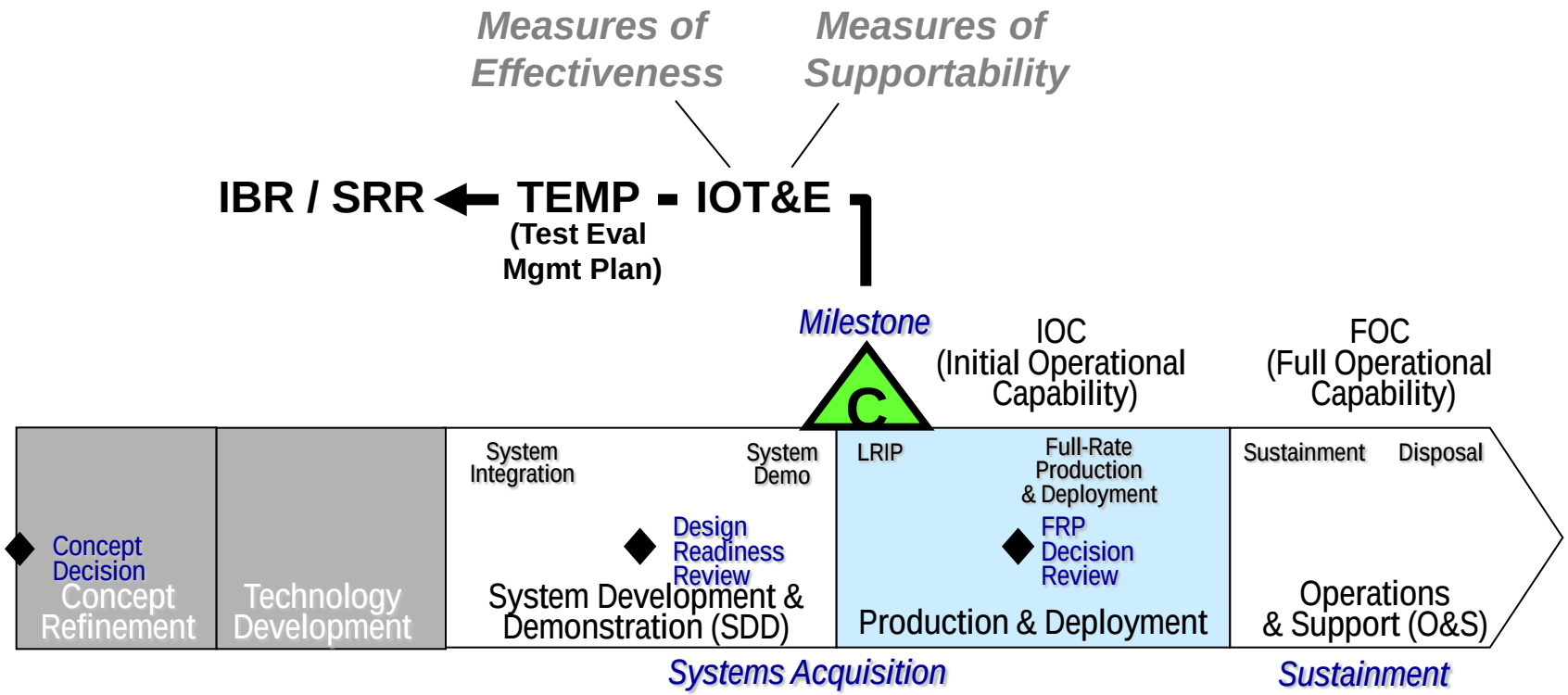
The Goal and the Trap



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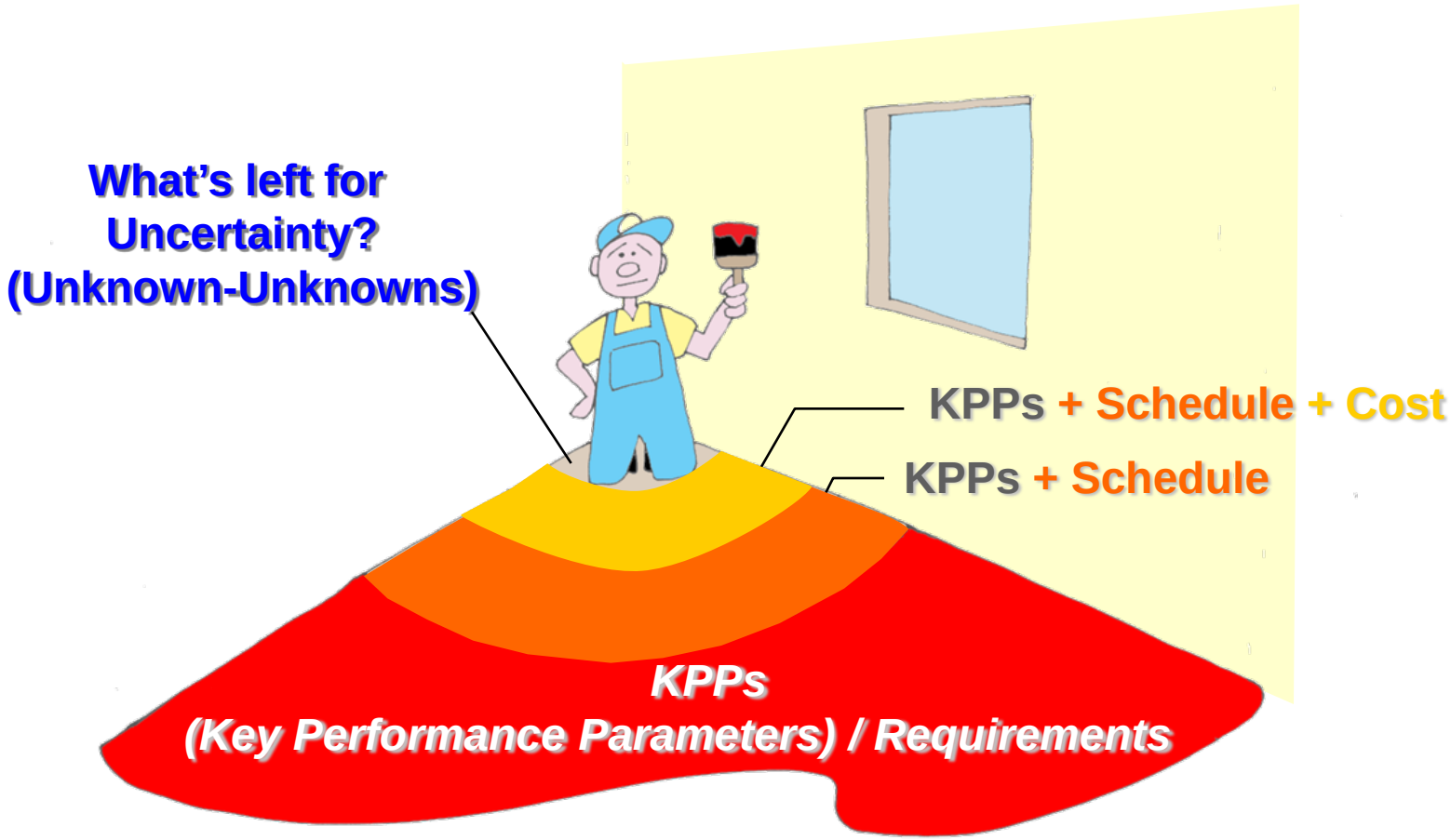
The Goal and the Trap



Programs are Inherently Unstable...
Allow Room to Re-balance

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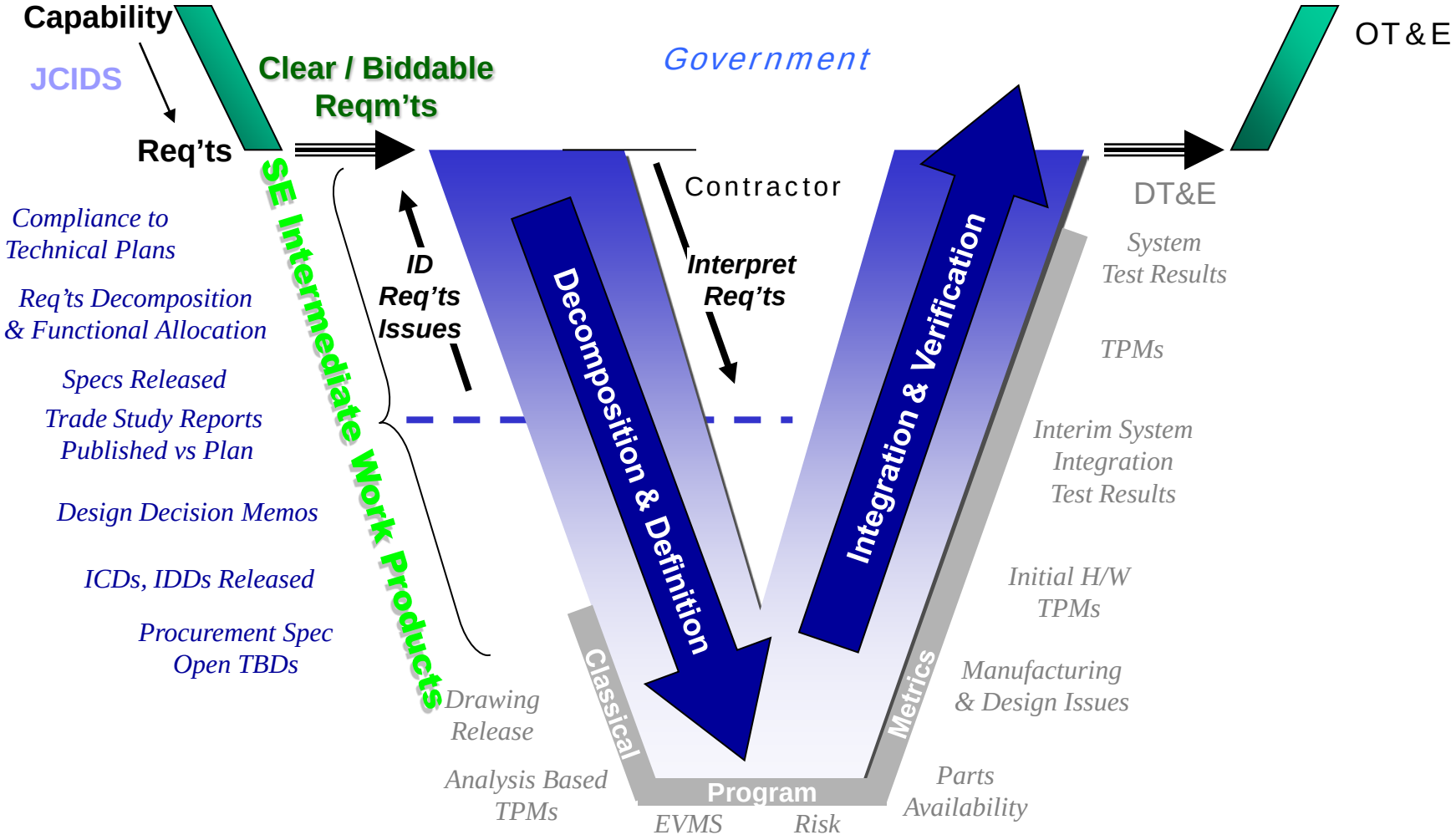
Leverage Intermediate SE Work Products



Track Release and Quality of Intermediate Work Products

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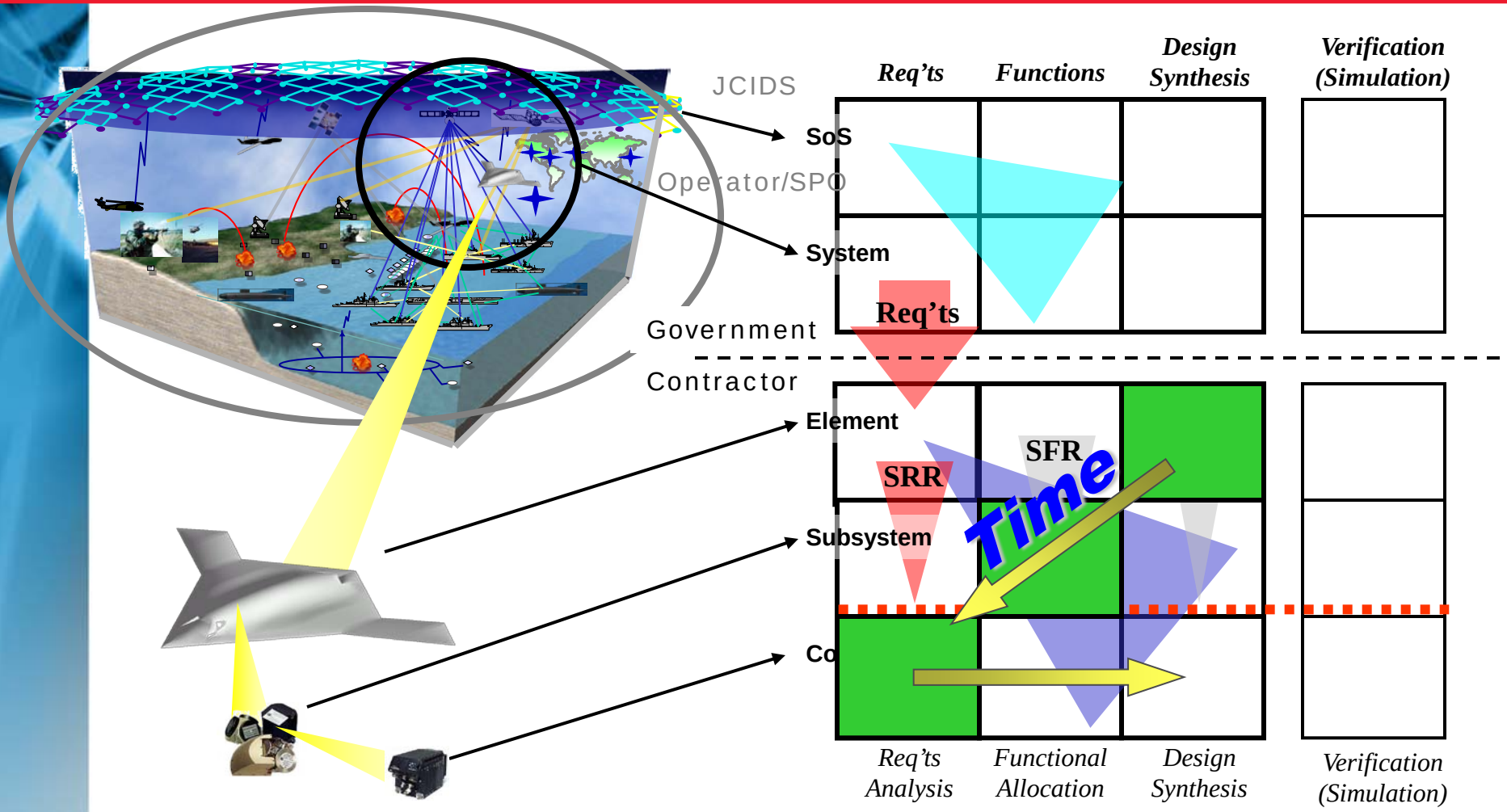
Requirements Availability / Maturity



Shift More Focus on Requirements-Technology Capability vs Design Pre-SDD

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Requirements Interpretation

Is the Traditional SRR Approach Sufficient in a Performance Based Specs World?

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Requirements Interpretation

Is the Traditional SRR Approach Sufficient in a Performance Based Specs World?

- **Establishment of a *System Requirements Interpretation Document (SRID) or Requirements Data Base* Which Clearly Interprets All Requirements in Simple English and Captures the Intent of the Parties**
- **Joint War Fighter (Require), SPO (Acquire) & Contractor (Developer) Participation Required in this Interpretation Process**
- **Drive Discovery of Key "Derived" Requirements… Early**

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Closing Thoughts

- **If You're *Only* Integrating in the Product Domain Beware… Program (Infrastructure), Process, Cost, GFE/GFP and Schedule are Domains that You Must Integrate as Part of the Systems Engineering Process**
- **Don't Paint Yourself Into a Corner… Leave Room for Unknown-Unknowns When Setting Requirement(s) Thresholds**
- **Don't Let Interpretation of Requirements be a Variable… Do it Jointly, Early and Allow Time for "Serial" Decomposition and Flow-Down of Requirements**

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"HOPE"… Isn't a System Engineering Process???