INCOSE 98 SYMPOSIUM

The Application of a Systems Engineering Process to the Re-engineering of an Air Defense System

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AGENDA

- Introduction
- Organizational Processes
- Re-Engineering Project
- Lessons Learned
- Next Steps
- Conclusion

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- **OERLIKON AEROSPACE**
  - System Integrator of an Air Defense System
  - Certified as Level 2 - Software Engineering Institute in 1997
    - ⇨ Has also met 8 of the 17 Level 3 Goals
  - ISO 9001 since 1993
  - NATO Secret Organization
  - Over 120 Systems and Software Engineers

■ ORGANIZATIONAL PROCESSES

- Systems & Software Engineering
- Document Inspection
- Configuration Management
- Quality Assurance
- Lessons Learned
- Staffing, Performance Management
- Documentation Management
- Contract Management
- Procurement Management

■ ENGINEERING PROCESS ASSET LIBRARY

- Policies
- Process Descriptions
- Guides, Forms and Templates
- Examples of Documents Produced
  - ⇨ Business Cases
  - ⇨ Proposals
  - ⇨ Engineering Plans
  - ⇨ Specifications
- Tailored Processes
- Process and Product Measures
- Lessons Learned
- Charter of Process Engineering Groups
- Training Material
- Historical Data

■ SYSTEMS ENGINEERING PROCESS (SEP)

- ⇨ Systems Engineering Capability Maturity Model
- ⇨ Generic Systems Engineering Process from Software Productivity Consortium (SPC)
- ⇨ The SEP activities can be performed:
  - ⇨ Concurrently
  - ⇨ Iteratively
  - ⇨ Recursively

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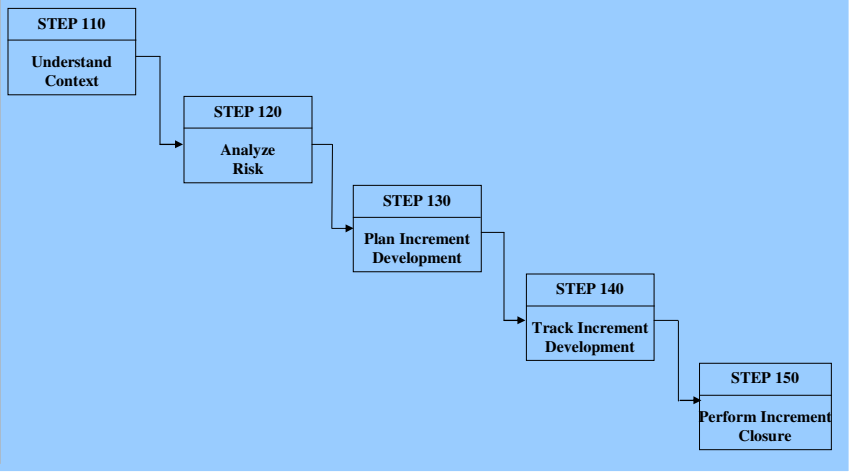
MANAGEMENT ACTIVITIES OF OA SEP



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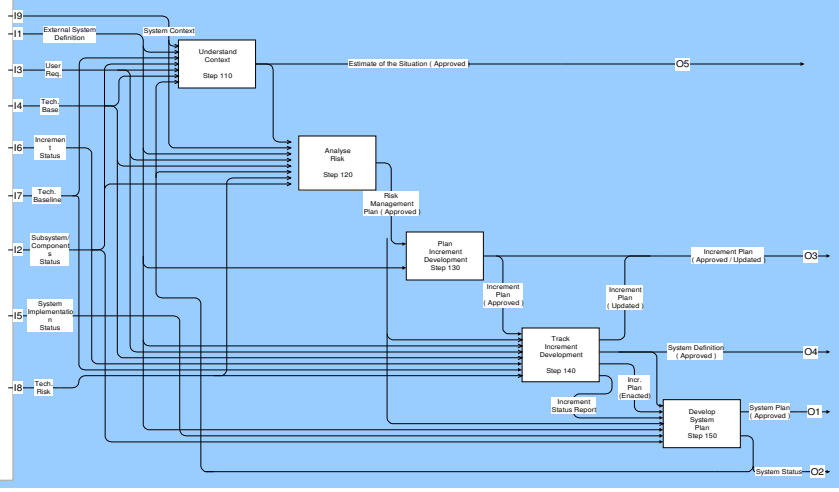
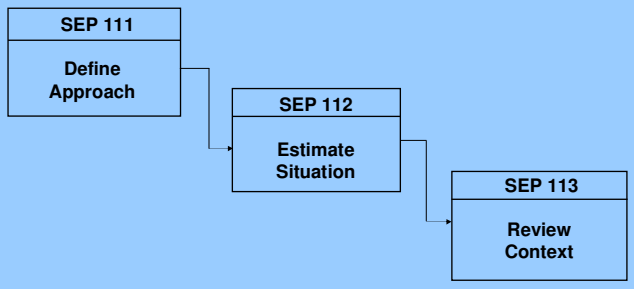
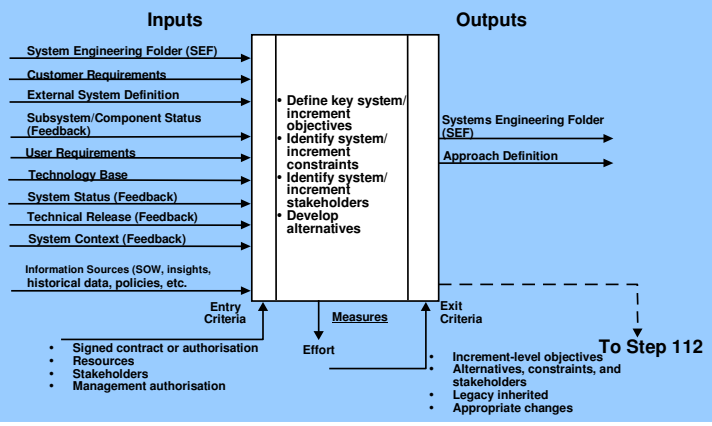


■ STEP 110 - UNDERSTAND CONTEXT

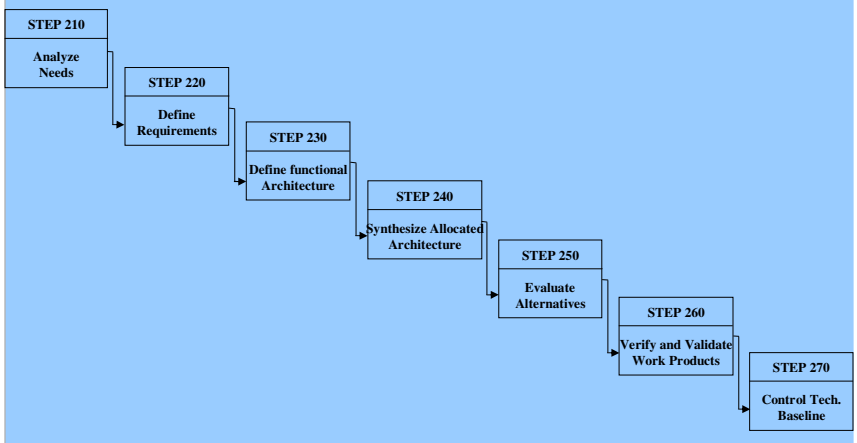


VIEW OF A PROCESS STEP

STEP 111 - Define Approach



TECHNICAL ACTIVITIES OF OA SEP



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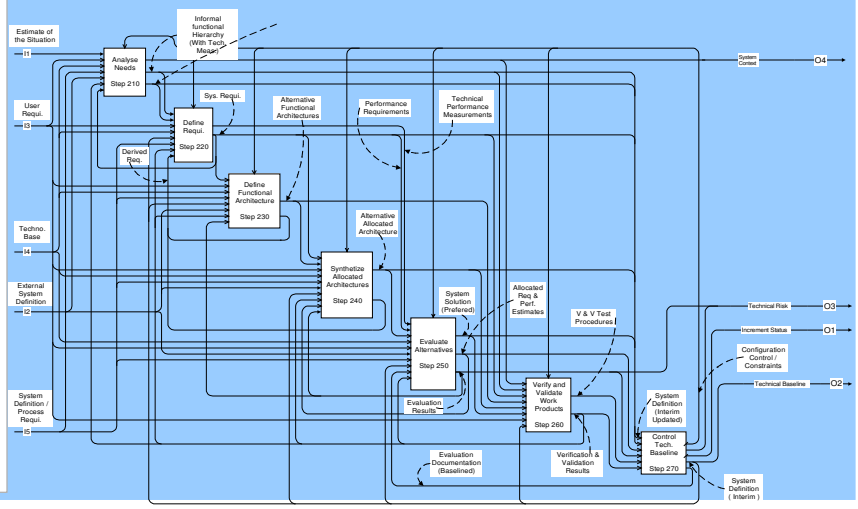

■ OVERVIEW OF LAUNCHER CONTROL UNIT

- Coordinates operation of sensors
  - Radar, FLIR,TV, wind sensor.
- Controls missile launch and guidance
- Guides missile flight with laser beam
- Tracks missile with infrared detectors
- Tracks targets
- Controls turret servo systems
- Interfaces with other sub-systems (consoles)

- MAIN OPERATOR CONSOLES FUNCTIONS
  - Radar console display and controls:
    - Radar Operation
    - C^3 Network Management
  - Electro-optical console display and controls:
    - Optical Sensors (FLIR, TV)
    - Missile Launch/Guidance

- RE-ENGINEERING PROJECTS
  - Divided in Two Increments
    - Increment One: System Definition Increment
      - Output:
        - System Requirement Specifications
    - Increment Two: Sw/Hw Development Increment
      - Outputs:
        - Set of Design and Equipment Specifications
        - Qualified Pre-Production Unit

Step 110 - Understand Context

- Sub Step 111 - Define the Approach
  - Activity 1 - Define Objectives of the Increment
    - Reduce production, life-cycle costs and part obsolescence
    - Improve growth potential (e.g. graceful degradation)
  - Activity 2 - Identify Project Constraints
    - Interface with existing components (e.g. missile, e-o)
    - HCI conflicting requirements from users/customers
  - Activity 3 - Identify Project Stakeholders
    - Current customer representatives and Current users
    - Marketing and business development
    - Senior management and Team members

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Step 110 - Understand Context

- Sub Step 111 - Define the Approach
  - Activity 4 - Develop Project Alternatives
    - Rehost functions on new hardware or incorporate new requirements
    - Select a development life-cycle
      - V ee (Forsberg)
    - Conduct Pilot project
    - Select Alternative Technologies (e.g. trade-off analysis)
    - Identify COTS
      - communication bus
      - processors
      - displays

Step 110 - Understand Context

- Sub Step 112 - Estimate the Situation
  - Put project knowledge together by documenting assumptions, decisions and their rationale
- Sub Step 113 - Review Context
  - Review estimate of the situation with stakeholders
  - Obtain commitment to go ahead
    - Go - No Go decision point
  - Agree on strategy
  - Commit resource allocation

Step 120 - Analyze Risks

- Risk Management Plan
  - Risk Descriptions and Impacts
    - Budget overrun, schedule delays, integration risks due to concurrency, new technologies
    - Documented, updated and stored in a database
  - Mitigation Strategies
    - Pilot projects, engineering models, mock-ups
    - Analyses
    - Component and subsystem modeling
    - Training
    - Reviews with stakeholders

Step 130 - Plan Increment Development

- Systems Engineering Management Plan (SEMP)
  - Revision of alternative solutions
  - Definition of TPMs, requirement management approach, training plan, CM,QA, technical and project reviews.
  - Description of the increment, e.g. reverse engineering
  - Look ahead of next increment, e.g. forward engineering
    - Problems, needs and constraints (SEP 210)
    - Function definition (SEP 220, 230)
    - Functional allocation (SEP 240)
    - Definition of system (SEP 250)
- Development of the Organizational Breakdown Structure (OBS)
- Development of the Work Breakdown Structure (WBS)
- On-going execution of risk aversion

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Step 140 - Track Increment Development

- Formal reviews
- Update the SEMP

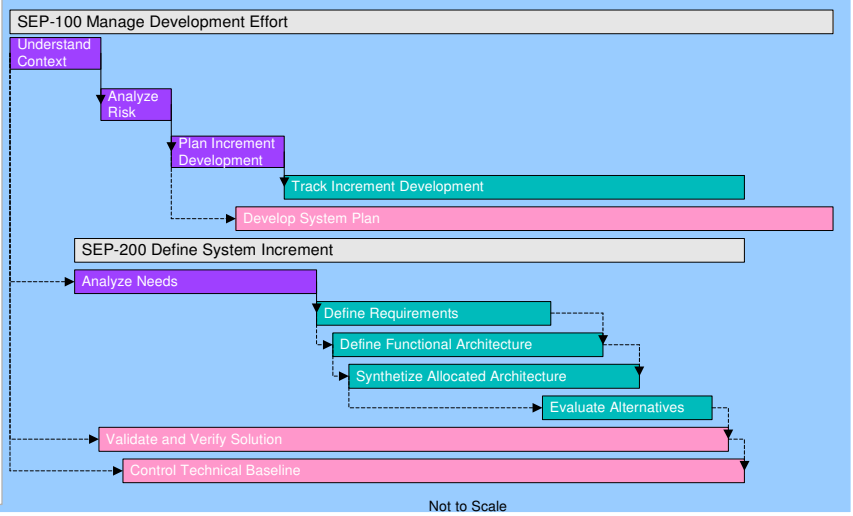
Step 150 - Perform Increment Closure

- On-going capture of work products (e.g. developmental configuration management)
- Capture Lessons learned from the increment
- Baseline work products

Step 200 - Technical Activities

- Step 210 - Analyze Needs
  - Legacy system requirements were known
  - Comments, suggestions, deficiencies were captured
  - Potential customer's requirements were captured
  - Compile, analyze, prioritize
  - Operational scenarios and environment re-assessed
  - Review with stakeholders in parallel with Risk Management Plan
- Steps 220 - Define Requirements, 230 - Define Functional Architecture, 240 - Synthesize Allocated Architecture and 250 -Evaluate Alternatives
  - Performed iteratively
- Step 260 - Verify and Validate Work Products
  - Requirements and verification requirements, stored in a database

A SEP INCREMENT (*THE REAL LIFE*)



■ LESSONS LEARNED

- Use Pilot Projects to Mitigate Risk
  - ⇨ Members of Pilots projects have a Safety Net for ¨mistakes¨
    - Selection of participants that knew the system process
    - Other participants were coached
  - ⇨ Success of Pilots facilitates adoption of technologies
- Size of Increments
  - ⇨ Manageable length so to be able to assess progress.
  - ⇨ Well identified deliverables: % of completion can be assessed.
- Experienced Project Manager
  - ⇨ First time use of an incremental process
- Series 100 steps were performed in sequence while series 200 steps were performed in multiple iterations

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■ NEXT STEPS

- Integrate SEP with Project Management Process and Software Development Process (e.g. risk management)
- Define Project Metrics and Process Tailoring Guidelines
- Apply SEP to detailed design & development phase
- Map SEP to CORE® Systems Engineering Tool

■Conclusion

- Process was found very useful in planning activities, collecting and managing technical information
- Pilot projects helped in better understanding the SEP
- Experienced project managers are still required
  - ⇨ The systems engineering process cannot be followed blindly