PROBLEM SPACE MODELING
A Dynamic Future For Requirements Analysis

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Agenda

• A current reality
• Program preparation
• Traditional structured analysis
• UML
• The future
How Should the Engineer Approach Unprecedented Problem Space?
System Entities

FAMILY OF SYSTEMS A

AIRCRAFT SYSTEM A1

SATellite SYSTEM A2

LAND SYSTEM A3

WEAPONS SYSTEMS A4

SOFTWARE ENTITIES
A Single Model Will Not Work

System Elements

Software Content

Hardware Content
Prepare the Enterprise

- TOOLS
- TEMPLATE
- DOMAINS
- METHODS
- SDD TEMPLATE
- MAP METHODS AND DOMAINS TO TEMPLATE, BUILD DID
- RAS & DATABASE
- REQUIREMENTS ANALYSIS
- SYSTEM & HW SOFTWARE
- PREPARE SDD
- PUBLISH SPECIFICATIONS
- SPECIFICATIONS

SYSTEM DEFINITION DOCUMENT

11-A-6
Prepare the Enterprise

• Select standards and corresponding templates
• Select preferred structured analysis models
• Tailor templates for alignment with models you choose to use to explore problem space
• Build data item description (DID) for each specification type/model application
  – System specification/TSA
  – Hardware performance specification/TSA
  – Software performance specification/UML
  – Software performance specification/DoDAF
  – Hardware ICD/TSA and software IRS/UML and DoDAF
• Map organization and models to template
• Apply SDD as a means to capture models products
### Generic Template

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
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<tbody>
<tr>
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<td>Entity capability m</td>
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<td>3.6</td>
<td>Precedence and criticality considerations</td>
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11-A-8
Do the Analysis Work Using Preferred Models

- **Tools**
- **Template**
- **Domains**
- **Methods**

MAP METHODS AND DOMAINS TO TEMPLATE, BUILD DID

**Prepare SDD**

PREPARE SDD

1I-A-9

**RAS & Database**

RAS & DATABASE

**System & HW**

SYSTEM & HW

**Software**

SOFTWARE

**Requirements Analysis**

REQUIREMENTS ANALYSIS

**Publish Specifications**

PUBLISH SPECIFICATIONS

**Specifications**

SPECIFICATIONS

**System Definition Document**

SYSTEM DEFINITION DOCUMENT

SDD TEMPLATE

**System & HW**
The Process

- Available Specification Templates
- Available Functional Departments
- Available Approved Models
- System Definition Document Template
- Available Computer Tools
- Specification Data Item Description
- Map Models & Departments to Templates
- Generic Preparation Work
- Accomplish Planned Modeling Work
- Manage Database
- Enter Requirements into RAS
- Publish Specification
- Enter SDD Data into the Record
- Publish SDD

Enterprise Engineering
Traditional Structured Analysis

Template/ DID

System Definition Document

Specification

NOTE
Specification template paragraph numbers in red.
Functional Decomposition

Using decimal-delimited level notation.
Integrated RAS and N-Square Diagram
For Internal and External Interface
## Identification of Specialty Engineering Constraints

### ARCHITECTURE-SPECIALTY ENGINEERING MATRIX (DESIGN CONSTRAINTS SCOPING MATRIX)

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### SPECIALTY ENGINEERING REQUIREMENTS FLOW INTO THE INDICATED SPECIFICATIONS THROUGH THE RAS

### SDD APPENDIX E
Specialty Engineering Allocation
Specialty Discipline Q7 Allocated to Architecture A11
Four System Environmental Classes

- **SYSTEM ENVIRONMENT**
  - **COOPERATIVE ENVIRONMENT** (QC)
  - **NON-COOPERATIVE ENVIRONMENT** (QX)
  - **HOSTILE ENVIRONMENT** (QH)
  - **NATURAL ENVIRONMENT** (QN)
  - **SELF-INDUCED ENVIRONMENT** (QI)

  **SYSTEM SPACE** (QN1)
  **SYSTEM TIME** (QN2)
  **NATURAL STRESSES** (QN3)

  DEVELOPED AS ENVIRONMENTAL STRESSES
  SEE SDD APPENDIX B

  DEVELOPED AS EXTERNAL INTERFACES
  SEE SDD APPENDIX D

SEE SDD APPENDIX B

SEE SDD APPENDIX D
Three Environmental Requirements Layers

• **System**
  – Identify spaces within which the system will have to function
  – Select standards covering those spaces
  – For each standard, select parameters that apply
  – Tailor the range of selected parameters

• **End item**
  – Build three dimensional model of end items, physical processes, and process environments
  – Extract item environments

• **Component**
  – Zone end item into spaces of common environmental characteristics
  – Map components to zones
  – Components inherit zone environmental requirements
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Prepare the SDD Capturing the Analytical Work Products

- TOOLS
- TEMPLATE
- DOMAINS
- METHODS
- SDD TEMPLATE

MAP METHODS AND DOMAINS TO TEMPLATE, BUILD DID

PREPARE SDD

RAS & DATABASE

REQUIREMENTS ANALYSIS

SYSTEM & HW

SOFTWARE

PUBLISH SPECIFICATIONS

SPECIFICATIONS

SYSTEM DEFINITION DOCUMENT

SYSTEM & HW

SOFTWARE

PREPARE SDD

TOOLS

TEMPLATE

DOMAINS

METHODS

SDD TEMPLATE

1I-A-20
Structured Analysis Work Product
Capture and Configuration Management
Accomplish the SW Analysis

1. MAP METHODS AND DOMAINS TO TEMPLATE, BUILD DID
2. RAS & DATABASE
3. REQUIREMENTS ANALYSIS (RAS & DATABASE)
4. SYSTEM & HW
5. SOFTWARE
6. PREPARE SDD
7. PUBLISH SPECIFICATIONS
8. SYSTEM DEFINITION DOCUMENT

TOOLS

TEMPLATE

DOMAINS

METHODS

SDD TEMPLATE
Unified Modeling Language Implementation Approach

1. Need
   - AND
   - XOR

2. Dynamic Analysis
   - Communication Analysis
   - Sequence Diagram Analysis
   - State Analysis

3. Requirements Analysis and Specification Publication
   - Design Software
     - Packaging Analysis This Level
     - Class, Object, Component, Node, Subsystem

4. Structural Classifier Analysis
   - Start Spiral N+1

5. Format and Publish Specification
   - Write Code
   - Formally Verify Code

6. Specification Template
   - Simulate

7. XOR
   - Assign Swim Lanes To Activity Diagrams
   - Assign/Adjust Classifiers
   - Integrate Activity Diagrams

8. IOR
   - Build Context Diagram
   - Build Use Cases For Each Terminator
   - Build Scenarios For Each Use Case

9. XOR
   - Translate Scenarios Into Activity Diagrams
   - LP
   - LP
   - LP

10. XOR
    - Allocate
Structural Classifier Analysis

Context Diagram

Use Cases

Scenarios

Activities

Final Activity View

Swim Lanes
Not Illustrated

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Activity Integration

Not Illustrated
Swim Lanes for Allocation

COMPONENT AX31  COMPONENT AX32  COMPONENT AX33

NY1

NY2

NY3

NY4  NY5

NY6

ACTIVITY DIAGRAM FOR NODE AX3

II-A-25
Progressive Identification of Product Entities

SYSTEM A

SOFTWARE ENTITY AX

NODE AX1

NODE AX2

NODE AX3

COMPONENT AX33

COMPONENT AX31

COMPONENT AX32

CLASS AX311

OBJECT AX3111
Dynamic Diagrams to Explore Product Entity Capabilities

Sequence Diagram

State Diagram

Communication Diagram
The Entity Capabilities Flow Into the Specification Through the RAS

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<th>PRODUCT ENTITY</th>
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Specification
A Particular Implementation Today

- Enhanced FFBD in Core
- Modern Structured Analysis using STP
- Manually accomplished N-Square Analysis
- Publish Specification
- RAS in Doors
- Vertically traceability
- Manually accomplished Environmental Analysis
- UML accomplished with Rational Products
Publish the Results

- TOOLS
- TEMPLATE
- DOMAINS
- METHODS

MAP METHODS AND DOMAINS TO TEMPLATE, BUILD DID

RAS & DATABASE

SYSTEM & HW

SOFTWARE

PREPARE SDD

SPECIFICATIONS

SDD TEMPLATE

SYSTEM DEFINITION DOCUMENT

SPECIFICATIONS

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ANALYSIS

SOFTWARE

SYSTEM & HW

SPECIFICATIONS

ANALYSIS
Specification Review and Approval Process
Toward Process Simplicity

Modern Structured Analysis

Early OOA

SOFTWARE PATH

Use of Executable Models

1950s

SYSTEMS AND HARDWARE PATH

Traditional Structured Analysis

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## Evidence of an Approach Path

### UML and TSA

#### UNIFIED MODELING LANGUAGE (UML)

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#### TRADITIONAL STRUCTURED ANALYSIS (TSA)

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11-A-33
We Still Have to Push These Together Some More
Movement to Model-Driven Development

RISE IN THE USE OF STRUCTURED ANALYSIS

1920  1970  1990  2010  2030  DATES ARE NOTIONAL

MODEL DRIVEN DEVELOPMENT

DATABASE DRIVEN DEVELOPMENT

DOCUMENT DRIVEN DEVELOPMENT

DATES ARE NOTIONAL