Step 1 for Systems Engineering: Establish a Tangible Requirements Management Process

25 Oct 06

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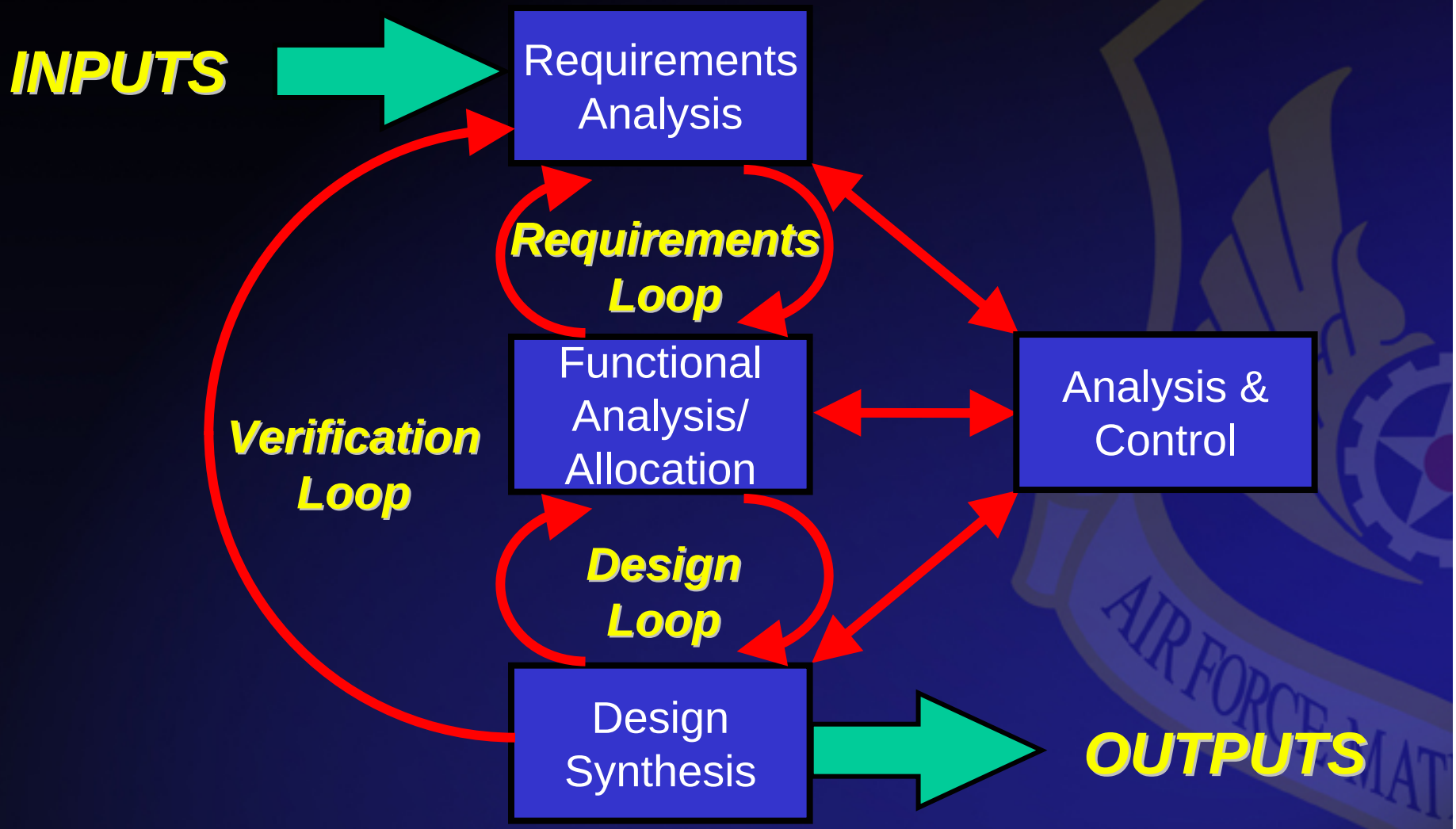
Basic Systems Engineering Process



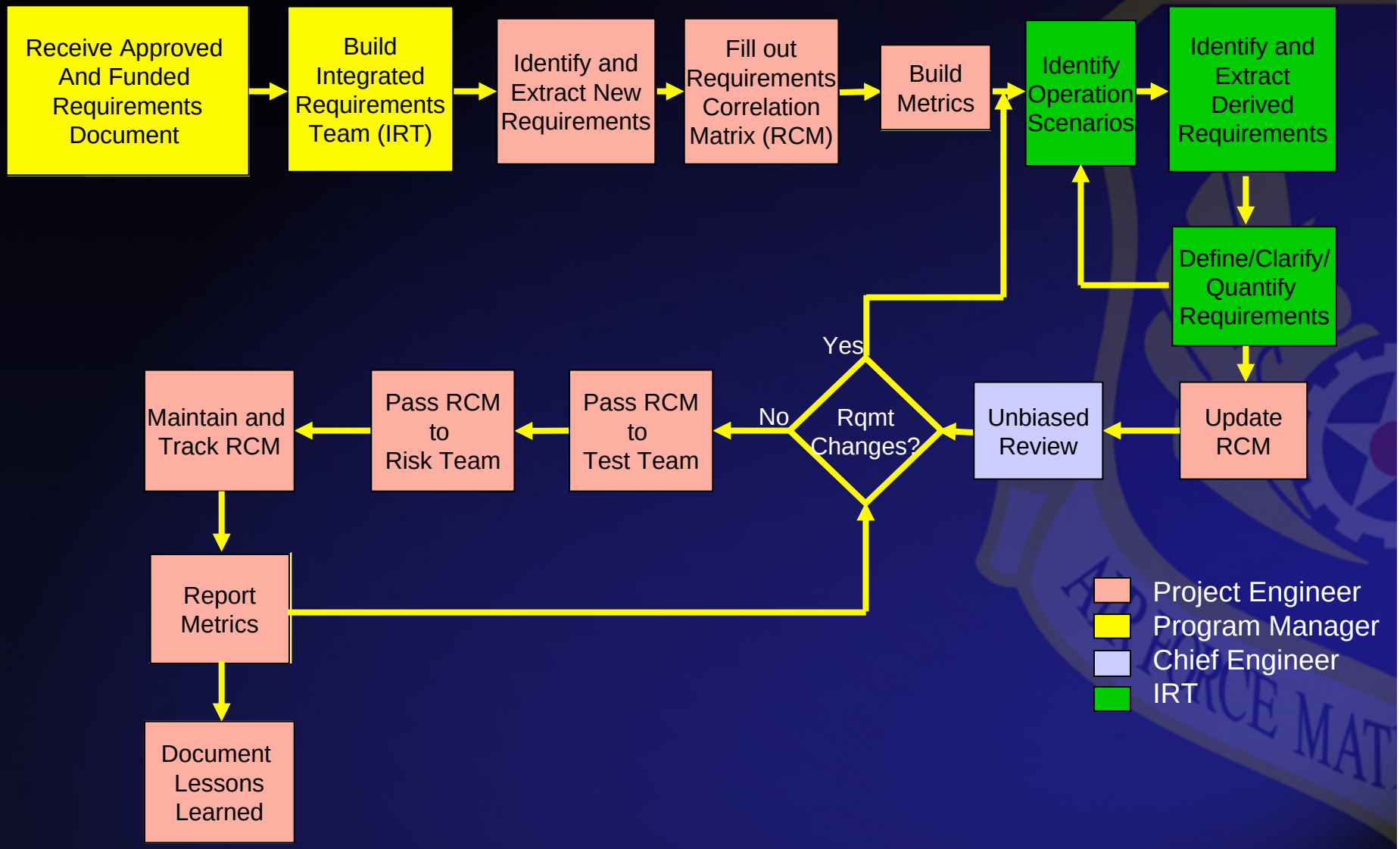
Purpose

- **Published Operating Instruction to provide:**
  - **An organization-wide process to ensure the development of concise, quantifiable, and unambiguous requirements**
  - **Guidance for a requirements management process including the preparation, update, and maintenance of requirements documentation to support the program office**
  - **Means to implement a consistent application of a disciplined systems engineering process for the management of requirements**

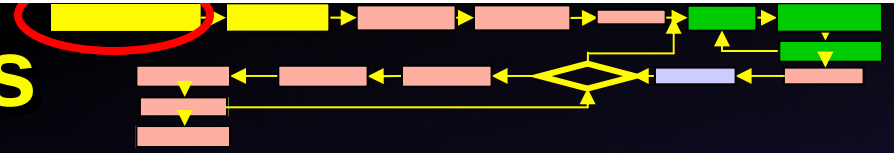
Purpose (Cont)

- Is an iterative process
- Intended for the working level
- Orderly, team-oriented process involving:
  - Project engineers - Contractors
  - Program managers - Users/Customers
- Requirement process to work with contractor's processes/timelines—not duplicative
- Documented output via Requirements Correlation Matrix (RCM)

Requirements Mngt Process Flowchart

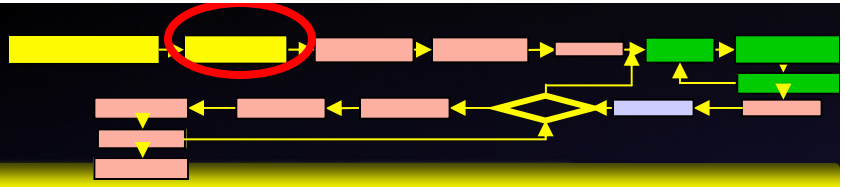


Step 1: Receive Req's



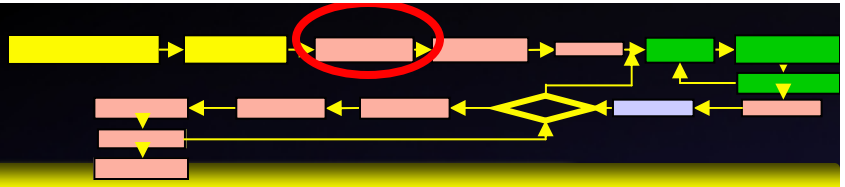
- **Receive Approved and Funded Requirements Document:**
  - **Formally starts this process**
  - **Document can be anything that is recognized as "official" by the Program Manager**
    - **Contract**
    - **SOW/PWS**
    - **AF Form 1067**
    - **Email**
  - **OPR: Program Manager**

Step 2: Build IRT



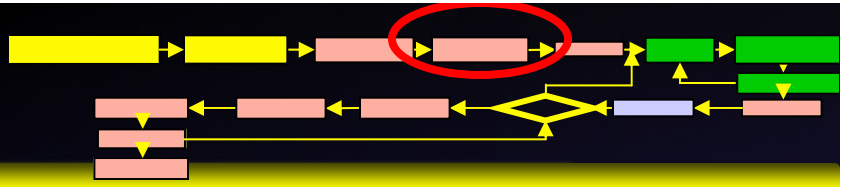
- **Build Integrated Requirements Team (IRT):**
  - **Formally established in writing**
  - **Will include at a minimum:**
    - **Project Engineer**
    - **Program Manager**
    - **Representative(s) from the User**
    - **Representative(s) from the contractor**
  - **Each member there to ensure entire IRT:**
    - **Fully understands each requirement**
    - **Concurs with all derived requirements**
    - **Quantifies each requirement**
    - **Provides detailed operational uses/cases for each req**
  - **Intended to meet regularly**
  - **OPR: Program Manager**

Step 3: ID New Req's



- **Identify and Extract New Requirements:**
  - **Identify, extract and list all requirements from the requirements document in Step 1**
  - **Identify the specific reference (e.g. paragraph and document)**
  - **OPR: Project Engineer**

Step 4: RCM



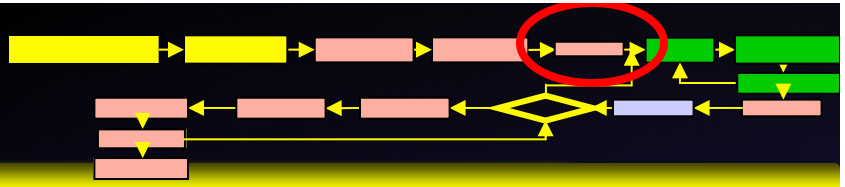
- **Fill Out Requirements Correlation Matrix (RCM):**
  - **Document in a software application to allow for future updates (e.g. spreadsheet)**
  - **Intended Fields:**
    - **Requirement title**
    - **Requirement source (specific reference, e.g. para & doc)**
    - **Derived Requirements (logical breakdown of req)**
    - **Brief requirement definition (1-3 sentences only)**
    - **Quantification of the requirement (this is key)**
    - **Operational Assessment (all scenarios and uses)**
    - **Initial Risk Assessment (e.g. red/yellow/green)**
  - **Review any lessons learned from previous teams**
  - **OPR: Project Engineer**

Step 4: RCM (Cont)

Each IRT member is a SME

- **Requirement title** ← Program Manager
- **Requirement source** ← Program Manager
- **Derived Requirements** ← Project Engineer(s) (Government & Contractor)
- **Brief requirement definition** ← Project Engineer(s) (Government & Contractor)
- **Quantification of the requirement** ← Project Engineer(s) (Government & Contractor)
- **Operational assessment** ← User
- **Initial risk assessment** ← All: PM, Engineers, contractors and Users

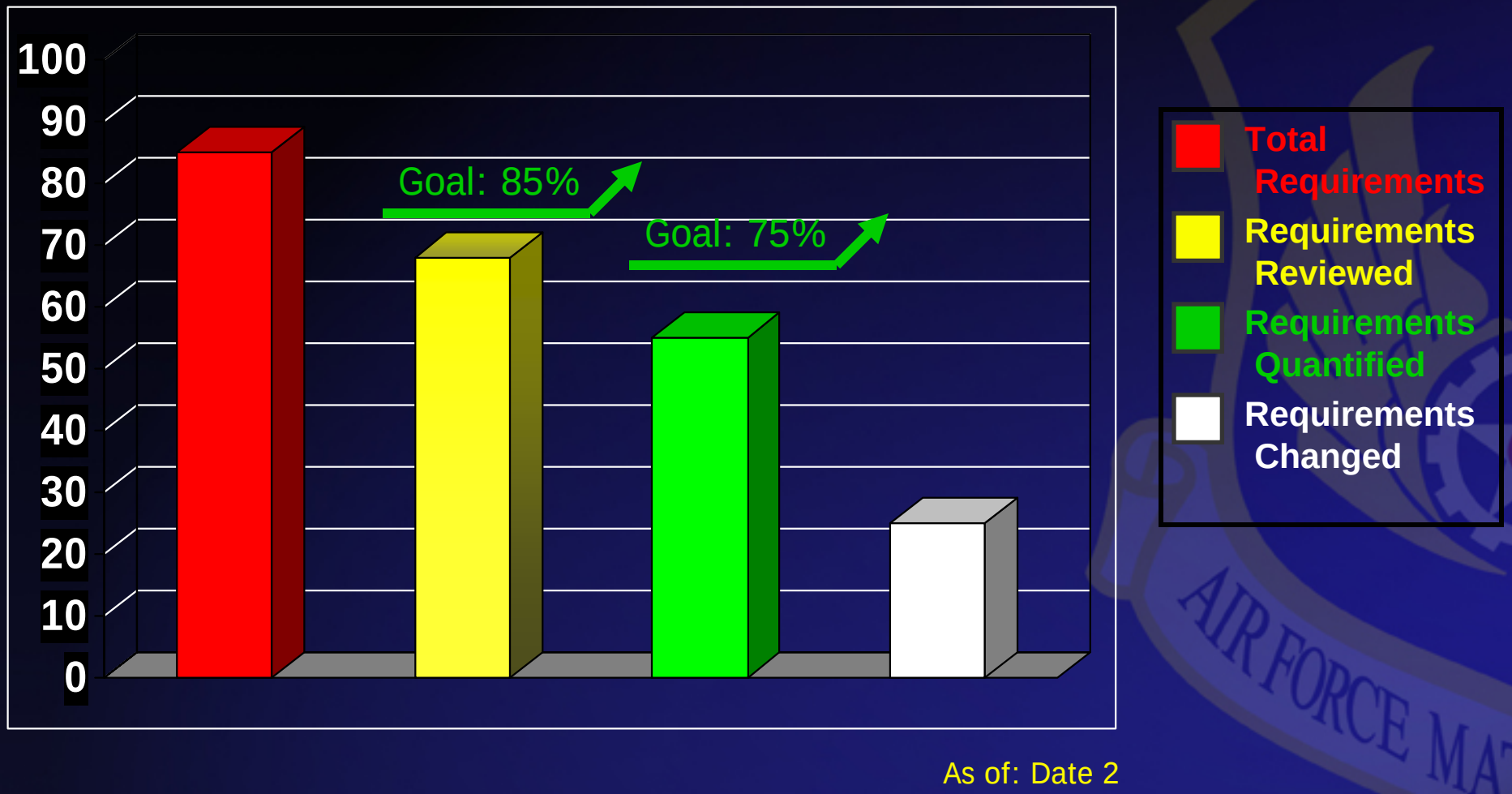
Step 5: Build Metrics



- **Build Metrics:**
  - **Two Metrics:**
    - **Requirement Management Metric (i.e. a snapshot)**
    - **Requirement Growth (i.e. a trend)**
  - **Must be updated throughout process**
  - **Must be shown regularly to management**
    - **Quarterly Weapon System Review**
    - **Once a Month Staff Meeting**
    - **Any significant event (e.g. PMR, PDR, CDR, TIM, …)**
  - **OPR: Project Engineer**

Requirement Management Metric

Example 2

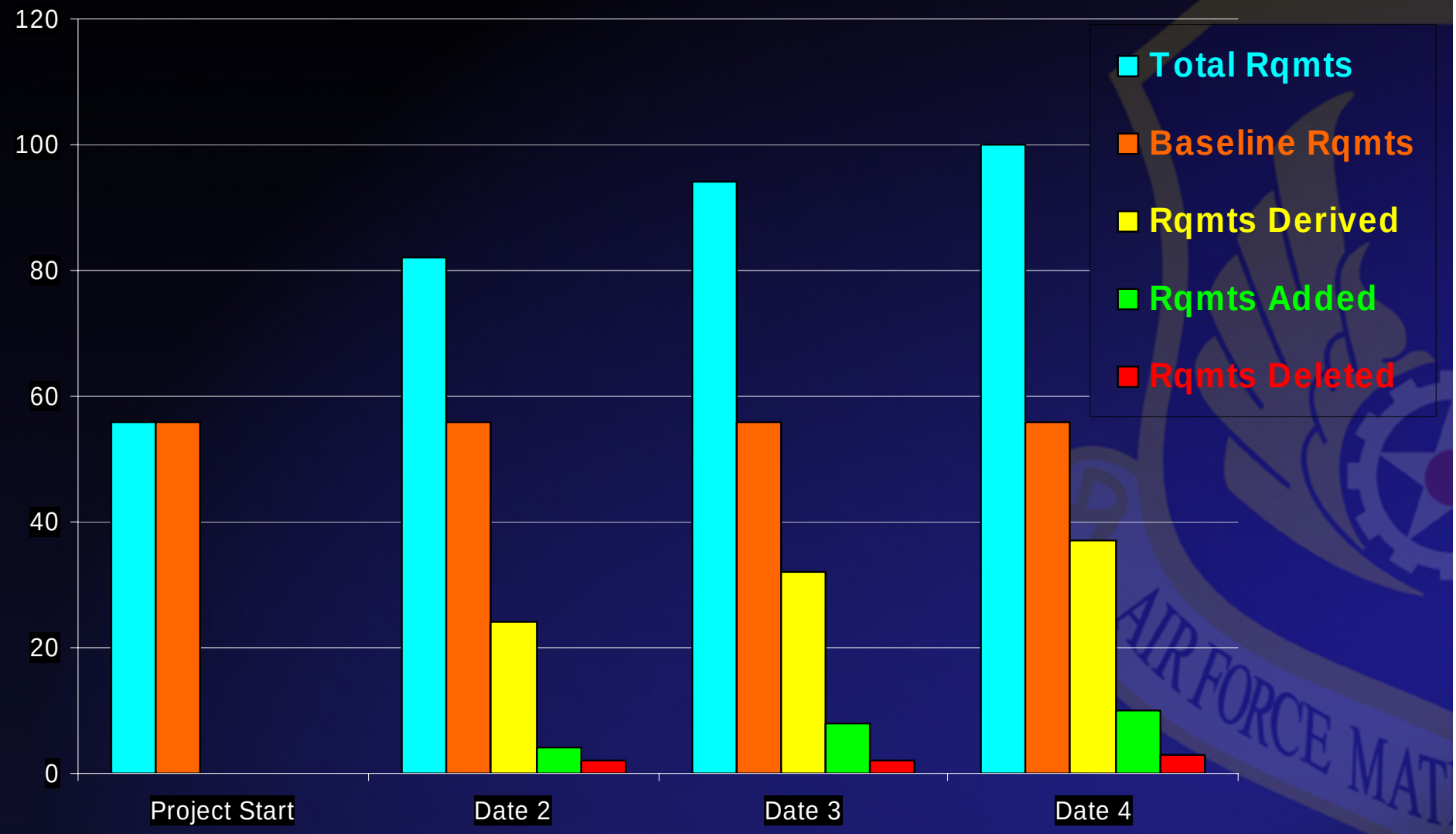


As of: Date 2

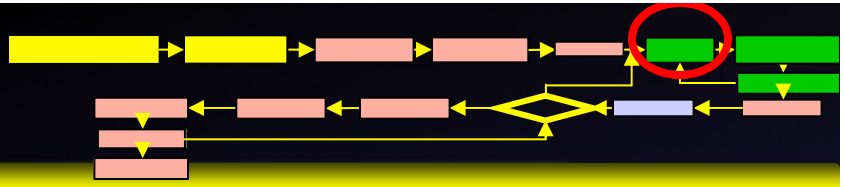
Total Requirements = Requirements + Derived Requirements

Requirement Growth

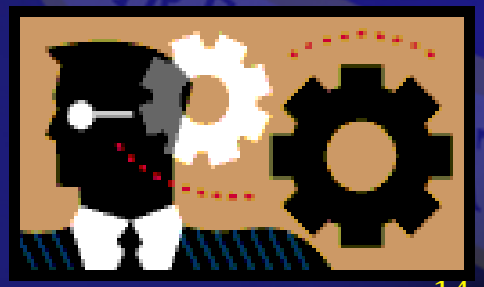
Example 2



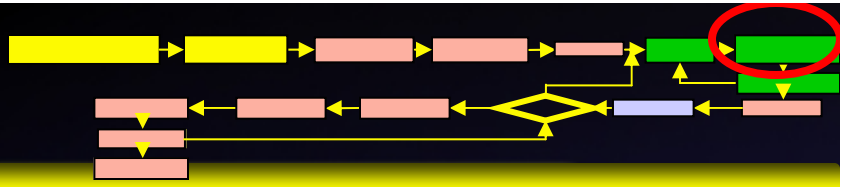
Step 6: ID Use Cases



- **Identify Operational Scenarios:**
  - **Clearly list all operational uses and scenarios**
  - **Done for each req and derived req**
  - **Necessary to ensure design:**
    - **Encompasses all user's intentions**
    - **Helps identify all potential special cases**
    - **Comprehensive list of what to test/measure**
  - **OPR: Integrated Requirements Team**

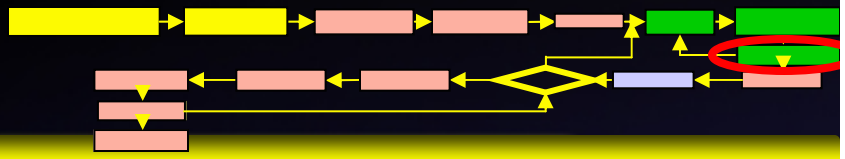


Step 7: Derived Req's



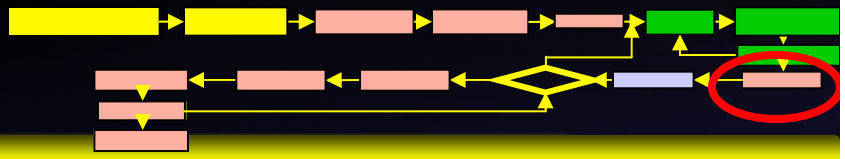
- **Identify and Extract Derived Requirements:**
  - **This is an iterative, spiral process**
  - **Expect derived requirements to increase/clarify as user discusses all operational uses**
  - **Key is not to "assume" anything**
  - **OPR: Integrated Requirements Team**

Step 8: Quantify



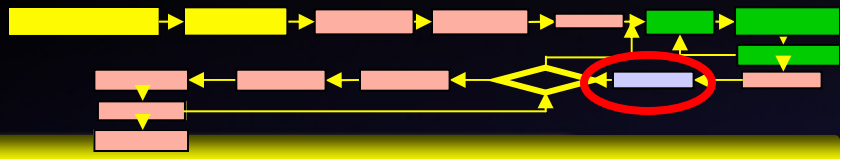
- **Define/Clarify/Quantify Requirements:**
  - **The heart of the RCM**
  - **Specific, unambiguous quantification of each req**
    - **Key for later testing**
    - **Provide agreed on pass/fail criteria**
    - **Not open to interpretation**
  - **Resolve all "TBDs"**
  - **Document in minutes how quantification determined on requirements and indication of concurrence from all members**
  - **OPR: Integrated Requirements Team**

Step 9: Update RCM



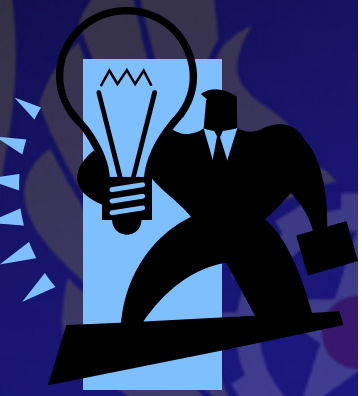
- **Update RCM:**
  - **Update with each spiral from the IRT**
  - **Serves as the “common sheet of music” for the IRT**
  - **This is the source of data for the metrics**
  - **OPR: Project Engineer**

Step 10: Req Review

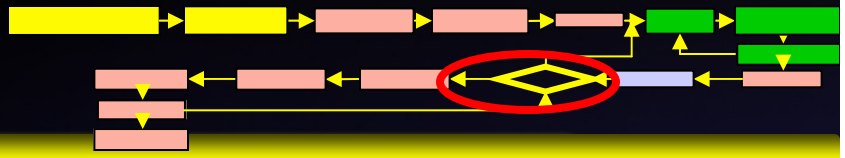


- **Unbiased Review:**
  - **Purpose to validate the RCM**
    - **Sufficient level of detail via derived requirements**
    - **Proper quantification of each requirement**
    - **Strong review of non-quantified and TBD req's**
    - **Comprehensive review of use cases and what-ifs**
  - **Project Engineer presents the RCM to review board**
  - **Chief Engineer is the Chair**
  - **Other members are SMEs and experienced personnel**
  - **Members from both inside and outside organization**

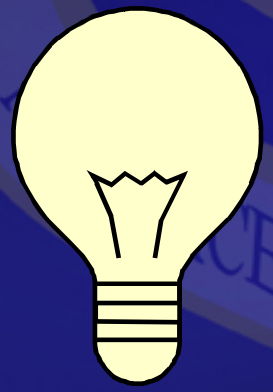
  - **OPR: Chief Engineer**



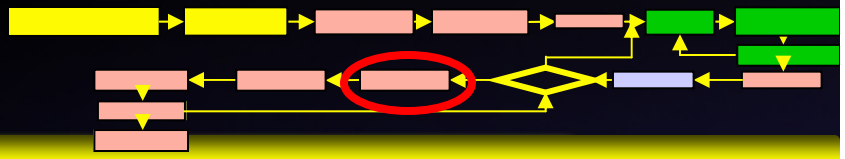
Step 11: Changes



- **Requirements Changes:**
  - **Project Engineer takes Review Board results back to IRT**
    - **Requests for clarification**
    - **Recommendations**
    - **Corrections**
  - **Can also result from IRT meetings or program events (PDR, CDR, PMRs, etc..)**
  - **OPR: Project Engineer**

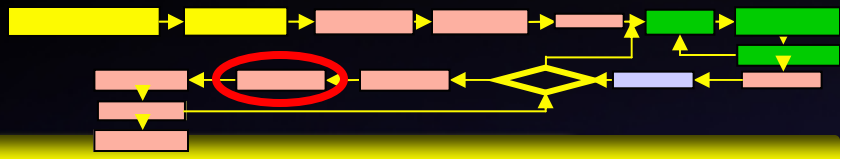


Step 12: RCM to Test



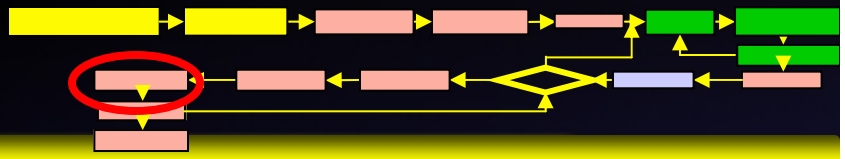
- **Pass RCM to Test Team:**
  - **Test Team uses this a core input to build successful test program:**
    - **Are the quantified requirements testable**
    - **Determine method of testing**
    - **Awareness of problem, or risk, areas**
    - **What resources are needed**
    - **Ensure test plan is comprehensive**
    - **How handle non-quantified requirements**
  - **Another OI is in work to describe this process**
  - **OPR: Project Engineer**

Step 13: RCM Risk



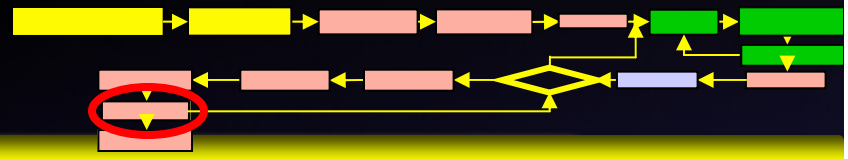
- **Pass RCM to Risk Team:**
  - **Risk Management Team uses this a key input for risk management plan:**
    - **Review all requirements the IRT initially flagged as red or yellow**
    - **What resources are needed to mitigate**
    - **Ensure risk plan is comprehensive**
    - **Incorporate into program schedule**
  - **Another OI is in work to describe this process**
  - **OPR: Project Engineer**

Step 14: Maintain RCM



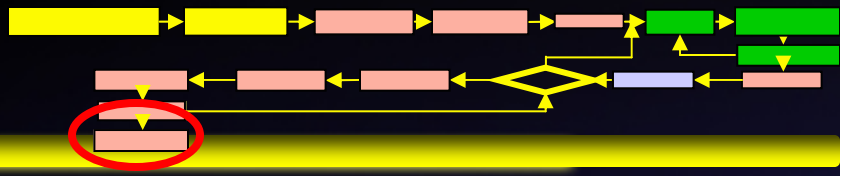
- **Maintain and Track RCM:**
  - **Have regular IRT Meetings to continually update RCM**
    - **Eliminate TBDs**
    - **Review quantification**
    - **Ensure have all operational uses/scenarios**
    - **Ensure included all derived requirements**
  - **OPR: Program Manager**

Step 15: Report

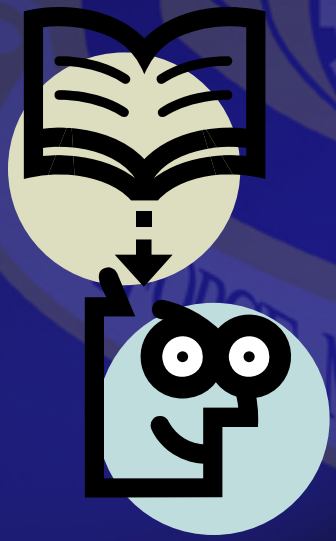


- **Report Metrics:**
  - **Regularly update metrics**
  - **Ideal Goal is 100% reviewed and 100% quantified**
  - **OPR: Project Engineer**

Step 16: Lessons Learned



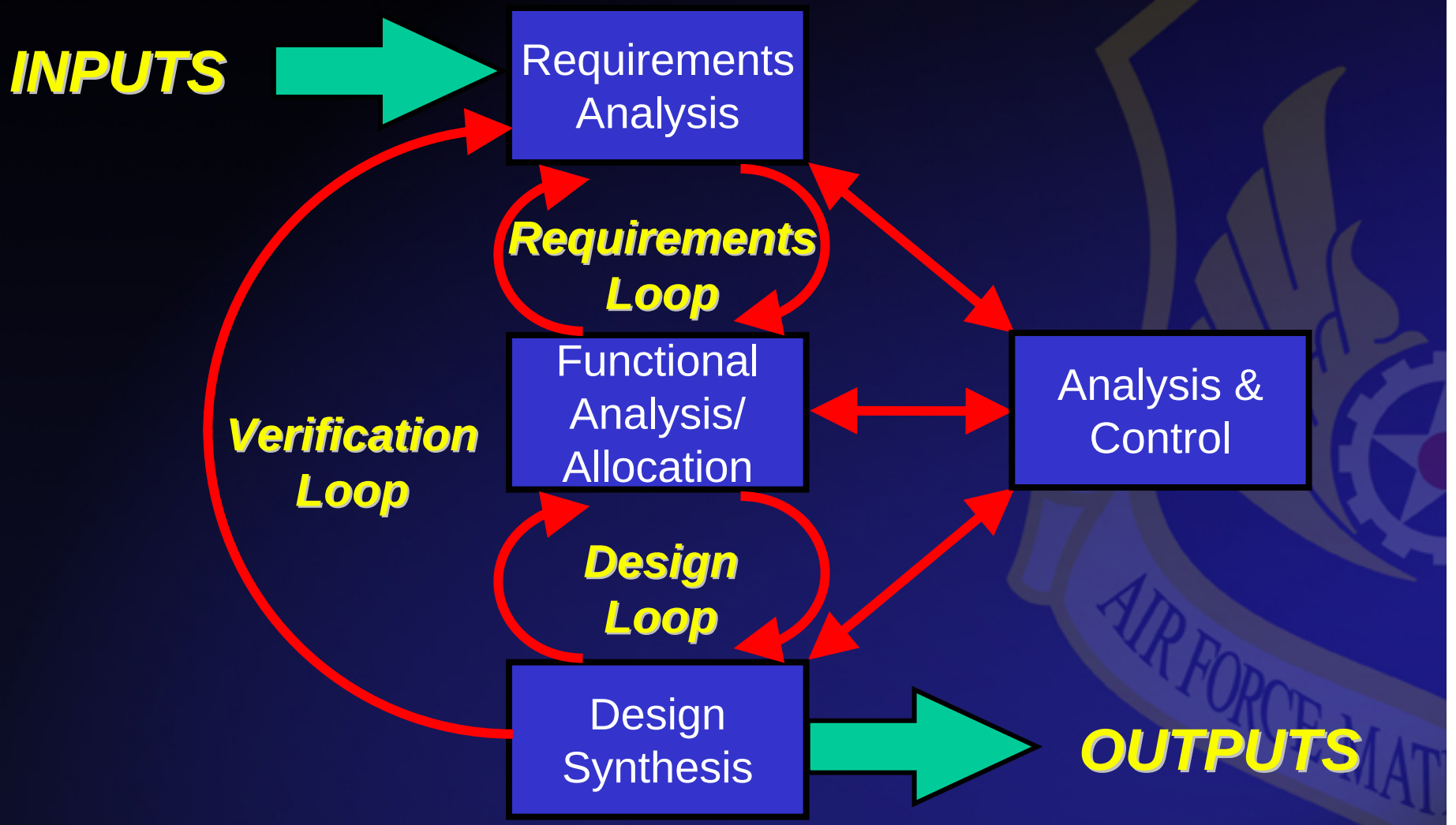
- **Document Lessons Learned:**
  - **Develop a place for the organization to log this (if not have already)**
  - **Good place to start developing "standard" quantification to common requirements**
    - **Light brightness on aircraft**
    - **Noise levels on headphones**
    - **VTC standards**
  - **OPR: Project Engineer**



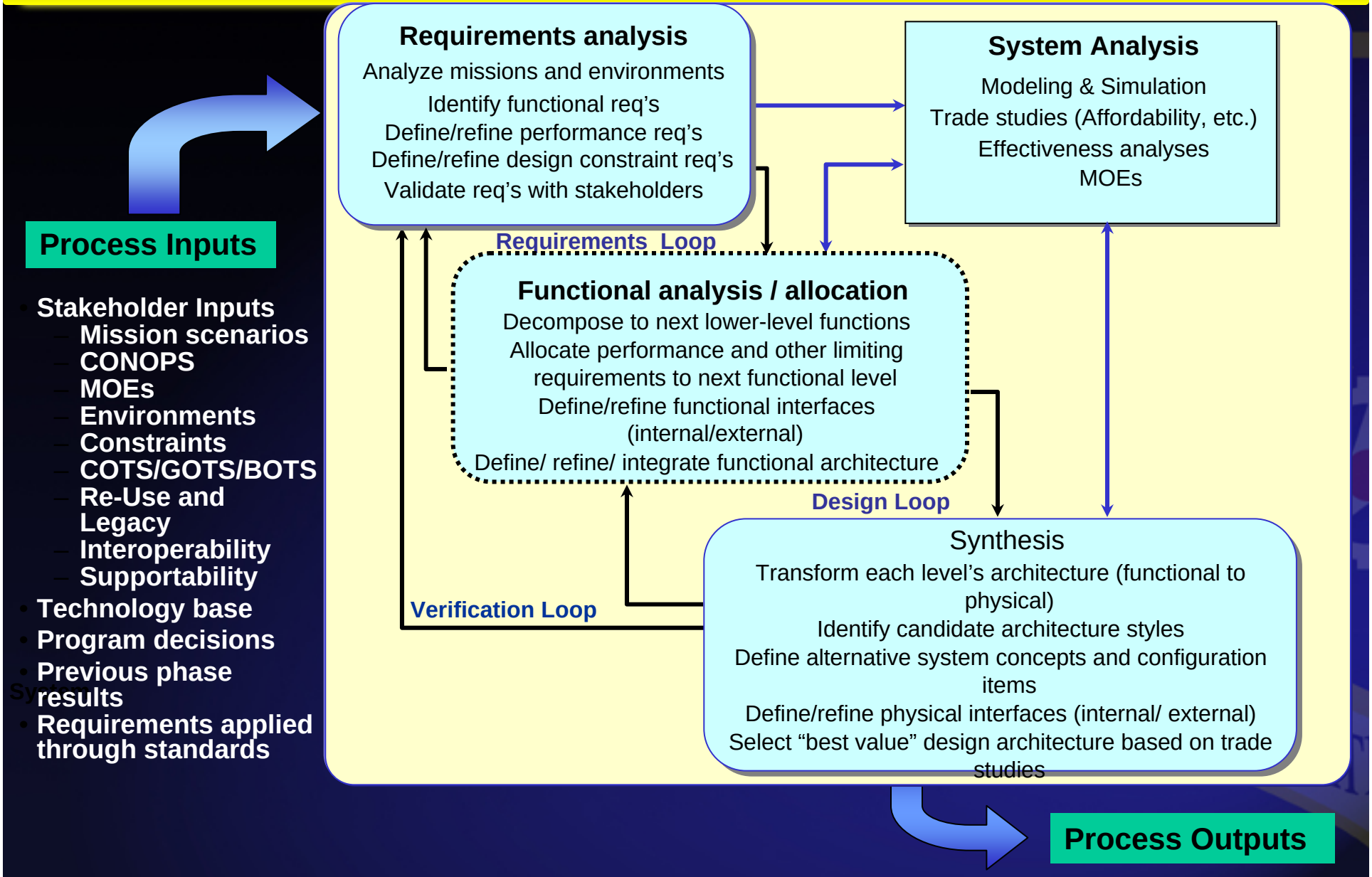
Typical Schedule

- **Show the Flow days here**
  - **Recommend basing on Requirement receipt plus days**

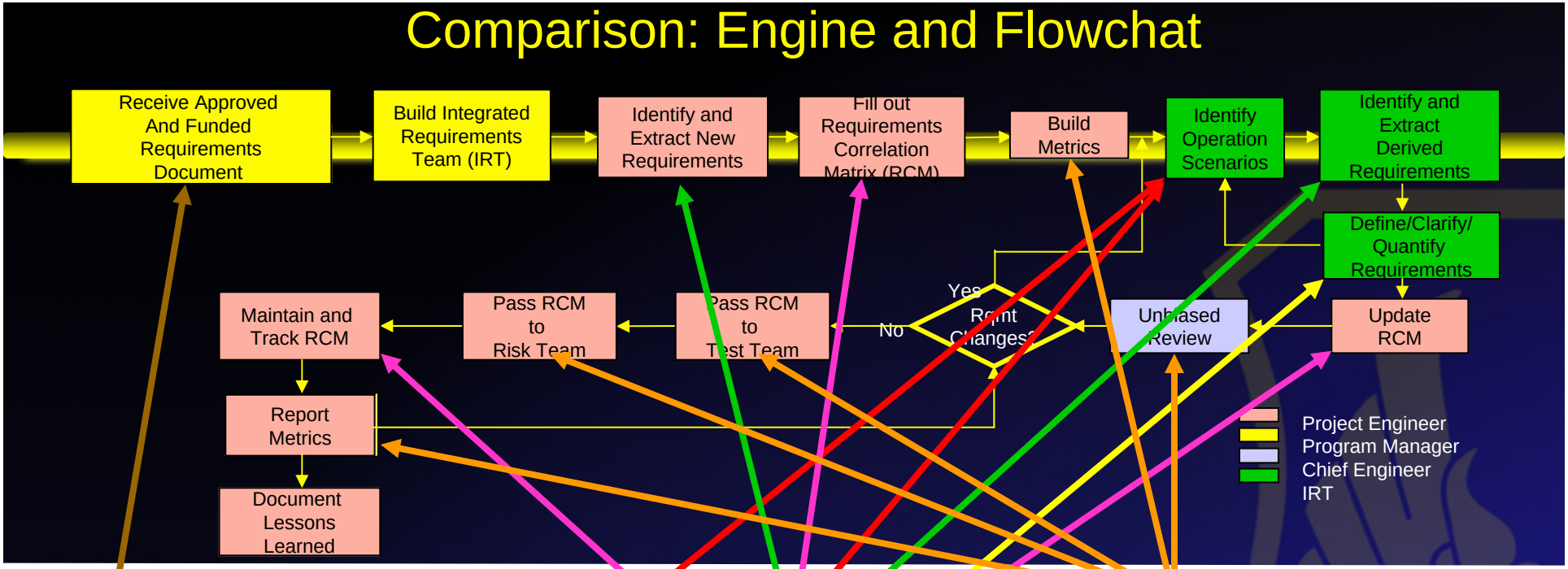
Basic Systems Engineering Process

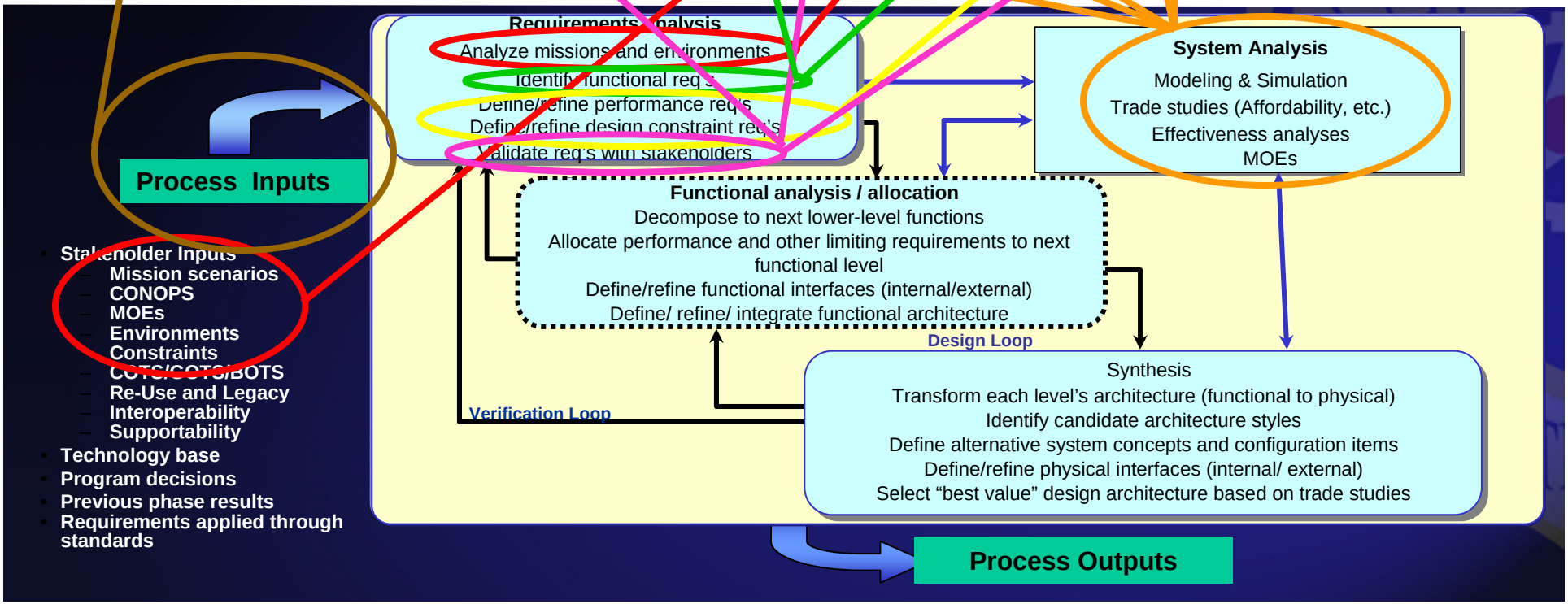


Detailed Systems Engineering Engine



Comparison: Engine and Flowchat





Questions?

Detailed Systems Engineering Functional Instructions

Systems Engineering Process Manual

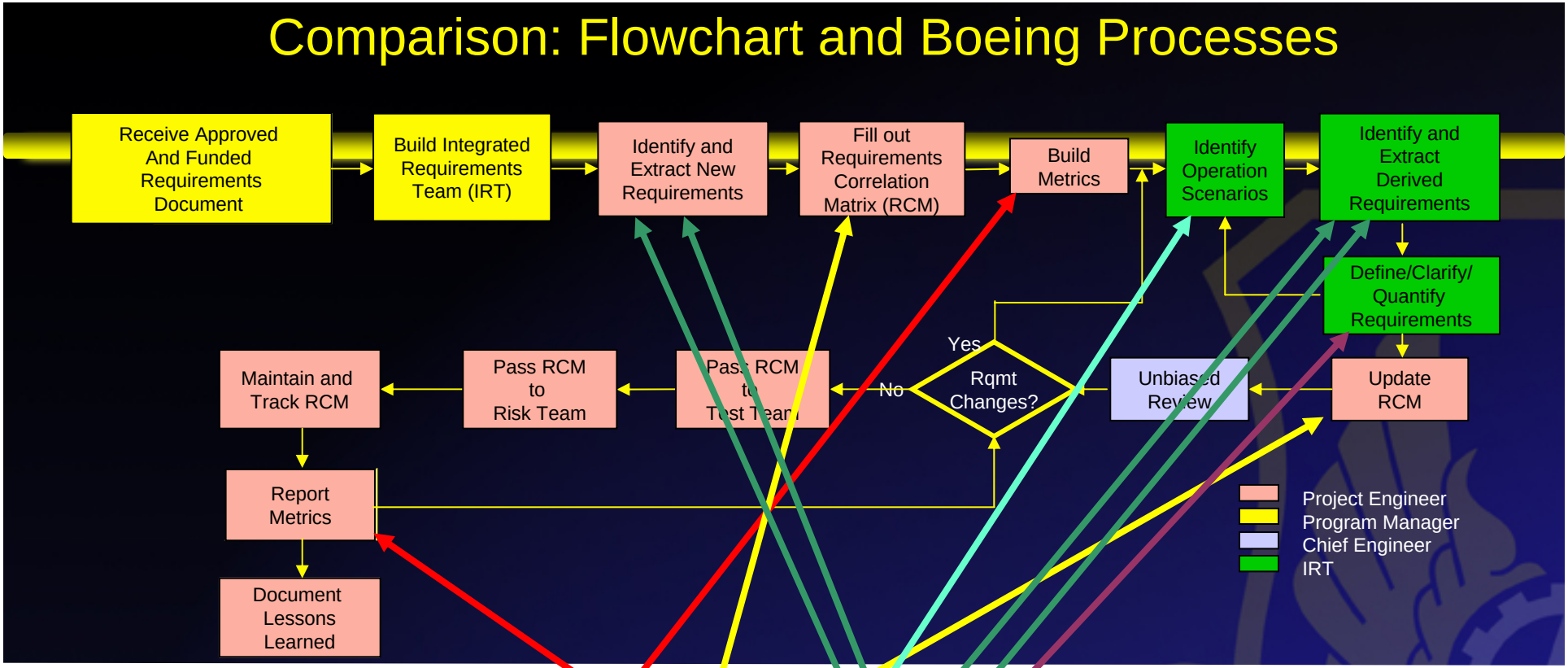
Expand Collapse Previous Next Create

Launch No.	Title
000 General - Systems Engineering	
WH-SE-000.01	PRO-3751 Systems Engineering Process Documents
WH-SE-000.02	PRO-6188 Define and Manage Product/Service Requirements
WH-SE-000.03	PRO-6189 Plan and Control Product/Service Development and Definition
WH-SE-000.04	PRO-6190 Concurrently Develop and Define Products/Services
WH-SE-000.05	PRO-6191 Verify & Validate Products/Services
WH-SE-000.06	D950-10459-1 Common Systems Engineering Process Framework (CSEPF)
WH-SE-000.07	D950-10446-1 Systems Engineering Process Manual (SEPM)
100 Manage Product Traceability	
WH-SE-100	Manage Product Traceability
WH-SE-100.01	BPI-3472 Manage Product Requirements Traceability
WH-SE-101	Requirements Traceability
WH-SE-FI.102	Product Requirements Traceability at IDS Wichita
200 Define and Analyze System Requirements	
WH-SE-200	Define and Analyze System Requirements
WH-SE-200.01	BPI-3471 Manage Requirements
WH-SE-200.02	BPI-3473 Perform Systems Analysis
WH-SE-200.03	BPI-3483 Define and Develop Requirements
WH-SE-201	Requirements Analysis
WH-SE-202	Requirements Parse
WH-SE-203	Requirements Allocation Sheet
WH-SE-204	Prepare Specifications
WH-SE-206	System of Systems Engineering Process
WH-SE-207	System/Segment Specification Template
WH-SE-209	System/Subsystem Specification DID (DI-IPSC--81431A)
WH-SE-210	Analyze and Define Hardware Requirements
WH-SE-211	Hardware Requirements Documentation
WH-SE-212	Nuclear Hardness and Survivability – Requirements Flowdown
300 Define and Analyze System Functions	
WH-SE-300	Define and Analyze System Functions
WH-SE-300.01	BPI-3479 Define and Develop Functions
WH-SE-301	Define System States and Modes
WH-SE-302	Functional Analysis Allocation

Launch No.	Title
400 System Design Synthesis	
WH-SE-400	Perform System Design Synthesis
WH-SE-400.01	BPI-3464 Develop Integrated Design
WH-SE-400.02	BPI-3468 Integrate System
WH-SE-402	System Design Procedure
WH-SE-403	Manage Technology and Product Line Evolution
WH-SE-404	Technology Management
WH-SE-405	Tailoring the Systems Engineering Process
WH-SE-407	Operational Concept/Mission Analysis/Measures of Effectiveness
WH-SE-408	Define System States and Modes
WH-SE-410	Technical Performance Measurement
WH-SE-411	Technical Performance Measures Template
500 Plan System Verification and Validation	
WH-SE-500	Plan System Verification and Validation
600 Manage Interfaces	
WH-SE-600	Manage Interfaces
WH-SE-600.01	BPI-3470 Manage Interfaces
WH-SE-601	Interface Design/Control Procedure
WH-SE-603	ICP No. 208, Strategic Systems Interface Control Plan

Launch No.	Title
700 Perform Verify and Validate Systems	
WH-SE-700	Validate System
WH-SE-700.01	BPI-3475 Perform Verification
WH-SE-700.02	BPI-3474 Perform Validation
900 Miscellaneous	
WH-SE-901	Simulation Performance Analysis Procedure
WH-SE-904	Human-System Integration Process
WH-SE-905	System Safety Program Implementation, Management and Control
WH-SE-906	System Safety Process
WH-SE-907	System Safety Analysis
WH-SE-908	Joint Tasks - Safety, Health & Environmental Affairs (SHEA) Support Procedure

Comparison: Flowchart and Boeing Processes



WH-SE-000.07 D950-10446-1 Systems Engineering Process Manual (SEPM)

100 Manage Product Traceability

- WH-SE-100 Manage Product Traceability
- WH-SE-100.01 BPI-3472 Manage Product Requirements Traceability
- WH-SE-101 Requirements Traceability
- WH-SE-[illegible] Product Requirements Traceability at IDS Wichita

400 System Design Synthesis

- WH-SE-400 Perform System Design Synthesis
- WH-SE-400.01 BPI-3464 Develop Integrated Design
- WH-SE-400.02 BPI-3468 Integrate System
- WH-SE-402 System Design Procedure
- WH-SE-403 Manage Technology and Product Line Evolution
- WH-SE-404 Technology Management
- WH-SE-405 Tailoring the Systems Engineering Process
- WH-SE-407 Operational Concept/Mission Analysis/Measures of Effectiveness

200 Define and Analyze System Requirements

- WH-SE-200 Define and Analyze System Requirements
- WH-SE-200.01 BPI-3471 Manage Requirements
- WH-SE-200.02 BPI-3473 Perform Systems Analysis
- WH-SE-200.03 BPI-3483 Define and Develop Requirements
- WH-SE-201 Requirements Analysis
- WH-SE-202 Requirements Parse
- WH-SE-203 Requirements Allocation Sheet
- WH-SE-204 Prepare Specifications
- WH-SE-206 System of Systems Engineering Process
- WH-SE-207 System/Segment Specification Template
- WH-SE-209 System/Subsystem Specification DID (DI-IPSC--81431A)
- WH-SE-210 Analyze and Define Hardware Requirements
- WH-SE-211 Hardware Requirements Documentation
- WH-SE-212 Nuclear Hardness and Survivability – Requirements Flowdown

300 Define and Analyze System Functions

- WH-SE-300 Define and Analyze System Functions
- WH-SE-300.01 BPI-3479 Define and Develop Functions
- WH-SE-301 Define System States and Modes
- WH-SE-302 Functional Analysis Allocation