Requirements Engineering

An introduction to requirements engineering

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Objectives

- To introduce the notion of system requirements and the requirements engineering process.
- To explain how requirements engineering fits into a broader system engineering process
- To explain the importance of the requirements document

System requirements

- Define what the system is required to do and the constraints under which it is required to operate
  - The system shall maintain records of all library materials including books, serials, newspapers and magazines, video and audio tapes, reports, collections of transparencies, computer disks and CD-ROMs.
  - The system shall allow users to search for an item by title, author, or by ISBN.
  - The system's user interface shall be implemented using a World-Wide-Web browser.
  - The system shall support at least 20 transactions per second.
  - The system facilities which are available to public users shall be demonstrable in 10 minutes or less.

Types of requirements

- Very general requirements which set out in broad terms what the system should do.
- Functional requirements which define part of the system's functionality.
- Implementation requirements which state how the system must be implemented.
- Performance requirements which specify a minimum acceptable performance for the system.
- Usability requirements which specify the maximum acceptable time to demonstrate the use of the system.

Requirements problems

- The requirements don't reflect the real needs of the customer for the system.
- Requirements are inconsistent and/or incomplete.
- It is expensive to make changes to requirements after they have been agreed.
- There are misunderstandings between customers, those developing the system requirements and software engineers developing or maintaining the system.

FAQS about requirements

- What are requirements?
  - A statement of a system service or constraint
- What is requirements engineering?
  - The processes involved in developing system requirements
- How much does requirements engineering cost?
  - About 15% of system development costs
- What is a requirements engineering process?
  - The structured set of activities involved in developing system requirements

FAQs contd.

- What happens when the requirements are wrong?
  - Systems are late, unreliable and don't meet customers needs
- Is there an ideal requirements engineering process?
  - No - processes must be tailored to organisational needs
- What is a requirements document?
  - The formal statement of the system requirements
- What are system stakeholders?
  - Anyone affected in some way by the system

FAQs contd.

- What is the relationship between requirements and design?
  - Requirements and design are interleaved. They should, ideally, be separate processes but in practice this is impossible
- What is requirements management?
  - The processes involved in managing changes to requirements

Systems engineering

- There is a close relationship between software and more general system requirements
- Computer-based systems fall into two broad categories:
  - User-configured systems where a purchaser puts together a system from existing software products
  - Custom systems where a customer produces a set of requirements for hardware/software system and a contractor develops and delivers that system

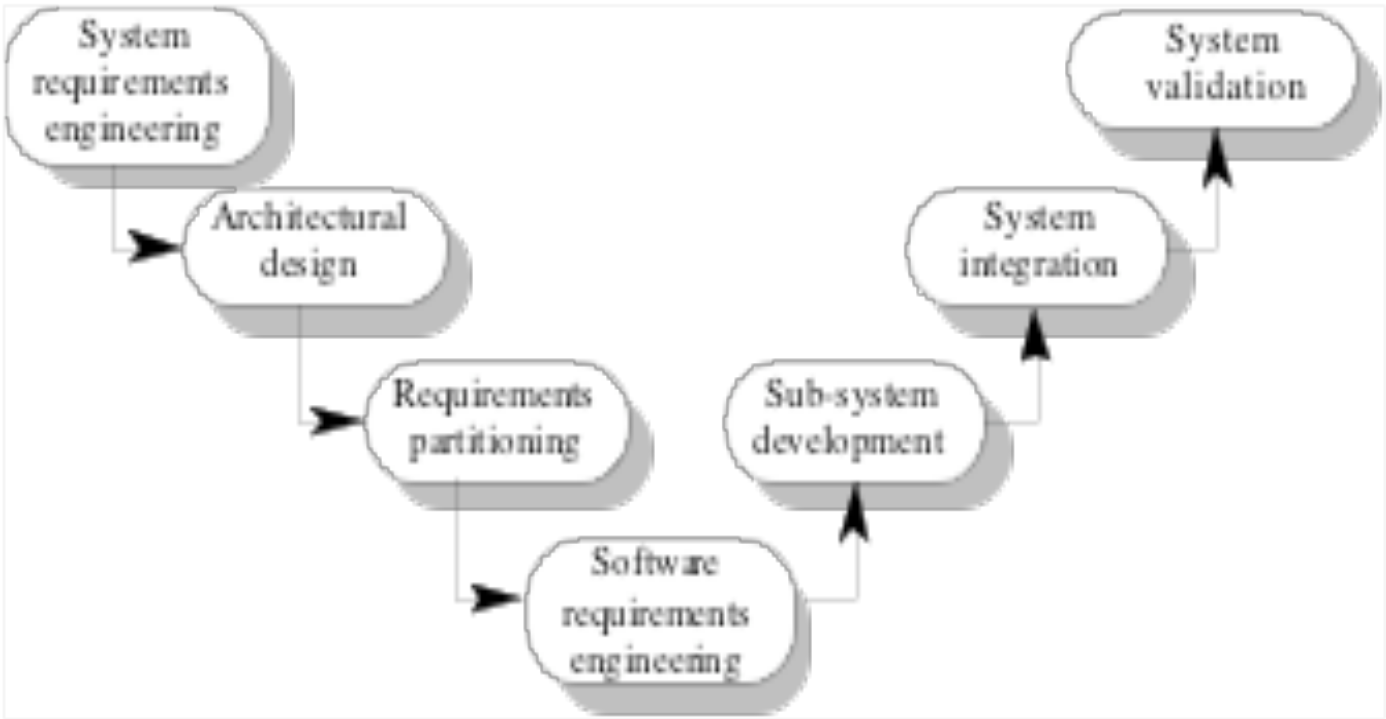
Classes of custom systems

- Information systems
  - Primarily concerned with processing information which is held in some database.
- Embedded systems
  - Systems where software is used as a controller in some broader hardware system
- Command and control systems
  - Essentially, a combination of information systems and embedded systems where special purpose computers provide information which is collected and stored and used to make decisions

Emergent properties

- Emergent properties are properties of the system as a whole and only emerge once al of its individual sub-systems have been integrated
- Examples of emergent properties
  - Reliability
  - Maintainability
  - Performance
  - Usability
  - Security
  - Safety

The systems engineering process



System engineering activities

- System requirements engineering
  - The requirements for the system as a whole are established and written to be understandable to all stakeholders
- Architectural design
  - The system is decomposed into sub-systems
- Requirements partitioning
  - Requirements are allocated to these sub-systems
- Software requirements engineering
  - More detailed system requirements are derived for the system software

System engineering activities

- Sub-system development
  - The hardware and software sub-systems are designed and implemented in parallel.
- System integration
  - The hardware and software sub-systems are put together to make up the system.
- System validation
  - The system is validated against its requirements.

Requirements document

- The requirements document is a formal document used to communicate the requirements to customers, engineers and managers.
- The requirements document describes:
  - The services and functions which the system should provide
  - The constraints under which the system must operate
  - Overall properties of the system i.e.. constraints on the system's emergent properties
  - Definitions of other systems which the system must integrate with.

Requirements document

- The requirements document describes:
  - Information about the application domain of the system e.g. how to carry out particular types of computation
  - Constraints on the processes used to develop the system
  - Description of the hardware on which the system is to run
- In addition, the requirements document should always include an introductory chapter which provides an overview of the system, business needs supported by the system and a glossary which explains the terminology used.

Users of requirements documents

- System customers
  - specify the requirements and read them to check they meet their needs
- Project managers
  - Use the requirements document to plan a bid for system and to plan the system development process
- System engineers
  - Use the requirements to understand the system being developed
- System test engineers
  - Use the requirements to develop validation tests for the system
- System maintenance engineers
  - Use the requirements to help understand the system

Requirements document structure

- IEEE/ANSI 830-1993 standard proposes a structure for software requirements documents
- Introduction
  - 1.1 Purpose of requirements document
  - 1.2 Scope of the product
  - 1.3 Definitions, acronyms and abbreviations
  - 1.4 References
  - 1.5 Overview of the remainder of the document

Requirements document structure

- 2. General description
  - 2.1 Product perspective
  - 2.2 Product functions
  - 2.3 User characteristics
  - 2.4 General constraints
  - 2.5 Assumptions and dependencies
- 3. Specific requirements

  Covering functional, non-functional and interface requirements.
- 4. Appendices
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Adapting the standard

- The IEEE standard is a generic standard which is intended apply to a wide range of requirements documents.
- In general, not all parts of the standard are required for all requirements documents
- Each organisation should adapt the standard depending on the type of systems it develops
- Consider a company (XYZ) that develops scientific instruments

Organisation XYZ standard

- Preface
  - This should define the expected readership of the document and describe its version history including a rationale for the creation of a new version and a summary of the changes made in each version.
- Introduction
  - This should define the product in which the software is embedded, its expected usage and present and overview of the functionality of the control software.
- Glossary
  - This should define all technical terms and abbreviations used in the document.

Organisation XYZ standard

- General user requirements
  - This should define the system requirements from the perspective of the user of the system. These should be presented using a mixture of natural language and diagrams.
- System architecture
  - This chapter should present a high-level overview of the anticipated system architecture showing the distribution of functions across system modules. Architectural components which are to be reused should be highlighted.
- Hardware specification
  - This is an optional chapter specifying the hardware that the software is expected to control. It may be omitted if the standard instrument platform is used.

Organisation XYZ standard

- Detailed software specification
  - This is a detailed description of the functionality expected of the software of the system. It may include details of specific algorithms which should be used for computation. If a prototyping approach is to be used for development on the standard instrument platform, this chapter may be omitted.
- Reliability and performance requirements
  - This chapter should describe the reliability and performance requirements which are expected of the system. These should be related to the statement of user requirements in Chapter 4.

Organisation XYZ standard

- The following appendices may be included where appropriate:
  - Hardware interface specification
  - Software components which must be reused in the system implementation
  - Data structure specification
  - Data-flow models of the software system
  - Detailed object models of the software system
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Writing requirements

- Requirements are usually written as paragraphs of natural language text supplemented by diagrams and equations
- Problems with requirements
  - use of complex conditional clauses which are confusing
  - sloppy and inconsistent terminology
  - writers assume readers have domain knowledge

Writing essentials

- Requirements are read more often than they are written. You should invest time to write readable and understandable requirements
- Do not assume that all readers of the requirements have the same background and use the same terminology as you
- Allow time for review, revision and re-drafting of the requirements document

Writing guidelines

- Define standard templates for describing requirements
- Use language simply consistently and concisely
- Use diagrams appropriately
- Supplement natural language with other description of requirements
- Specify requirements quantitatively

Key points

- Requirements define what the system should provide and define system constraints
- Requirements problems lead to late delivery and change requests after the system is in use
- Requirements engineering is concerned with eliciting, analysing, and documenting the system requirements

Key points

- Systems engineering is concerned with systems as a whole including hardware, software and operational processes
- The requirements document is the definitive specification of requirements for customers, engineers and managers.
- The requirements document should include a system overview, glossary, statement of the functional requirements and the operational constraints