

REQUIREMENTS & SPECIFICATIONS

18-849b Dependable Embedded Systems

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Required Reading: **Designing Real-Time Systems with UML by Bruce Powel Douglass**

**Carnegie
Mellon**

Overview: Requirements & Specifications

◆ Introduction

- Why do we care about requirements and specifications?

◆ Key concepts

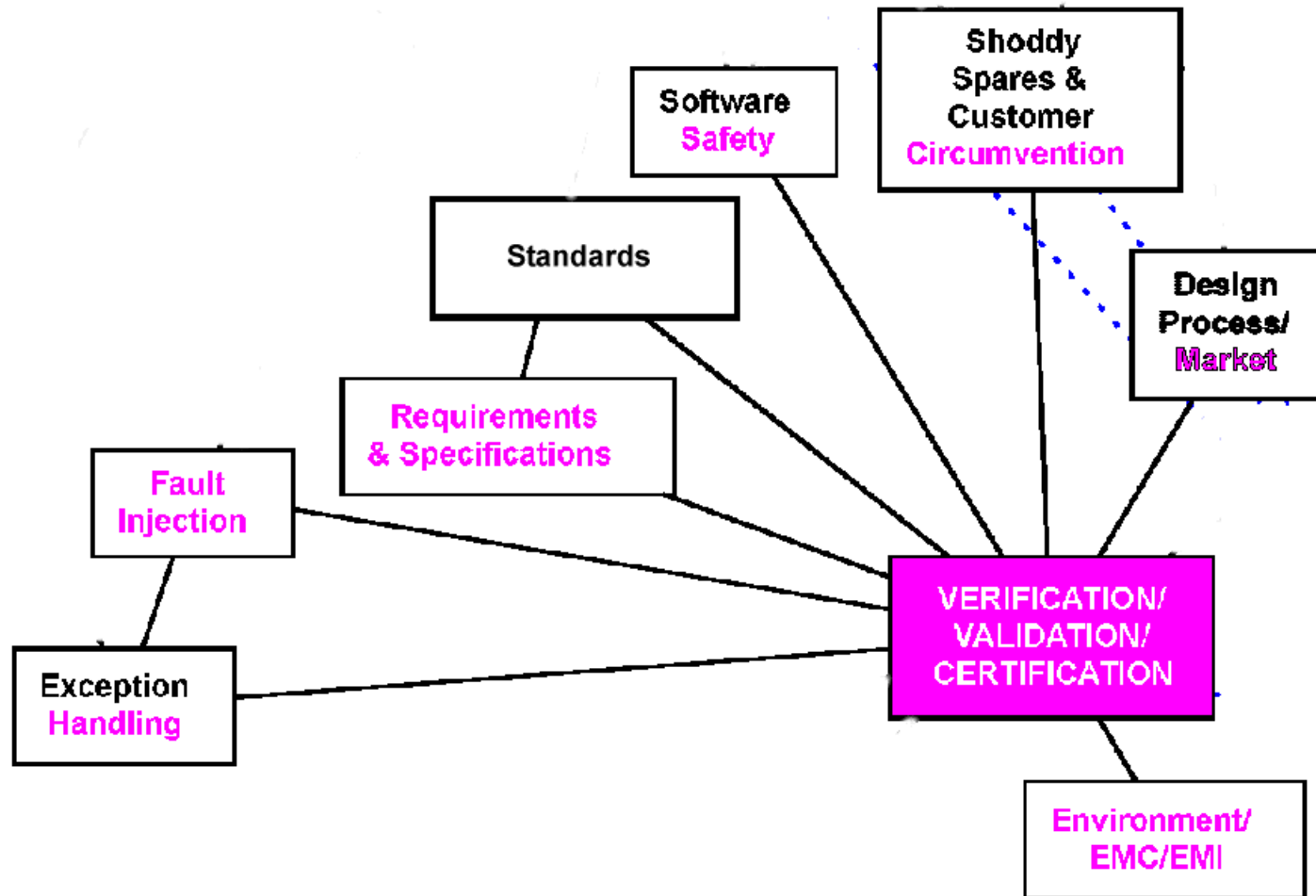
- Establishing correct requirements
- Requirement and specification's role in system design
- Requirements Traceability
- Requirements Standards

◆ Tools / techniques

◆ Relationship to other topics

◆ Conclusions & future work

YOU ARE HERE MAP



Description of Topic

Requirement - a condition needed by a user to solve a problem or achieve an objective.

Requirements specification - a document that specifies the requirements for a system or component. Includes functional, performance, interface, design requirements and development standards.

Specification - a document that specifies, in a complete, precise, verifiable manner, the requirements, design, behavior, or other characteristics of a system, and often, the procedures for determining whether these provisions have been specified.

Description of Topic

Why do we care about requirements and specifications?

- Requirements analysis is the first step in any system design process, where a user's requirements should be clarified and documented to generate the corresponding specifications.
- Activities in this first stage has significant impact on the downstream results in the system life cycle.
- Many accidents are traced to requirements flaws, incomplete implementation of specifications, or wrong assumptions about the requirements.

Establishing Correct Requirements

◆ Negotiating a common understanding

- *“There’s no sense being exact about something if you don’t even know what you’re talking about”* - John von Neumann
- Problem stems from ambiguities in stating requirements

◆ Getting started

- Asking questions
- Getting the right people involved and making meetings work
- Reducing ambiguities

◆ Exploring possibilities

- Generating ideas
- Resolving conflicts

Establishing Correct Requirements

◆ Clarifying expectations

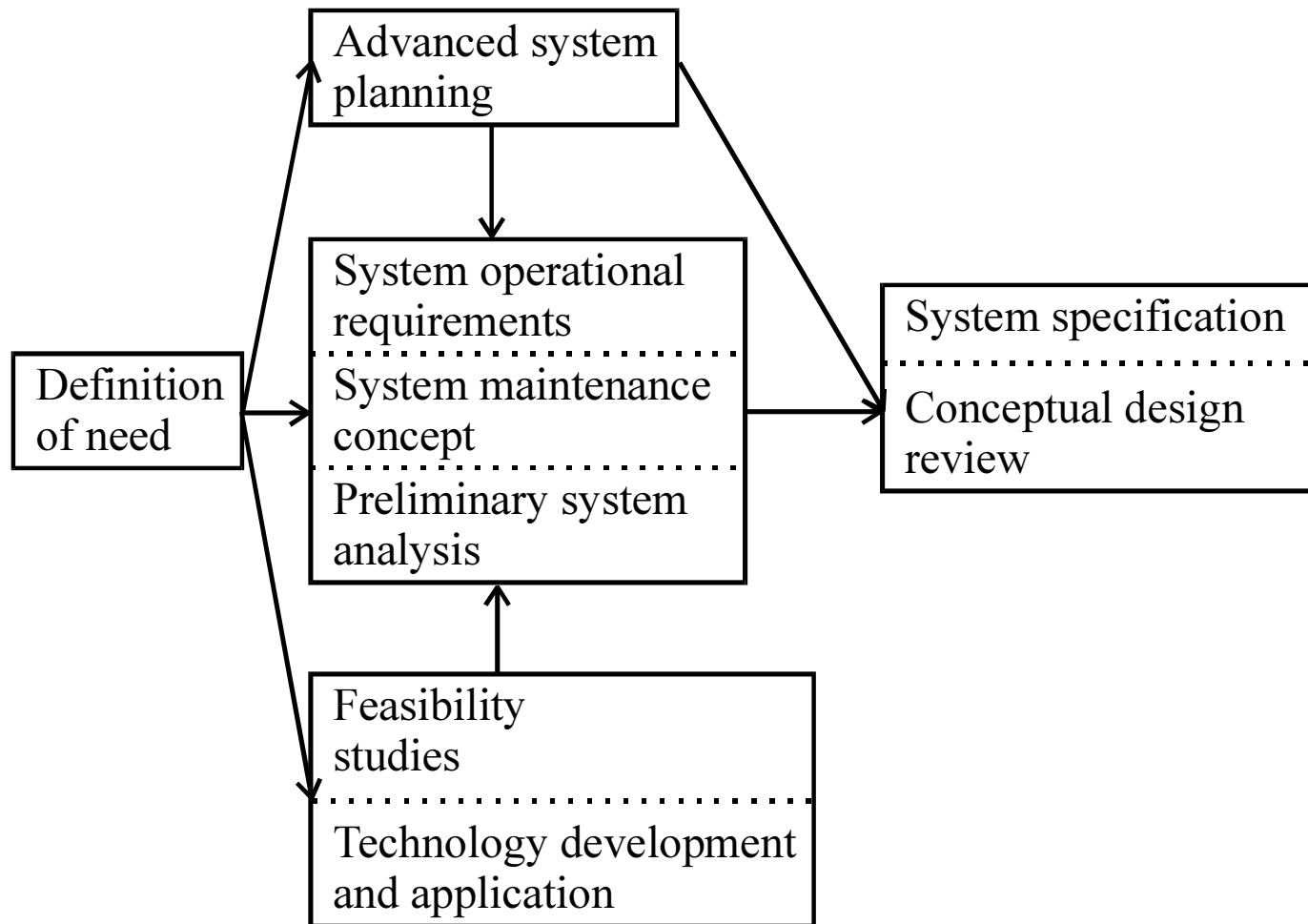
- Establishing functions, attributes, constraints, preferences, and expectations

◆ Improving the odds of success

- Ambiguity metrics
- Technical reviews
- Measuring satisfaction
- Test cases
- Studying existing products

Req. & Spec.'s Role in System Design

◆ Definition of Need



[Blanchard90]

Req. & Spec.'s Role in System Design

◆ Preliminary systems analysis process

1. Define the problem
2. Identify feasible alternatives
3. Select the evaluation criteria
4. Apply modeling techniques
5. Generate input data
6. Manipulate the model

◆ System planning

- Results from system planning are classified into 2 kinds of requirements - technical requirements and management requirements

◆ Conceptual design review

Requirements Traceability

- ◆ Defined as “the ability to follow the life of a requirement, in both forwards and backwards direction (i.e. from its origins, through its development and specification, to its subsequent deployment and use, and through periods of on-going refinement and iteration in any of these phases.)” [Ramesh95]
- ◆ Captures relationships between requirements, specifications, and design.
- ◆ Major problem currently is that definition of traceability differs when taken from different points of view of the system.(i.e. view of the system is different customer, project manager, test engineer, etc.)

Requirements Standards

- ◆ **Mostly military standards as opposed to “commercial” standards.**
- ◆ **Mostly in systems engineering area, and deals with software aspects.**
- ◆ ***Standards, Guidelines, and Examples on System and Software Requirements Engineering* from IEEE Computer Society Press contains a compilation of international requirements standards and U. S. military standards, and a section on requirements analysis methodologies and examples.**

Tools / Techniques

◆ QFD (Quality Function Deployment)

- Method for structured product planning and development that enables a development team to specify clearly the customer's wants and needs, and then evaluate each proposed product or service capability systematically in terms of its impact on meeting those needs.

	1	2	3	4	5
A		◎			
B	○				
C					
D					
E					

- Moderate relationship
◎ Strong relationship

◆ UML (Unified Modeling Language)

- An object-oriented modeling language for the specification of complex systems.

Tools / Techniques

- ◆ **Requirements traceability tool**
 - RDD-100 from Ascent Logic
- ◆ **Requirements simulation tools**
 - Foresight from Nu Thena Systems
 - SES Workbench
 - Rational Rose

Relationship To Other Topics

◆ Standards

- Some requirements come from standards

◆ Verification/validation/certification

- It is necessary to be able to trace implementation back to requirements

◆ Social and legal concerns

- Whose responsibility is it when the cause of an accident traces back to the requirements and specifications?

Conclusions & Future Work

- ◆ It is essential to establish correct requirements and specifications early in the development process to prevent errors later on in the system life cycle.
- ◆ This requires people with not only technical skills but also communication skills.
- ◆ Specifying correct requirements is more of an art than a science.
- ◆ **Future work**
 - Use of the UML for real-time embedded systems - are there any shortfalls?
 - Trend toward executable requirements and simulations.

Required Paper

Designing Real-Time Systems With UML - Part 1, 2, and 3 *by Bruce Powel Douglass*

◆ Part 1

- Identifies the major notational and semantic features of the UML

◆ Part 2 and 3

- Example of how the UML can be used to develop a real-time embedded system, an anesthesia patient ventilator

◆ Major results

- The UML provides an effective way for analyzing and designing real-time embedded systems
- The UML is supported by all major CASE tool vendors