Early Systems Engineering Initiative

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Purpose

- **Status AFMC Early Systems Eng Initiative**
- **Summarize Recent Changes**
- **Identify Weak Areas**
- **Suggest Improvements**

Topics

- Initiative Motivation
- Early Acquisition Process Studies
- Core Problems
- Opportunity and New Challenges
- History and Current Approach
- Shortfalls
- Possible Improvements

Initiative Motivation

- **GAO Defense Acquisitions Study – April 2009**
  - **MDAP initial capability delivery delay 22 months**
  - **Total acquisition cost increase 25%**

- **Weapons Systems Acq Reform Act of 2009**
  - **Overwhelming Congressional approval**
  - **Indicative of significant concern with DoD acquisition**

70-75% Cost Decisions Made Pre-MS A*

Richard Andrews, 2003, *An Overview of Acquisition Logistics*.

Core Problems

- **Inadequate Milestone Information**
  - **Senior leadership cannot accurately assess concept**
  - **No process for defining/providing required data**
  - **Impacts acquisition decision process**

- **Analysis of Alternatives Take Too Long**
  - **Average AoA two years … max around six years**
  - **Inadequate/Insufficient pre-AoA Information**

AFMC Opportunity

- **Acquires Most AF Weapon Systems**
- **Manages $59B Annually (41% of AF Budget)**
- **Early Acquisition Process Involvement**
- **Systems Engineering Expertise**

New Challenges

- **Joint Capabilities Integration and Development System (JCIDS) Changes**
  - **F-Studies eliminated**
  - **ICD no longer provides prioritized materiel solutions**
    - Rationale for a materiel solution
    - Increased AoA activity
- **DoDI 5000.02**
  - **New Materiel Development Decision Milestone (MDD)**
  - **New Materiel Solution Analysis Phase**

Little Guidance On Pre-MDD/Post ICD Acquisition Process

Specific Activities

- **Pre-Acquisition Systems Engineering Process (PASEP) Study**
- **USAF Early Systems Engineering Guidebook**
- **Air Force Materiel Command Instruction 63-1201***
- **Center for Systems Engineering Workshops**

***Implementing Operational Safety, Suitability & Effectiveness and Life Cycle Systems Engineering**

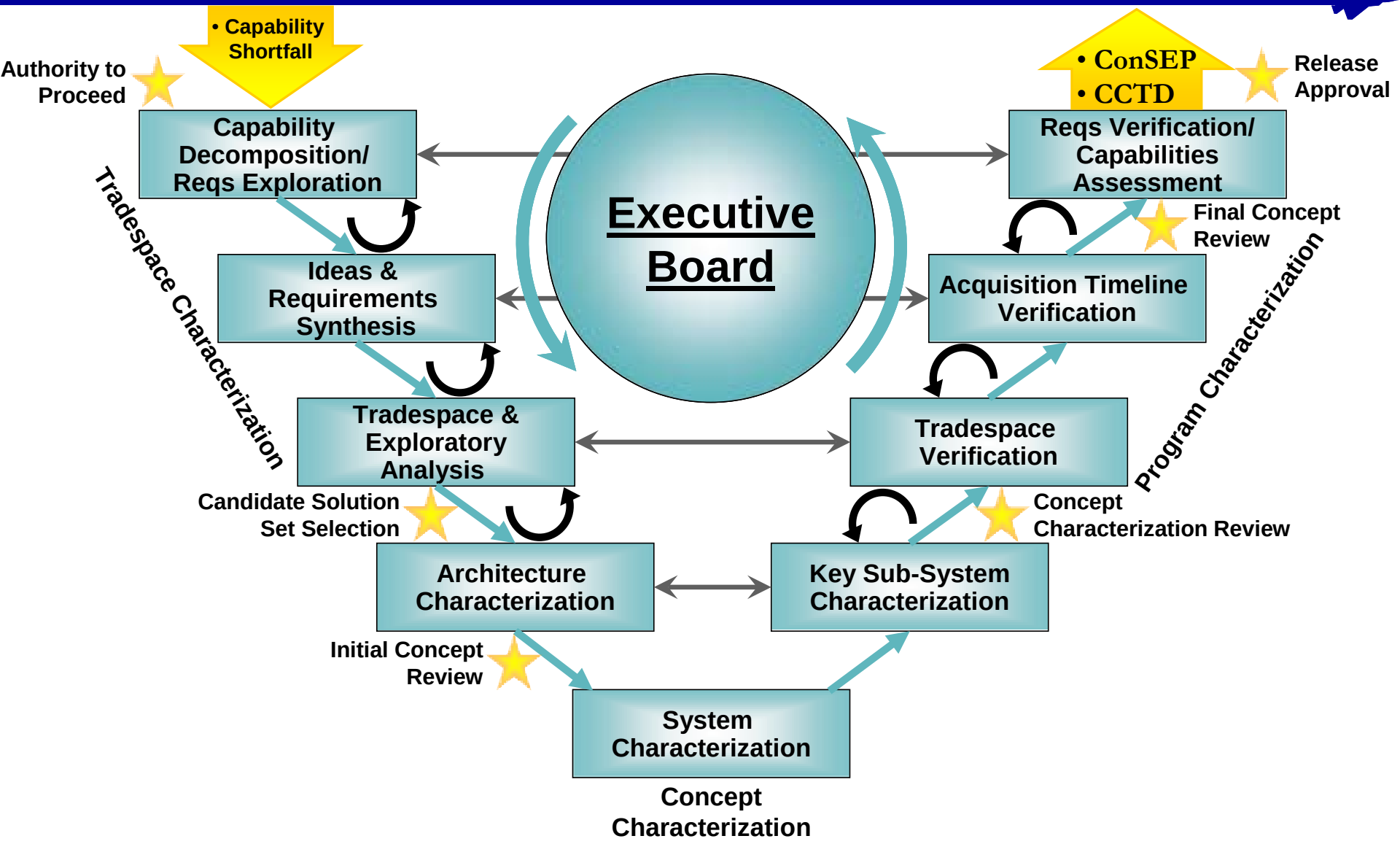
Pre-Acquisition Systems Engineering Process (PASEP)

- **Study commissioned by SAF/AQR in July 2006**
- **Objectives:**
  - **Develop & document a systems engineering process for developing pre-AoA materiel solutions**
  - **Validate the process using a case study with a stated capability shortfall & document the results**
- **Deliverables:**
  - **Systems Engineering Plan specifically tailored for pre-AoA material concepts**
  - **Characterization & technical data of the materiel solutions developed for the stated capability shortfall**

Important PASEP Results

- **Concept Development Process Diagram**
- **Control Function Identification**
- **Concept Systems Engineering Plan**
  - **Organizational**
  - **Concept specific**
- **Concept Characterization & Technical Description (CCTD)**

Pre-Acquisition Systems Engineering Process (PASEP) V-Chart



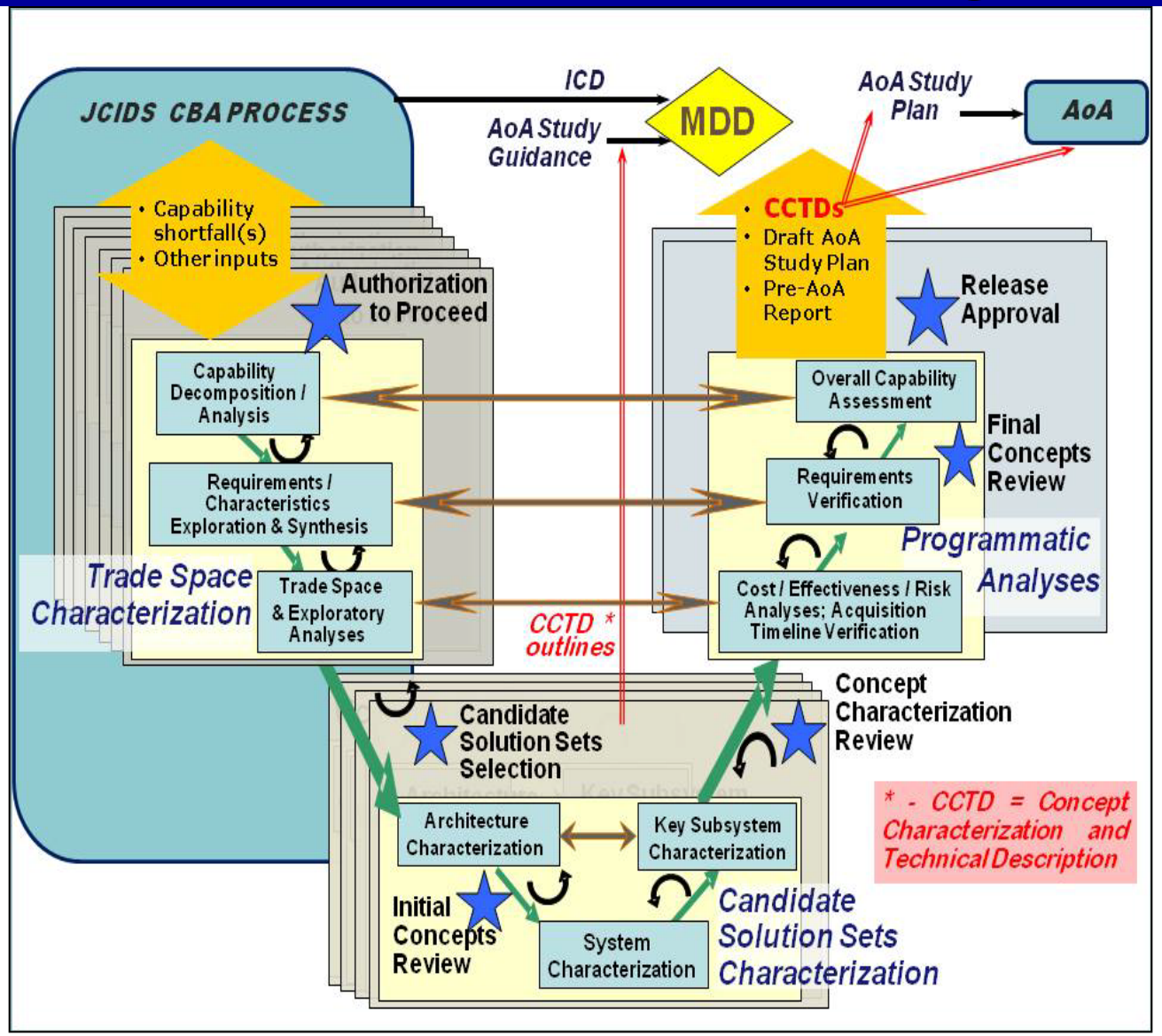
Early Systems Engineering Guidebook

- **Based On PASEP Results**
- **SAF/AQRE & HQ AFMC/ENS Authored**
  - **Expanded scope to entire Air Force**
  - **Published 31 March 2009**

Guidebook Changes From PASEP

- **Modified Process Diagram**
- **Removed Control Function Guidance**
- **Eliminated Concept Specific ConSEP**
- **Revised CCTD Format**

Early Systems Engineering Guidebook Process Diagram



Current Status

- **AFMC & SAF Guidance Memoranda**
  - **SAF/AQR released 19 December 2008**
  - **AFMC/EN released 18 February 2009**
  - **Concept Development (CD) Operating Instruction**
    - Equivalent to PASEP Organizational ConSEP
    - Standardized concept development processes
- **Draft AFMCI 63-1201**
  - **Document standard concept processes**
  - **CCTD required**
  - **Processes based on Early Systems Eng Guidebook**

AFMC Product Center CD Operating Instructions Published

Shortfalls

- **PASEP Process Relatively Immature**
- **Early Systems Engineering Guidebook**
  - **Based on PASEP**
  - **Includes non-systems engineering elements**
- **Some Key Study Findings Not Addressed**

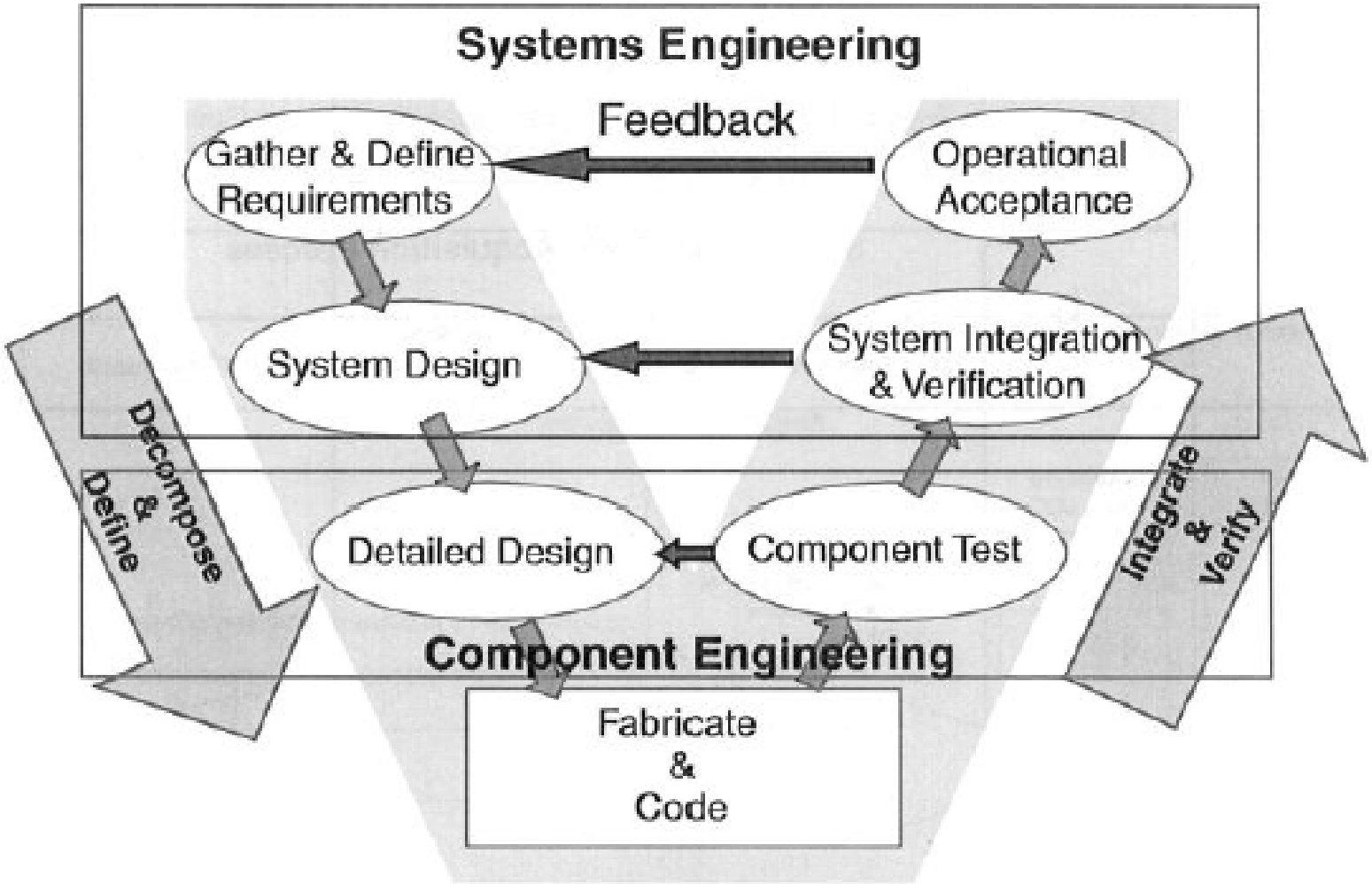
PASEP Systems Engineering Process

- Started July 2006 … completed February 2008
- Objective to develop and document a systems engineering process for developing pre-AoA materiel solutions
- Limited CCTD experience

Current Policy Based Largely On PASEP

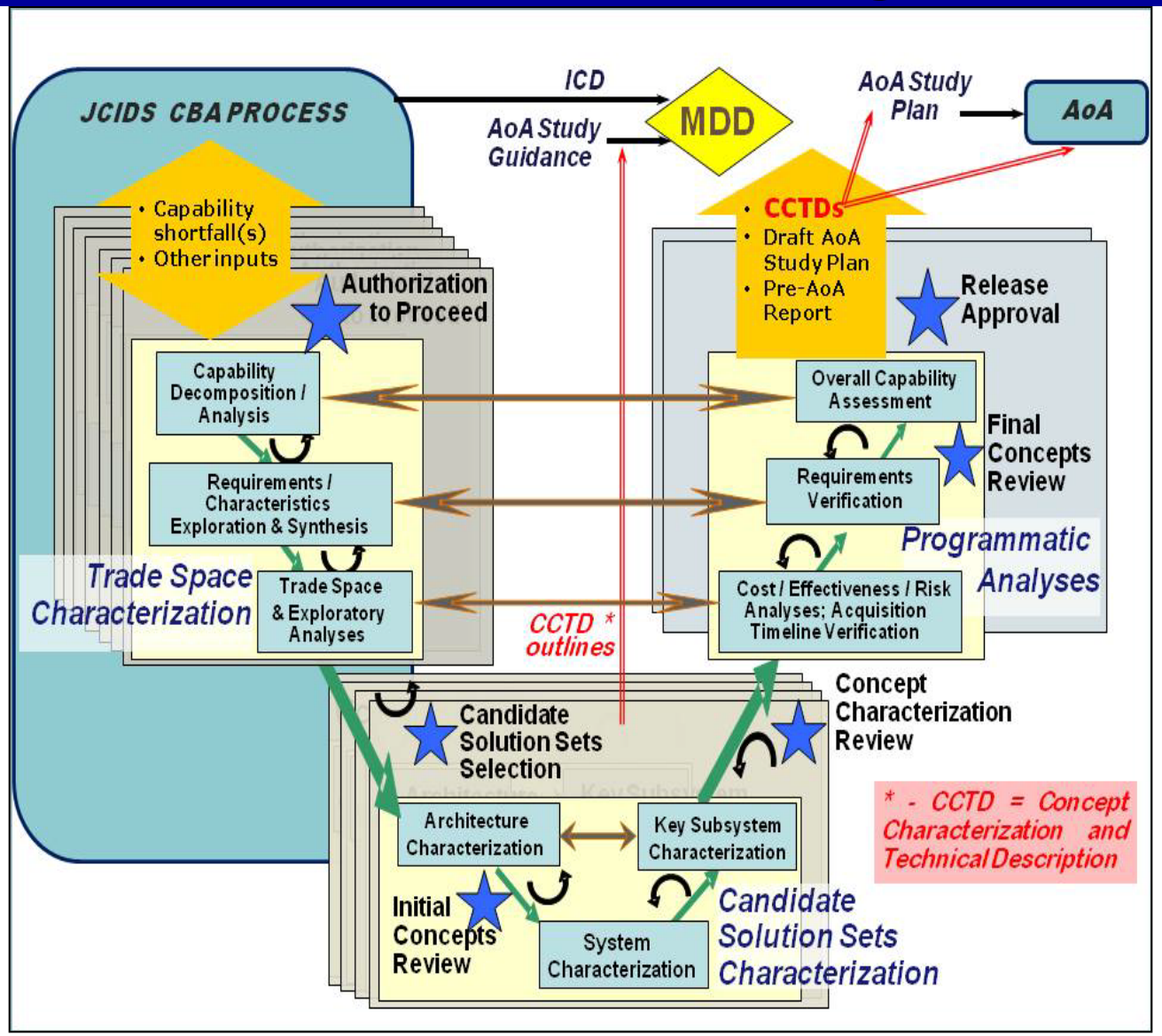
Early Systems Engineering Guidebook Weak Areas

Classic Systems Engineering Vee Diagram



Each step on the left of the "V" has a corresponding step on the right

Early Systems Engineering Guidebook "V" Diagram



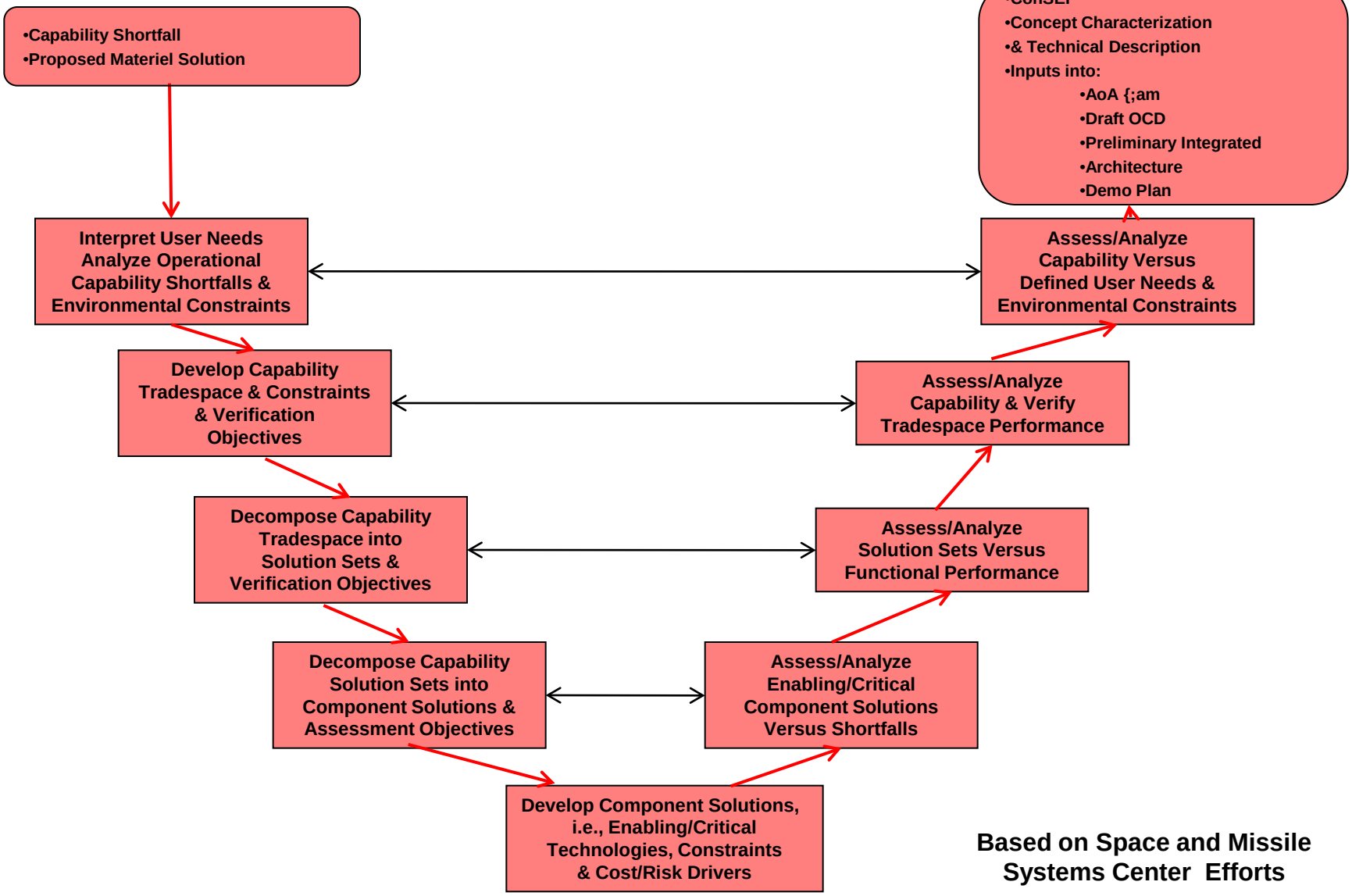
“Vee” Diagram Comparison

- **Several ESE Guidebook “V” Elements Atypical**
  - **Cost analysis**
  - **Effectiveness analysis**
- **Not Clear How Sides Of “V” Relate**
- **Other Early Acquisition Processes**
  - **Cost est, schedule prediction, concept elim, etc.**
  - **Systems engineering combined with others on“Vee” diagram?**

Early SE Guidebook “V” includes important steps …

Not all are systems engineering

Possible Pre-MDD Systems Engineering "V" Diagram



Based on Space and Missile Systems Center Efforts

Some Study Findings Not Addressed*

- **Inexperienced Leadership**
- **External Interface Complexity**
- **System Complexity**
- **Incomplete Requirements**
- **Immature Technology**
- **High Reliance On New Software**

*** The above is a partial list based only on the *National Research Council Pre-Milestone A and Early-Phase Systems Engineering Report.***

Recommendations

- **Build Upon Existing PASEP Process**
- **Address All Study Findings**
- **Concentrate On Systems Engineering**
- **Ensure Future Changes Cover Study Findings**
- **Adopt Greater Customer Focus**
  - **Engage early systems engineering customers**
    - Office of Aerospace Studies
    - Milestone Decision Authorities/PEOs
  - **Identify specific data needs (AoAs, MDDs, etc.)**
  - **Document requirements**
- **Apply Systems Engineering Process To Documented Requirements**


LEADING EDGE TECHNOLOGY
WORLD CLASS SUSTAINMENT
WAR-WINNING SYSTEMS

Study Recommendations

- **National Research Council, 2008**
  - **… better systems engineering could help shorten the time required for development making it more like what it was 30 years ago.**

- **Defense Acquisition Performance Assessment, 2006**
  - **… a successful response to the instabilities caused by the current process or proper program initiation as envisioned requires early and detailed SE practices. (***DAPA Study committee member)*

- **Government Accountability Office, 2005**
  - **… employ the techniques of SE to close gaps between available technologies and customer needs before committing to new product development.**

Methodology

- **Focus on early (pre-MDD) acquisition**
  - **High ability to influence LCC cost**
  - **No formal systems engineering process**

- **Address key study findings**
  - **Requirements definition**
  - **Technology immaturity**

- **Improve early concept definition**
  - **Enhanced Materiel Development Decision (MDD)**
  - **Faster and better AoAs**

Process Control Function

- **Control Milestones**
  - **Strategically placed reviews w/ well defined entrance & exit criteria**
  - **Evaluates potential solutions for continuation and/or satisfactory progress**
- **Executive Board**
  - **Acts as gatekeeper for the process**
  - **Approving all Control Milestones and related materials, templates, etc.**
  - **Authority level corresponds to level of tasking**

Concept Characterization & Technical Description (CCTD)

- Concept or Family of Concepts History
- Required For All
- Retained For Future Capability Needs
- Initiated Early During Pre-MDD Phase
- Includes:
  - Mission Statement & Requirements Synthesis
  - Research Summary
  - Trade Space Definition & Parametric Studies
  - Concept & Program Characterization
  - Final Conclusions & Recommendations

Concept Systems Engineering Plan (ConSEP)

- **Organizational ConSEP**
  - **Used as a general guide & systems engineering plan for developing concepts**
  - **Details:**
    - Organization & Responsibilities
    - Documentation
    - Tools
    - Step-by-Step Process Execution
- **Concept specific ConSEP**
  - **Any amendments to the Organizational ConSEP based on authority level or any planned deviations**
  - **Required to start the process**

Acquisition Process Studies

- **National Research Council, 2008**
  - **Incomplete MS B requirements**
  - **Technology immaturity**
  - **Insufficient consideration of alternative concepts**
  - **http://books.nap.edu/catalog.php?record_id=12065**
- **Defense Acquisition Performance Assessment, 2006**
  - **Requirements instability**
  - **Technology immaturity**
  - **Funding instability**
- **Government Accountability Office, 2005**
  - **Requirements not adequately defined early or changed**
  - **Technologies typically not mature enough**
  - **Acquisition workforce deficiencies**