REQUIREMENTS ANALYSIS AND SPECIFICATION

By

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Source: Rajib Mall

Requirements Analysis and Specification

- Many projects fail:
  - Because they start implementing the system.
  - Without determining whether they are building what the customer really wants.

WHY BOTHER ABOUT REQUIREMENTS

- Improper requirements increase the no. of iterative changes required during life cycle phases.
- Incorrect requirements lead to huge costs.
- If not bothered leads to customer dissatisfaction and may also lead to legal battles.

GOAL OF REQUIREMENTS SPECIFICATION

- To clearly understand the customer requirements.
- Systematically organize the requirements into specification document.
- The output is called Software Requirements Specification (SRS).

WHO DOES THIS?

- System Analyst

- The person who gathers the information from the customer, analyzes and conceptualize it and projects it in an understandable way.

- During analysis the inconsistencies, anomalies and incompleteness are removed.

Qualities of System Analyst

- Some desirable attributes of a good system analyst:
  - Good interaction skills,
  - Imagination and creativity,
  - Experience.

WHAT NEXT?

- Once the SRS is done it is given to the customer for review.

- When the customer agrees to it, it forms the basis for all future development activities and serves as a contract document between the customer and the development organization.

ACTIVITIES IN REQUIREMENTS

- There are mainly two activities involved in requirements, they are,
  - Requirements gathering and analysis
  - Requirements specification.

REQUIREMENTS GATHERING AND ANALYSIS

- This activity is further divided into two tasks
  - Requirements Gathering
  - Requirements Analysis

- Requirements Gathering is not a simple task as it involves interacting with different type of customers who have different level of understandability of the software and work.

REQUIREMENTS GATHERING

- Requirements gathering would be little easier if there exists a working model.

- It would be tedious if it has to be collected for a totally new project. Here, it would be a test for the analysts creativity and experience.

- Requirements collected generally would be in bits and pieces which has to be integrated and put it into proper meaningful format.

REQUIREMENTS GATHERING Contd..

- Requirement gathering can be done in the following way
  - Studying the existing documentation
  - Interview
  - Task analysis
  - Scenario analysis
  - Form analysis

SIT IN SAN FRANCISCO

- Read the case study in page 111 of Rajib Mall.

Analysis of the Gathered Requirements

- Main purpose of requirements analysis:
  - *Clearly understand the user requirements,*
  - *Detect inconsistencies, ambiguities, and incompleteness.*

- Incompleteness and inconsistencies:
  - Resolved through further discussions with the end-users and the customers.

Inconsistent Requirement

- Some part of the requirement:
  - contradicts with some other part.
- Example:
  - One customer says turn off heater and open water shower when temperature > 100 C
  - Another customer says turn off heater and turn ON cooler when temperature > 100 C

Incomplete Requirement

- Some requirements have been omitted:
  - Possibly due to oversight.
- Example:
  - The analyst has not recorded:
    when temperature falls below 90 C
    - *heater should be turned ON*
    - *water shower turned OFF.*

Analysis of the Gathered Requirements (CONT.)

- Requirements analysis involves:
  - Obtaining a clear, in-depth understanding of the product to be developed,
  - Remove all ambiguities and inconsistencies from the initial customer perception of the problem.

Analysis of the Gathered Requirements (CONT.)

- It is quite difficult to obtain:
  - A clear, in-depth understanding of the problem:
    - *Especially if there is no working model of the problem.*

Analysis of the Gathered Requirements (CONT.)

- Experienced analysts take considerable time:
  - To understand the exact requirements the customer has in his mind.

Analysis of the Gathered Requirements (CONT.)

- Experienced systems analysts know - often as a result of painful experiences ---
  - Without a clear understanding of the problem, it is impossible to develop a satisfactory system.

Analysis of the Gathered Requirements (CONT.)

- Several things about the project should be clearly understood by the analyst:
  - What is the problem?
  - Why is it important to solve the problem?
  - What are the possible solutions to the problem?
  - What complexities might arise while solving the problem?

Analysis of the Gathered Requirements (CONT.)

- Some anomalies and inconsistencies can be very subtle:
  - Escape even most experienced eyes.

solution

- If a formal model of the system is constructed,
  - *Many of the subtle anomalies and inconsistencies get detected.*

Analysis of the Gathered Requirements(CONT.)

- After collecting all data regarding the system to be developed,
  - Remove all inconsistencies and anomalies from the requirements,
  - Systematically organize requirements into a Software Requirements Specification (SRS) document.

PROBLEMS TO BE SOLVED BY ANALYST

- Ambiguity
  - Using inappropriate words like upper grade, lower grade, etc
- Inconsistency
  - Contradictory values/data must not be present
- Incompleteness
  - Missing data or incomplete data.

SOFTWARE REQUIREMENT SPECIFICATION(SRS)

- Among all the documents produced during a software development, SRS is the toughest. Because, it cater to the needs of a wide variety of audience.

- Different people need SRS document for different purposes.

SRS Continued

- Different categories of users and their needs are as follows,
  - Users, customers and marketing people
  - Software developers
  - Test Engineers
  - User documentation writers
  - Project Managers
  - Maintenance Engineers

STUPUM

Software Requirements Specification

- Main aim of requirements specification:
  - Systematically organize the requirements arrived during requirements analysis.
  - Document requirements properly.

Software Requirements Specification

- The SRS document is useful in various contexts:
  - Statement of user needs
  - Contract document
  - Reference document
  - Definition for implementation

SRS Document (CONT.)

- The requirements at this stage:
  - Written using end-user terminology.
- If necessary:
  - Later a formal requirement specification may be developed from it.

Properties of a Good SRS Document

- It should be concise
  - and at the same time should not be ambiguous.
- It should specify what the system must do
  - and not say how to do it.
- Easy to change.,
  - i.e. it should be well-structured.
- It should be consistent.
- It should be complete.

concise : not ambiguous
what to do, not how
easy to change:well structure
consistent
complete
verifiable
traceable

CEW CCTV

Properties of a Good SRS Document (cont…)

- It should be traceable
  - You should be able to trace which part of the specification corresponds to which part of the design, code, etc and vice versa.
- It should be verifiable
  - e.g. “system should be user friendly” is not verifiable

Examples of Bad SRS Documents

- Unstructured Specifications:
  - Narrative essay --- one of the worst types of specification document:
    - *Difficult to change,*
    - *Difficult to be precise,*
    - *Difficult to be unambiguous,*
    - *Scope for contradictions, etc.*

Unstructured specification
Noise
silence
over specification
contradiction
ambiguity
forward references
wishful thinking

UNSAFCOW

Examples of Bad SRS Documents

- Noise:
  - Presence of text containing information irrelevant to the problem.
- Silence:
  - aspects important to proper solution of the problem are omitted.

Examples of Bad SRS Documents

- Overspecification:
  - Addressing "how to" aspects
  - For example, "Library member names should be stored in a sorted descending order"
  - Overspecification restricts the solution space for the designer.
- Contradictions:
  - Contradictions might arise
    - *if the same thing described at several places in different ways.*

Examples of Bad SRS Documents

- Ambiguity:
  - Literary expressions
  - Unquantifiable aspects, e.g. “good user interface”
- Forward References:
  - References to aspects of problem
    - *defined only later on in the text.*
- Wishful Thinking:
  - Descriptions of aspects
    - *for which realistic solutions will be hard to find.*

IMPORTANT ASPECTS OF SRS

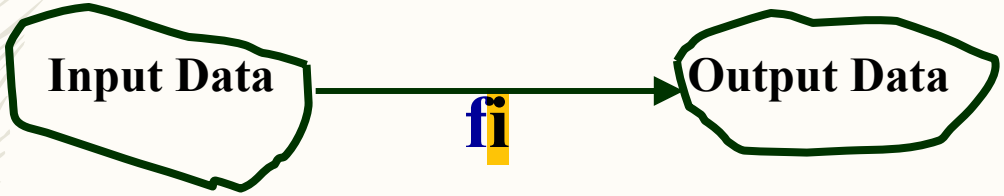
- SRS normally contains three important parts
  - Functional requirements
  - Non-functional requirements
  - Goals of implementation

Functional Requirements

- Functional requirements describe:
  - A set of high-level requirements
  - Each high-level requirement:
    - *takes in some data from the user*
    - *outputs some data to the user*
  - Each high-level requirement:
    - *might consist of a set of identifiable functions*

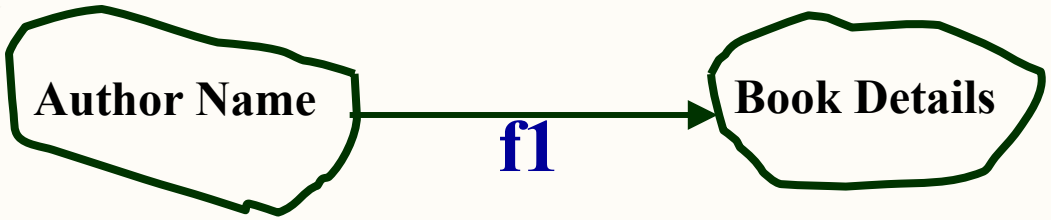
Functional requirements (CONT.)

- It is desirable to consider every system:
  - Performing a set of functions {fi}.
  - Each function fi considered as:
  - Transforming a set of input data to corresponding output data.



Example: Functional Requirement

- F1: Search Book
  - Input:
    - *an author's name:*
  - Output:
    - *details of the author's books and the locations of these books in the library.*



Functional Requirements

- For each high-level requirement:
  - Every function is described in terms of:
    - *Input data set*
    - *Output data set*
    - *Processing required to obtain the output data set from the input data set.*

Example Functional Requirements

- List all functional requirements
  - with proper numbering.
- Req. 1:
  - Once the user selects the “search” option,
    - *he is asked to enter the key words.*
  - The system should output details of all books
    - *whose title or author name matches any of the key words entered.*
    - *Details include: Title, Author Name, Publisher name, Year of Publication, ISBN Number, Catalog Number, Location in the Library.*

Req. 1:

- R.1.1:
  - Input: “search” option,
  - Output: user prompted to enter the key words.
- R1.2:
  - Input: key words
  - Output: Details of all books whose title or author name matches any of the key words/Error.
    - *Details include: Title, Author Name, Publisher name, Year of Publication, ISBN Number, Catalog Number, Location in the Library.*
  - Processing: Search the book list for the keywords

Nonfunctional Requirements

- Characteristics of the system which can not be expressed as functions:
  - *Maintainability,*
  - *Portability,*
  - *Usability, etc.*

Nonfunctional Requirements

- Nonfunctional requirements include:
  - Reliability issues,
  - Performance issues:
    - *Example: How fast the system can produce results*
      - so that it does not overload another system to which it supplies data, etc.
  - Human-computer interface issues,
  - Interface with other external systems,
  - Security, maintainability, etc.

SHRIP

Non-Functional Requirements

- Hardware to be used,
- Operating system
  - or DBMS to be used
- Capabilities of I/O devices
- Standards compliance
- Data representations
  - by the interfaced system

HOD CS

Goals of Implementation

- Goals describe things that are desirable of the system:
  - But, would not be checked for compliance.
  - For example,
    - *Reusability issues*
    - *Functionalities to be developed in future*

HOW TO IDENTIFY FR

- From an informal problem description document
- From a conceptual understanding of the problem
- The classification of high level requirement or other level is done with the help of domain expert.

HOW TO DOCUMENT FR

- Documentation is done by identifying the state at which the data is to be input to the system.
  - Its input data domain
  - The output data domain
  - The type of processing to be done.

Example Functional Requirements

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  - with proper numbering.
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    - *he is asked to enter the key words.*
  - The system should output details of all books
    - *whose title or author name matches any of the key words entered.*
    - *Details include: Title, Author Name, Publisher name, Year of Publication, ISBN Number, Catalog Number, Location in the Library.*

Example Functional Requirements

- Req. 2:
  - When the "renew" option is selected,
    - *The user is asked to enter his membership number and password.*
  - After password validation,
    - *The list of the books borrowed by him are displayed.*
  - The user can renew any of the books:
    - *By clicking in the corresponding renew box.*

Req. 2:

- R2.1:
  - Input: "renew" option selected,
  - Output: user prompted to enter his membership number and password.
- R2.2:
  - Input: membership number and password
  - Output:
    - *list of the books borrowed by user are displayed. User prompted to enter books to be renewed or*
    - *user informed about bad password*
  - Processing: Password validation, search books issued to the user from borrower list and display.

Req. 2:

- R2.3:
  - Input: user choice for renewal of the books issued to him through mouse clicks in the corresponding renew box.
  - Output: Confirmation of the books renewed
  - Processing: Renew the books selected by the in the borrower list.

ORGANIZATION OF SRS DOCUMENT

- Introduction.
- Functional Requirements
- Nonfunctional Requirements
  - External interface requirements
  - Performance requirements
- Goals of implementation

Handling complex logics

- The complex processing is analysed in two ways
  - Decision Trees
  - Decision tables

- A decision tree gives a graphic view of the processing logic involved in decision making.
- A decision table shows the decision-making logic and corresponding actions taken in a matrix form.

Decision Trees

- Decision trees:
  - Edges of a decision tree represent conditions
  - Leaf nodes represent actions to be performed.
- A decision tree gives a graphic view of:
  - Logic involved in decision making
  - Corresponding actions taken.

Example: LMS

- A Library Membership automation Software (LMS) should support the following three options:
  - New member,
  - Renewal,
  - Cancel membership.

Example: LMS

- When the new member option is selected,
  - The software asks details about the member:
    - *name,*
    - *address,*
    - *phone number, etc.*

Example(cont.)

- If proper information is entered,
  - A membership record for the member is created
  - A bill is printed for the annual membership charge plus the security deposit payable.

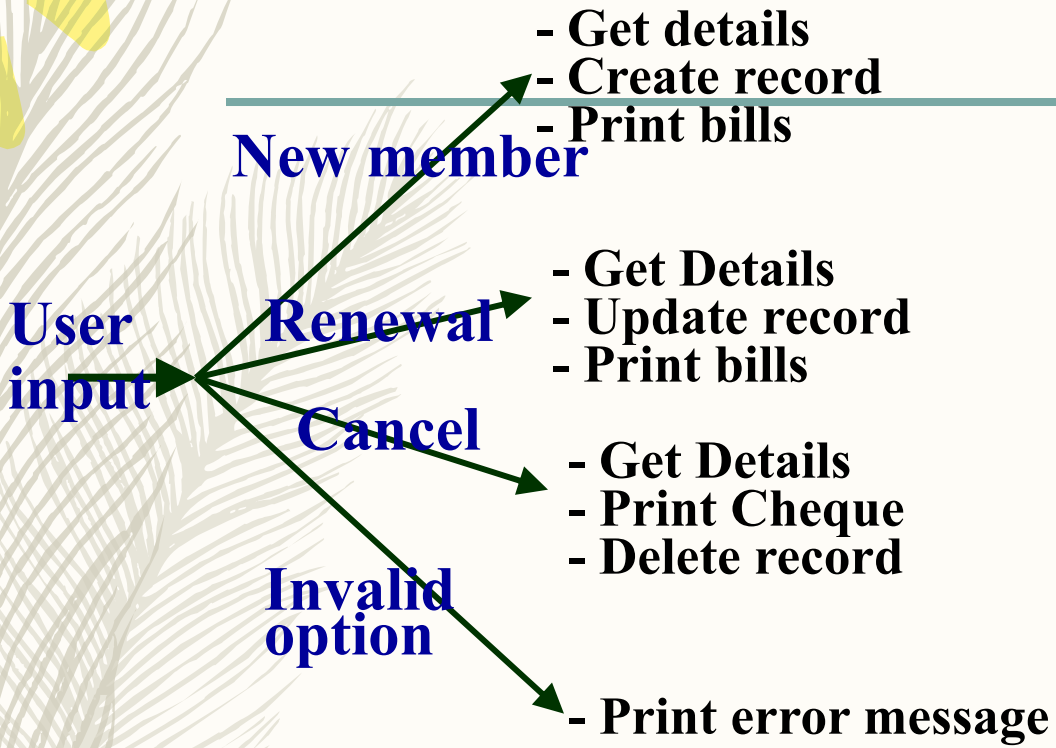
Example(cont.)

- If the renewal option is chosen,
  - LMS asks the member's name and his membership number
    - *checks whether he is a valid member.*
  - If the name represents a valid member,
    - *the membership expiry date is updated and the annual membership bill is printed,*
    - *otherwise an error message is displayed.*

Example(cont.)

- If the cancel membership option is selected and the name of a valid member is entered,
  - The membership is cancelled,
  - A cheque for the balance amount due to the member is printed
  - The membership record is deleted.

Decision Tree



Decision Table

- Decision tables specify:
  - Which variables are to be tested
  - What actions are to be taken if the conditions are true,
  - The order in which decision making is performed.

Decision Table

- A decision table shows in a tabular form:
  - Processing logic and corresponding actions
- Upper rows of the table specify:
  - The variables or conditions to be evaluated
- Lower rows specify:
  - The actions to be taken when the corresponding conditions are satisfied.

Decision Table

- In technical terminology,
  - a column of the table is called a rule:
  - A rule implies:
    - *if a condition is true, then execute the corresponding action.*

Example:

Conditions				
Valid selection	NO	YES	YES	YES
New member	--	YES	NO	NO
Renewal	--	NO	YES	NO
Cancellation	--	NO	NO	YES
Actions				
Display error message	--			
Ask member's name etc.		--	--	
Build customer record		--		
Generate bill		--	--	--
Ask membership details			--	--
Update expiry date			--	--
Print cheque			--	--
Delete record				--

Comparison

- Both decision tables and decision trees
  - Can represent complex program logic.
- Decision trees are easier to read and understand
  - When the number of conditions are small.
- Decision tables help to look at every possible combination of conditions.

Formal Specification

- A formal specification technique is a mathematical method to:
  - Accurately specify a system.
  - Verify that implementation satisfies specification.
  - Prove properties of the specification.

Formal Specification

- Advantages:
  - Well-defined semantics, no scope for ambiguity
  - Automated tools can check properties of specifications
  - Executable specification

Formal Specification

- Disadvantages of formal specification techniques:
  - Difficult to learn and use
  - Not able to handle complex systems

Formal Specification

- Mathematical techniques used include:
  - Logic-based
  - set theoretic
  - algebraic specification
  - finite state machines, etc.

Semiformal Specification

- Structured specification languages
  - SADT (Structured Analysis and Design Technique)
  - PSL/PSA (Problem Statement Language/Problem Statement Analyzer)
    - *PSL is a semi-formal specification language*
    - *PSA can analyze the specifications expressed in PSL*

Executable Specification Language

- If specification is expressed in formal language:
  - it becomes possible to execute the specification to provide a system prototype.
- However, executable specifications are usually slow and inefficient.

Executable Specification Language

- Executable specifications only test functional requirements:
  - If non-functional requirements are important for some product,
    - *The utility of an executable specification prototype is limited.*

4GLs

- 4GLs (Fourth Generation Languages) are examples of
  - executable specification languages.
- 4GLs are successful
  - because there is a lot of commonality across data processing applications.

4GLs

- 4GLs rely on software reuse
  - Where common abstractions have been identified and parameterized.
- Rewriting 4GL programs in higher level languages:
  - Result in upto 50% lower memory requirements
  - Also the programs run upto 10 times faster.

Summary

- Requirements analysis and specification
  - An important phase of software development:
  - Any error in this phase would affect all subsequent phases of development.
- Consists of two different activities:
  - Requirements gathering and analysis
  - Requirements specification

Summary

- The aims of requirements analysis:
  - Gather all user requirements
  - Clearly understand exact user requirements
  - Remove inconsistencies and incompleteness.
- The goal of specification:
  - Systematically organize requirements
  - Document the requirements in an SRS document.

Summary

- Main components of SRS document:
  - Functional requirements
  - Non-functional requirements
  - Constraints
- Techniques to express complex logic:
  - Decision tree
  - Decision table

Summary

- Formal requirements specifications have several advantages.
  - But the major shortcoming is that these are hard to use.