

# Chapter 3

Tuesday, September 24, 2019

10:13 PM

## Chapter 3: Establishing the Project Foundations

- A project to develop or modify a software-intensive system is conceived, initiated, and conducted in the belief that the benefits of the resulting system or product will offset the cost of the project. The perceived benefits, determined by some criteria, must outweigh the estimated cost of a project.
- Foundation elements for software projects include foundations for both the product to be delivered and the process by which it will be developed or modified.
- A contract typically specifies the scope of a project and legal clauses such as liabilities and penalties for breach of contract. It will likely include a rights-in-data clause or an intellectual property agreement that specifies exactly what the customer is paying for and what will be delivered to, and owned by, the customer.

**TABLE 3.1 Foundation elements of software projects**

	Concerned with
<i>Product foundations</i>	
Operational requirements	External view; users' view of the system
System requirements and system architecture	Hardware, software, and people elements; interconnections among elements; interfaces to the environment
Software requirements	Internal view; developers' view of the software to be developed or modified
□ Design constraints	Predetermined design decisions
<i>Process foundations</i>	
Contractual agreement	Statement of understanding between a developer and customer
Workflow model	Managerial work activities and work products
Development model	Technical work activities and work products
Project plan	The project roadmap

# Product Foundations

- **Requirements Engineering: Requirements Development and Requirements Management**

## Requirements Development

- *elicitation*: understanding user needs, customer expectations, and acquirer's conditions and documenting them in a Concept of Operations document
- *analysis*: translating user needs, customer expectations, and acquirer's conditions into technical requirements for hardware, software, and people elements
- *allocation*: allocating requirements to the hardware, software, and people elements of the system
- - *specification*: documenting technical requirements in standard notations and formats; recorded in a Technical Specifications document
  - *verification*: determining that the Technical Specifications are correct, complete, and consistent with respect to the Concept of Operations
  - *negotiation*: give-and-take discussions among stakeholders to achieve consensus views
  - *acceptance*: commitment to a requirements baseline, by all involved stakeholders, that accounts for the constraints of schedule, budget, resources, technology, and risk factors
- Requirements development consists of requirements elicitation, requirements analysis, and requirements acceptance.
- Users' needs and customer's expectations that include desired product features and quality attributes provide the inputs to requirements elicitation.
- Step 1: The operational requirements that result from requirements elicitation are documented in a Concept of Operations that, along with the acquirer's conditions and the design constraints, provide the input to requirements analysis.
- Step 2: The analysis activity produces the technical specifications, which, along with the process constraints, provide the input to requirements acceptance.
- Technical specifications include primary requirements, derived requirements, design goals, and design constraints.

- Step 3: Requirements verification determines the degree to which the technical specifications are correct, complete, and consistent with respect to the operational requirements and process constraints; it is a necessary activity of requirements acceptance.
- Verification Conditions: Correctness - Completeness - Consistency (no internal and external inconsistency).
- Step 4: The output of the requirements acceptance is requirements baseline which provides the input to Requirements Management.
- Change requests initiate changes to the requirements baseline, the activities (Step 1-4) may occur multiple times in an iterative development process.

### **Requirements Elicitation**

- The process of determining user needs and customer expectations is known as **requirements elicitation**.
- **User needs** and **customer expectations** provide the impetus for undertaking a software project. The ConOps should include a description of the deficiencies in the existing system or situation that provides the motivation for modifying an existing system or developing an automated system to replace or augment manual operations.
- Operational requirements and operational scenarios are the heart of a ConOps; they express the desired system features and quality requirements from the external viewpoint of users' needs and customer's expectations. (May be represented in Use Case examples)
- The operational requirements include:
  - operational features
  - quality attributes
  - design constraints
- Quality requirements, as expressed by users and customers, are often vague, imprecise, and ambiguous. Users may, for example, express a desire for a system that is highly reliable and easy to use. During requirements analysis these statements must be translated into technical specifications.
- **Operational Requirement:** The ATM terminals in the Automated Teller System shall provide good response time

provide good response time.

- **Technical Specification:** The ATM terminals in the Automated Teller System shall provide:
  - an average response time of 2 seconds and a maximum response time of 5 seconds for transaction initiation and balance inquiries
  - an average response time of 5 seconds and a maximum response time of 10 seconds for withdrawal and deposit requests.
  
- Establishing priorities among system features and quality attributes is an important step because users, customers, and other stakeholders will typically have more needs, expectations, and desires than can be implemented within the constraints of time, money, resources, and technology.
  
- Place each requirement in the category of Essential, Desirable, or Optional.
  
- Your initial project plan must provide sufficient schedule, budget, and resources to implement the Essential requirements and as many of the Desirable ones as can be accommodated within the project constraints.

### **Requirements Analysis**

- The process of requirements analysis is concerned with clarifying operational requirements and restating them in terms that provide objective criteria that can be used to verify and validate that the specified system, when it is ready for delivery, will be complete, correct, and consistent with respect to the objectively stated requirements (verification) and that it will satisfy its intended purpose in its intended environment (validation).
  
- Experience has shown that it is more efficient and more effective to develop two distinct documents for two distinct purposes: the Concept of Operations to document the operational requirements and the Requirements Specification to document the technical requirements.
  
- Operational Requirements translate into 1) **Primary Requirements** in the Technical Requirements.
  
- Translating design constraints from operational requirements to technical specifications may require some effort to determine acceptable trade-offs between levels of quantification and effort, schedule, technical feasibility, cost, and user acceptance. Some operational requirements may remain as 3) **design goals** for an extended period of time until acceptable, quantified values of the corresponding technical specifications can be determined.

values of the corresponding technical specifications can be determined. Translation of operational requirements into technical specifications may be an ongoing process.

- Note also that the number of operational features continues to grow over time.
- 2) **Derived requirements** (the second kind of technical specification) are requirements for system features and quality attributes that are not visible to users but are necessary to support the operational requirements.
- 3) **Design goals** are thus operational requirements that have not yet been, or cannot be, translated into objectively stated technical specifications.
- It may not be possible to translate **design goals** into technical specifications during the initial stages of requirements development because of uncertainties about the cost, schedule...
- 4) **Design constraints** are the fourth category of technical specification. A design constraint is a design decision stated in the requirements and for which no flexibility in design or implementation is allowed.
- **Design constraints** may also specify operations that the system must not do.
- Each design constraint restricts the design space available to the software designers and may result in a suboptimal design of the system.<sup>17</sup> Design constraints should therefore:
  - be identified as such,
  - have their necessity justified,
  - provide flexibility, if any, and
  - be restated in an objective manner.

### **Requirements Verification:**

- This means the work product must be complete, correct, and consistent with respect to other work products and work processes.
- Determining the internal completeness, correctness, and consistency of each of operational requirement and each technical specification.
- Determining that each operational requirement and each of the technical specifications is externally complete, consistent, and correct with respect to





the other requirements and related work products such as test plans and test scenarios.

- Determining the internal completeness, correctness, and consistency of related test plans, test scenarios and other mechanisms of end-product verification and validation.
- Traceability is the primary technique for establishing external completeness, correctness, and consistency between the operational and technical requirements.

## Requirements Management

- An important aspect of requirements management is *impact analysis*, which is concerned with assessing the need for and making necessary changes to schedules, budgets, resources, technology, and risk factors commensurate with changes to baselined requirements.
- Requirements management is concerned with managing subsequent changes to the operational requirements and technical specifications and keeping those changes in balance with schedule, budget, resources, technology and other project factors.
- Requirements may be changed by addition, modification, and deletion of operational requirements, design constraints, and technical specifications.
- Each change to requirements must be accompanied by an impact analysis to determine the effect of the change on schedule, budget, resources, quality attributes, technology, and other factors.
- A *baseline* is a work product that is placed under version control and may not be further modified with the approval of a change control board (CCB).
- Requested changes are submitted as CRs (Change Requests). Defects in a work product are documented in PRs (Problem Reports).
- Impact analysis for a new CR or PR is conducted to determine whether the proposed change is in scope or out of scope.
- Impact analysis may determine that the proposed change is in scope, meaning that it can be handled without changes to other project factors or

meaning that it can be handled without changes to other project factors or the change may be out of scope, meaning that the proposed change to the requirements cannot be accepted without compensating changes to other project factors.

## Process Foundations

- Chapter 1 and 2

### Development Model

- The scope of your project may involve development of hardware and software and training of operations personnel, or it may be a “software-only” project.
- The scope of some software-only projects involves working with users, customers, acquirer, and other stakeholders to develop the project foundations, construct a software solution, deliver and install the resulting system, train the users, and provide ongoing support for a specified period of time.

### Contractual Agreement

- Project scope can be documented in a contractual agreement.
- Formal contracts are legally binding documents that include legally enforceable consequences to both parties if either party should violate the terms of the contract.
- Items typically contained in a contractual agreement include:
  - scope of work
  - deliverable work products
  - delivery date(s)
  - customer/user and developer joint review schedule
  - change request procedures
  - development constraints
  - product acceptance criteria
  - additional items, as appropriate
- The scope of work includes all of the major work activities that must be

- The scope of work includes all of the major work activities that must be accomplished to deliver a satisfactory product, for example, project management, analysis, design, implementation, verification, and validation; activities such as user training, providing support for evolution of the system after delivery, and similar work activities would be included as appropriate.