Managing Requirements within the Context of Architecture:
Logical Architecture and Functional Requirements

Raymond Jorgensen
Rockwell Collins
Objectives

- Materials extracted from course “Requirements Analysis & Design”

- Understand ‘product requirements’ classification and derivation.
- Understand why we define product requirements and solution architecture
- Understand ‘requirements’ and ‘design’ and their complementary natures.
- Describe the relationship between functional requirements and functions or activities.
- Apply basic logical architectural diagramming concepts.
- Apply an effective structure for organizing functional requirements.
Categories of Requirements

- Contract
- Organizational Policy
- Military Regulations
- Agency Directives
- Project Requirements
- Policy Requirements
- Statement of Work
- Technical Requirements
  - Origination Requirements
  - Operational Concepts
  - Product Requirements

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A statement that identifies a product or process operational, functional, or design characteristic or constraint, which is unambiguous, testable, or measurable, and necessary for product or process acceptability. IEEE Std 1220-1998
Why Define Product Requirements?

- Product requirements...
  - Define the thing to be built – what are it’s expected capabilities & characteristics?
  - Establishes an agreement/ understanding between you and your customer about the definition of your product
  - Establishes an agreement/ understanding between you and your design team about the definition of your product
  - Defines the basis for product verification
  - Reconciles your product definition (or product family) with a diverse collection of customer source requirements
Why Define Solution Architecture & Design?

- Solution Architecture...
  - Establishes the vision of the product solution – what are we building?
  - Assigns project participants to individual components – who is responsible for what parts?
    - Divide and conquer
    - Ownership and control
  - Bounds the context of each individual component – how does it fit into the greater whole?
  - Establishes common understanding of the solution to be created
Who Defines Product Requirements and Solution Architecture?

- Commonly – systems engineers
  - Or any engineer on the project team serving in the role
    - Analyst – expose the problem statement – what should be built?
    - Architect – expose the solution space – how are we going to build it

- A lead engineer or any engineer assigned “ownership” of a product item

It’s in the lead engineer’s best interest to define the product requirements and solution architecture.
Understanding Requirements & Design

• **Product Requirements**
  - Express boundaries of the problem statement (what)
    - Capability
    - Behavior
    - Characteristics
    - Performance
    - Quality

• **Product Design**
  - Define the solution to the problem (how)
    - Form
    - Structure
    - Composition
    - Relationships
    - Interaction

"derived from" or "satisfies"

Myth?
“One product’s design becomes another product’s requirement.”

Truth?
“One product’s design provides the context and constraints for another product’s requirements.”

Requirements - Define the “Problem Space.”

Design – Defines the “Solution Space.”
Functional Analysis with Logical Design

- Define Functional Requirements (what does it do?)
- Define Interface Requirements (what are the logical interfaces?)
- Define Physical Requirements (what are the characteristics of the physical product/environment?)
- Define Logical Architecture (how does it logically fit together?)
- Define Interface Design (what is the interface design definition?)
- Define Physical Architecture (what will the solution look like?)

Capture Originating Requirements
Define Operational Concepts
Define Requirements
Design Solution
Implement Solution
Perform detailed design

Support Solution
Develop Validation Cases & Procedures
Develop Verification Cases & Procedures
Develop Acceptance Procedures
Integrate Solution
Validate Solution
Verify Solution

Perform product analysis
Functional Requirements

- Describe behavior: logical and mathematical
- Answer “What does this function do?”
- Must address each input / output interface introduced
- Derived from:
  - most important requirements (MIRs)
  - use cases & scenarios
  - source requirements
  - stakeholder needs
  - architectural context

A solution update SHALL be provided for application to the following Navigation Solutions:
- INU
- ---/A/H or DEAD RECKON
Shout Out!

• What is a “function”?

• What is the difference between each of the following?
  – Function
  – Activity
  – Use Case
  – Scenario
  – Application
  – Component
What is a Function?

Function:
- Logical construct that illustrates conceptual understanding of behavior – represents work, activity, action (not a physical or software component)

Functional Requirement
- Defines behavior or capability
- Captures performance of the capability

“realizes” or “defined by”

Functional definition must be independent of the physical architecture or implementation

“Form Follows Function”
Exposing Functionality

Scenarios expose:
- Functions
- Functional Requirements
- Functional Interfaces
- User Interfaces
Deriving Functionality

Which comes first? The function ... or the functional requirement?

Where did the outline of the functional requirements section of your requirements document come from?
Functional Analysis - Hierarchical Relationship

Functions are often associated within a functional hierarchy. Outline of functional requirements document often a functional hierarchy.

Logical hierarchy provides the basis for organization and order of functional requirements.
Functional Analysis – Logical Hierarchy

Functional Composition is a DESIGN activity –
Breaking down and grouping similar functions
Functional Analysis – Logical Architecture

Functional Design: Within a layer of the functional hierarchy, the declaration of each function and the interrelationships between the different functions is DESIGN.

Functional Design – the relationships between each of the functions – provides the basis for the Logical Architecture
### Functional Definition

For each function, a design definition is captured for further functional composition (as needed).

Each requirement may have one of more definitions that elaborate on that requirement:
- Comment
- Rationale
- Trade Study

A set of requirements defines a function.
Logical Representation Diagrams

- Hierarchical Perspective – diagrams showing composition
- Chronological Perspective – diagrams showing timing, flow, or sequence
- Transactional Perspective – diagrams showing object or transactional flows
- Allocation Perspective – diagrams showing allocation of function to physical element
Logical Representation – Hierarchical Perspective

- «RC_Activity» Compute INU/GPS Navigation Solution
- «RC_Activity» Compute GPS Smoothed Solution
- «RC_Activity» Computer Inertial (INU) Navigation Solution
- Update Navigation Solution
- «RC_Activity» Compute Radio Navigation Solution

- Provide update fix reference
- Determine Estimated Position
- Calculate update vector
- Apply updated navigation solution

Illustrates composition “is part of”
Logical Representation – Hierarchical Perspective

Hierarchy shown with superposition.

- Provide update fix reference
- Determine Estimated Position
- Calculate update vector
- Apply updated navigation solution
Logical Representation – Chronological Perspective

- Illustrates sequence of activities
- Captures activity order – parallel or serial work

Illustrates sequence or control flow "...and then ..."

Note also combined "Allocation Perspective"
**Logical Representation – Chronological Perspective**

Illustrates parallel/serial nature of work flow.

- **Determine Estimated Position**
- **Provide update fix reference**
- **Calculate update vector**
- **Apply updated navigation solution**

... and this one also includes Hierarchical Perspective.

... could include fork/join and/or decision nodes.
Logical Representation – Chronological Perspective

- Activity Initial
- «RC_Activity» Activity or Function aka f(x)
- «RC_Activity» Another Activity
- Decision Activity
- [True]
- «RC_Activity» and then we do this...
- [False]
- «RC_Activity» or we do this...
- «RC_Activity» and end doing this
- Activity Final

Illustrates a decision point with two or more optional paths to proceed forward.
Logical Representation – Transactional Perspective

- With implied sequence/order
- With hierarchical nesting

Illustrates transaction or object flows
Composite view of many object flows from all scenarios

... with hierarchical nesting.

Illustrates transaction or object flows

Transactional Perspective
Functional Requirements Referencing Logical Interface Objects

Functional requirements should consider inputs and outputs, and how the product acts on the inputs to produce the outputs.

[When <input> <conditional clause>,] the solution shall <function, action, behavior> [<output> <conditional clause>]

When an interface identifier name is referenced within a requirement statement, the reference should be made directly to the actual logical interface object. A relationship should exist between the reference and the interface itself.
Functional Requirements: Logical Interface Objects

Reference Logical Interface Objects explicitly

Use a technique to call attention to the referenced logical interface object – bold, italics, different font, etc.

1. When a CURRENT Inventory Request is requested, the solution shall present a Current Inventory report listing.

2. When a SHORTAGE Inventory Request is requested, the solution shall present an Inventory Shortages report listing.

3. When an Updated Item inventory modification is submitted, the Current Inventory will be updated to account for the adjusted item.
Logical architecture provides the foundation for publishing the functional requirements and logical design information.
3.0 Functions

3.2 <Function Name>

Constraints (boundary)
Limits imposed by external actors on the function aka “Constraining Requirements”

Functional Requirements (what)
Capability definition, incl commentary

Performance Requirements (how well)
Performance definition, incl commentary

Logical Design (how)
Design definition – architecture diagrams with description

3.2.1 <Subfunction Name>
Same structure
3.2.2 <Subfunction Name>
3.2.3 <Subfunction Name>

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Summary

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Conclusions

• Definite synergy between functional requirements, functions (activities), and logical architecture (functional composition)
• Consider the following:
  – Where did the outline of your functional requirements come from?
• How can you more effectively express the structure of your requirements?
• Functional requirements more effectively expressed within context of the logical architecture
Presenter Information

Raymond Jorgensen
Rockwell Collins, Inc
400 Collins Rd NE, MS 188-400
Cedar Rapids, IA 52498
rwjorgen@rockwellcollins.com
319-295-2615