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## ACQUISITION REQUIREMENTS DEVELOPMENT

An Acquisition Process Area at Maturity Level 2

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### Purpose

The purpose of Acquisition Requirements Development (ARD) is to develop and analyze customer and contractual requirements.

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### Introductory Notes

This process area describes two types of requirements: customer requirements, which address the needs of relevant stakeholders, for which one or more products and services will be acquired, and contractual requirements, which are the requirements to be addressed through the acquirer's relationship with suppliers and other appropriate organizations. Both sets of requirements must address relevant to later product lifecycle phases (e.g., operation, maintenance, support, and disposal) and key product attributes (e.g., safety, reliability, and maintainability).

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Deleted: Requirements also address constraints caused by the selection of design solutions (e.g., integration of commercial off-the-shelf products).

In some acquisitions, the acquirer assumes the role of overall systems engineer, architect, or integrator for the product. In these acquisitions, the Requirements Development process area of CMMI-DEV should be used. Requirements Development in CMMI-DEV includes additional information helpful in these situations, including deriving and analyzing requirements at successively lower levels of product definition (e.g., establishing and maintaining product component requirements).

Deleted: All development projects have requirements. In the case of a project that is focused on maintenance activities, the changes to the product or product components are based on changes to the existing requirements, design, or implementation. The requirements changes, if any, might be documented in change requests from the customer or users, or they might take the form of new requirements received from the requirements development process. Regardless of their source or form, the maintenance activities that are driven by cha... [1]

Requirements are the basis for the selection and design or configuration of the acquired product. The development of requirements includes the following activities:

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- Elicitation, analysis, and validation of stakeholder needs, expectations, constraints, and interfaces to obtain customer requirements that constitute an understanding of what will satisfy stakeholders
- Development of the lifecycle requirements of the product (e.g., development, maintenance, transition to operations, decommissioning)
- Establishment of contractual requirements consistent with customer requirements, to a level of detail that is sufficient to be included in the solicitation package and supplier agreement
- Development of the operational concept
- Analysis of needs and requirements (for each product lifecycle phase), the operational environment, and factors that reflect overall customer and end-user needs and expectations for attributes such as safety, security, and affordability

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The requirements included in the solicitation package form the basis for evaluating proposals by suppliers and for further negotiations with suppliers and communication with the customer. The contractual requirements for the supplier are baselined in the supplier agreement.

Deleted: <#>Development of an operational concept¶  
<#>Definition of the required functionality¶  
The definition of functionality, also referred to as "functional analysis," is not the same as structured analysis in software development and does not presume a functionally oriented software design. In object-oriented software design, it relates to defining what are called "services" or "methods." The definition of functions, their logical groupings, and their association with requirements is referred to as a "functional architecture."¶

Requirements are refined throughout the project lifecycle. Design decisions, subsequent corrective actions, and feedback during each phase of the project's lifecycle are analyzed for their impact on contractual requirements.

Requirements analyses aid understanding, defining, and selecting requirements at all levels from competing alternatives. Analyses occur recursively at successively more detailed levels until sufficient detail is available to produce contractual requirements and to further refine these, if necessary, while the supplier builds or configures the product.

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Involvement of relevant stakeholders in both requirements development and analyses gives them visibility into the evolution of requirements. Participation continually assures stakeholders that requirements are being properly defined.

Deleted: enable detailed design, acquisition, and testing of the product to proceed. As a result of the analysis of requirements and the operational concept (including functionality, support, maintenance, and disposal), the manufacturing or production concept produces more derived requirements, including consideration of the following:

The Acquisition Requirements Development process area includes three specific goals. The Develop Customer Requirements specific goal addresses eliciting and defining a set of customer requirements. The Develop Contractual Requirements specific goal addresses defining contractual requirements that are based on customer requirements and are included in the solicitation package and supplier agreement. The specific practices of the Analyze and Validate Requirements specific goal support the development of the requirements in the first two specific goals. The specific practices associated with this specific goal cover analyzing and validating requirements with respect to the acquirer's intended environment.

Deleted: <#>Constraints of various types¶  
<#>Technological limitations¶  
<#>Cost and cost drivers¶  
<#>Time constraints and schedule drivers¶  
<#>Risks¶  
<#>Consideration of issues implied but not explicitly stated by the customer or end user¶  
<#>Factors introduced by the developer's unique business ... [8]

Related Process Areas

*Refer to the Requirements Management process area for more information about managing requirements and changes, obtaining agreement with the requirements provider, obtaining commitments with those implementing the requirements, and maintaining traceability.*

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Refer to the Solicitation and Supplier Agreement Development process area for more information about developing solicitation packages and supplier agreements.

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*Refer to the Acquisition Technical Management process area for more information about confirming that the resulting product meets contractual requirements.*

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Refer to the Verification proce... [10]

*Refer to the Acquisition Validation process area for more information about validating the acquired product or service against stakeholder needs, expectations, constraints, and interfaces.*

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Acquisition Requirements Development (ARD)

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Refer to the Risk Management process area for more information about identifying and managing risks that are related to requirements.

Specific Goal and Practice Summary

- SG 1 Develop Customer Requirements
  - SP 1.1 Elicit Stakeholder Needs
  - SP 1.2 Develop and Prioritize Customer Requirements
- SG 2 Develop Contractual Requirements
  - SP 2.1 Establish Contractual Requirements
  - SP 2.2 Allocate Contractual Requirements
- SG 3 Analyze and Validate Requirements
  - SP 3.1 Establish Operational Concepts and Scenarios
  - SP 3.2 Analyze Requirements
  - SP 3.3 Analyze Requirements to Achieve Balance
  - SP 3.4 Validate Requirements

- Deleted: Refer to the Configuration Management process area for information about ensuring that key work products are controlled and managed. ¶
- Deleted: the
- Deleted: Product
- Deleted: Product and Product Component
- Deleted: Product Component Requirements¶
- SP 2.3 Identify Interface
- Deleted: SP 3.2 Establish a Definition of Required Functionality¶
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- SP 3.4 Analyze Requirements
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Specific Practices by Goal

**SG 1 Develop Customer Requirements**

**Stakeholder needs, expectations, constraints, and interfaces are collected and translated into customer requirements.**

Stakeholders (e.g., customers, end users, suppliers, testers, integrators, maintainers, operators, supplier agreement management personnel, manufacturers, and logistics support personnel) are sources of requirements. Their needs, expectations, constraints, interfaces, operational concepts, and product concepts are analyzed, harmonized, refined, and elaborated for translation into a set of customer requirements.

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Frequently, stakeholder needs, expectations, constraints, and interfaces are poorly identified or conflicting. Since these needs, expectations, constraints, and interfaces must be clearly identified and understood throughout the project lifecycle, an iterative process is used throughout the life of the project to accomplish this objective. To facilitate the required interaction, relevant stakeholders are frequently involved throughout the project lifecycle to communicate their needs, expectations, and constraints, and to help resolve conflicts. Environmental, legal, and other constraints should be considered when creating and evolving the set of requirements for acquiring products or services.

- Deleted: stakeholder
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- Deleted: a surrogate for the end user or customer is
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- Deleted: The customer relations or marketing part of the organization as well as members of the development team from disciplines such as human engineering or support can be used as surrogates.

**SP 1.1 Elicit Stakeholder Needs**

**Elicit stakeholder needs, expectations, constraints, and interfaces for all phases of the product lifecycle.**

Eliciting goes beyond collecting needs by proactively identifying additional needs not explicitly provided by stakeholders. Relevant stakeholders who represent all phases of the product lifecycle in the acquirer's intended environment should include business as well as technical functions. Using this approach, needs for all product-related

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- Deleted: customers. Additional requirements should address the various product lifecycle

lifecycle processes are considered concurrently with concepts for acquired products.

An analysis of business processes is a common source of stakeholder needs, expectations, constraints, and interfaces. Additional needs typically address project lifecycle activities and their impact on the product.

Examples of techniques to elicit needs from stakeholders include the following:

- Questionnaires and interviews
- Operational scenarios obtained from end users
- Operational walkthroughs and end-user task analyses
- Prototypes and models
- Observation of existing products, environments, and workflow patterns
- Technology demonstrations
- Interim project reviews
- Brainstorming
- Quality Function Deployment
- Market surveys
- Extraction from sources such as business process documents, standards, or specifications
- Use cases
- Business case analyses
- Reverse engineering (for legacy products)

Examples of sources of requirements that might not be identified by the customer include the following:

- Government regulations
- Policies and standards
- Technology
- Legacy products or product components (for reuse)

**Typical Work Products**

**1. Stakeholder needs, expectations, constraints, and interfaces**

**Subpractices**

1. Engage relevant stakeholders using methods for eliciting needs, expectations, constraints, and external interfaces.

**SP 1.2 Develop and Prioritize Customer Requirements**

***Transform stakeholder needs, expectations, constraints, and interfaces into prioritized customer requirements.***

The customer typically describes requirements as capabilities expressed in broad operational terms concerned with achieving a

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<#>Interface control working groups¶  
<#>Technical control working groups¶  
<#>Interim project reviews¶

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<#>Quality Function Deployment¶  
<#>Market surveys¶  
<#>Beta testing¶  
<#>Extraction from sources such as documents, standards, or specifications¶

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Deleted: <#>Customer satisfaction surveys¶

Deleted: <#>Business policies¶  
<#>Standards¶  
<#>Business environmental requirements (e.g., laboratories, testing and other facilities, and information technology infrastructure)¶

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Deleted: The various inputs from the relevant stakeholders must be consolidated, missing information must be obtained, and conflicts must be resolved in documenting the recognized set of customer requirements. The customer requirements may include needs, expectations, and constraints with regard to verification and validation.¶ In some situations, the customer provides a set of requirements to the project, or the requirements exist as an output of a previous project's activities. In these situations, the customer requirements could conflict with the relevant stakeholders' needs, expectations, constraints, and interfaces and will need to be transformed into the recognized set of customer requirements after appropriate resolution of conflicts.¶ Relevant stakeholders representing all phases of the product's lifecycle should include business as well as technical functions. In this way, concepts for all product-related lifecycle processes are considered concurrently with the concepts for the products. Customer requirements result from informed decisions on the business as well as technical effects of their requirements.

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desired effect under specified standards and regulations. Customer requirements may also include needs, expectations, constraints, and interfaces with regard to verification and validation. Inputs from the customer and other stakeholders must be aligned to the organization's strategy. Missing information must be obtained and conflicts must be resolved as customer requirements are developed and prioritized.

Customer requirements may also exist as an output of another project's activities such as a previous project that delivered the initial capability.

Examples of factors to consider when expressing customer requirements include the following:

- Key characteristics (attributes) of the desired capability with appropriate parameters and measures
- Obstacles to overcome to achieve the capability
- Competitive gap between the existing and the desired capability
- Supportability of the desired capability
- Level of detail of customer requirements that does not prejudice decisions in favor of a particular means of implementation but are specific enough to evaluate alternative approaches to implement the capability

**Typical Work Products**

1. Prioritized customer requirements
2. Customer constraints on the conduct of verification
3. Customer constraints on the conduct of validation

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**Subpractices**

1. Translate stakeholder needs, expectations, constraints, and interfaces into documented customer requirements.
2. Establish and maintain a prioritization of customer requirements.  
Having prioritized customer requirements guides the acquirer in determining project scope and which requirements and requirements changes to include in supplier agreements. This prioritization ensures that requirements critical to the customer and other stakeholders are addressed quickly.  
Determining priorities and resolving conflicts among them can be addressed when eliciting stakeholder needs, as described in the previous specific practice.
3. Define constraints for verification and validation.

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**SG 2 Develop Contractual Requirements**

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***Customer requirements are refined and elaborated into contractual requirements.***

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Customer requirements are analyzed in conjunction with the development of the operational concept to derive more detailed and precise sets of requirements, called contractual requirements, to be included in the solicitation package for potential suppliers and

Deleted: "product and product component requirements." Product and product component requirements address the needs associated with each product lifecycle phase. Derived

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eventually in the supplier agreement. The level of detail of contractual requirements is based on the acquisition strategy and project characteristics.

Contractual requirements arise from constraints, consideration of issues implied but not explicitly stated in the customer requirements baseline, and factors introduced by design constraints and supplier capabilities. Contractual requirements include both requirements documented in contracts between an acquirer and supplier and requirements addressed through formal agreements between the acquirer and other organizations (e.g., partners, subcontractors, government agencies, and internal organizational units). (See the definition of “contractual requirements” in the glossary.) Requirements are reexamined throughout the project lifecycle.

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Deleted: , and the developer’s unique business considerations. The requirements are reexamined with each successive, lower level set of requirements and functional architecture, and the preferred product concept is refined

The requirements are allocated to supplier deliverables. The traceability across levels of requirements and supplier deliverables is documented.

Deleted: product functions and product components including objects, people, and processes.

Refer to the Maintain Bidirectional Traceability of Requirements specific practice of the Requirements Management process area for more information about maintaining bidirectional traceability.

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SP 2.1 Establish Contractual Requirements

Establish and maintain contractual requirements that are based on customer requirements.

Deleted: The allocated requirements and functions are the basis for the synthesis of the technical solution. As internal components are developed, additional interfaces are defined and interface requirements are established.

Customer requirements may be expressed in the customer’s terms and may be nontechnical descriptions. Contractual requirements are the expression of these requirements in technical terms that can be used for design decisions.

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In addition to technical requirements (e.g., requirements specifying interfaces with other products or applications, functional requirements and their validation, technical performance measures, and verification requirements such as product acceptance criteria), contractual requirements cover nontechnical stakeholder needs, expectations, constraints, and interfaces.

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Deleted: An example of this translation is found in the first House of Quality Function Deployment, which maps customer desires into

Deleted: parameters. For instance, “solid sounding door” might be mapped to size, weight, fit, dampening, and resonant frequencies.¶ Product and product component

Deleted: address the satisfaction of customer, business, and project objectives and associated attributes, such as effectiveness and affordability

- Examples of nontechnical requirements include the following:
- Frequency and format of supplier reviews
  - Supplier reports and other communication
  - Availability of support to meet levels of the business process or product performance
  - Warranty of products provided by a supplier
  - Logistics support that sustains both short- and long-term readiness
  - Minimal total lifecycle cost to own and operate (i.e., minimal total ownership cost)
  - Maintenance concepts that optimize readiness while drawing on both acquirer and supplier sources
  - Data management and configuration management that facilitates cost-effective product support throughout the product's use by the acquirer

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**Deleted:** Derived requirements also address the cost and performance of other lifecycle phases (e.g., production, operations, and disposal) to the extent compatible with business objectives.¶

The modification of requirements due to approved requirement changes is covered by the maintain function of this specific practice; whereas, the administration of requirement changes is covered by the Requirements Management process area.

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*Refer to the Requirements Management process area for more information about managing changes to requirements.*

**Typical Work Products**

1. External interface requirements
2. Contractual requirements
3. Contractual requirements priorities

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**Subpractices**

1. Develop functional and performance requirements necessary for the determination of alternative solutions and the development of the product by the supplier.  
Priorities may be assigned to product requirements to provide a basis for future requirements tradeoffs should this become necessary. Acquirers may assign priorities using categories such as Essential, Important, or Desirable.
2. Develop interface requirements of the acquired product to other products in the intended environment.  
Requirements for interfaces are defined in terms of origination, destination, stimulus, data characteristics for software, and electrical and mechanical characteristics for hardware.
3. Develop design constraints necessary for the determination of alternative solutions and the development of the product by the supplier.  
Design constraints express the qualities and technical performance that are critical to the success of the product in its intended operational environment. They account for customer requirements relative to product interoperability, implications

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**Deleted:** product and product component design.¶  
Develop architecture requirements addressing critical product qualities and performance necessary for product architecture design.¶

2. **Deleted:** Derive requirements that result from design decisions.¶  
Refer to the Technical Solution process area for more information about developing the

**Deleted:** that generate additional derived requirements

**Deleted:** Selection of a technology brings with it additional requirements. For instance, use of electronics requires additional technology-specific requirements such as electromagnetic interference limits.¶

from the use of commercial off-the-shelf (COTS) products, safety, security, durability, and other mission-critical concerns.

To achieve high levels of reuse and interoperability, acquirers may establish common design constraints for products or product families that can be deployed in one or more domains. Alternatively, acquirers may accelerate the development of technical requirements and design constraints by reusing shared or common constraints or requirements and their associated test cases from previous acquisitions or leverage the supplier's previous product developments.

**4. Develop requirements for verification and validation of the product to be developed by the supplier.**

Requirements for verification and validation typically include types and coverage of testing and review to be carried out in the supplier's and acquirer's environments.

Testing requirements may include mirroring the production environment of the acquirer, the type of test data to be used, and simulated testing of interfaces with other products.

**5. Establish and maintain relationships among the requirements under consideration during change management and requirements allocation.**

Relationships between requirements can affect evaluating the impact of requirements changes. Expected requirements volatility is a key factor in anticipating scope changes and supporting the acquirer's selection of the appropriate acquisition type.

**6. Identify nontechnical requirements.**

Contractual requirements consist of both technical and nontechnical requirements. Examples of nontechnical requirements are listed in the example box in this specific practice.

**7. Establish and maintain a prioritization of contractual requirements.**

Priority can be based on a combination of several factors that include customer desires, costs, timeframe for when the capabilities are needed, and length of time to satisfy a particular requirement.

When cost estimates can be determined for contractual requirements, their priority and costs can be used to guide contract and budget negotiations and to determine which changes should be made to the contract.

Priority may also help when developing a release strategy (e.g., first release only addresses high-priority requirements; lower priority requirements are deferred to a later release or maintenance phase).

Refer to the Project Planning process area for more information about establishing an acquisition strategy and estimating costs associated with requirements.

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**SP 2.2 Allocate Product Component Requirements¶**  
**Allocate the requirements for each product component.¶**  
Refer to the Technical Solution process area for more information about allocation of requirements to products and product components. This specific practice provides information for defining the allocation of

Deleted: but must interact with the specific practices in the Technical Solution process area to establish solutions to which the requirements are allocated

Deleted: The requirements for product components of the defined solution include allocation of product performance; design constraints; and fit, form, and function to meet requirements and facilitate production. In cases where a higher level requirement specifies performance that will be the responsibility of two or more product components, the performance must be partitioned for unique allocation to each product component as a derived requirement.¶

**SP 2.2 Allocate Contractual Requirements**

**Allocate contractual requirements to supplier deliverables.**

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Contractual requirements are allocated, as appropriate, to supplier deliverables. The requirements for each supplier deliverable are documented. In some cases, technical requirements are allocated to third-party products that must be used by the supplier (e.g., COTS products).

**Typical Work Products**

- 1. Requirement allocation sheets

**Subpractices**

- 1. Allocate requirements to supplier deliverables.
- 2. Allocate design constraints to supplier deliverables.
- 3. Document relationships among allocated requirements and design constraints.

Relationships include dependencies (i.e., a change in one requirement may affect other requirements).

- 4. Allocate requirements to suppliers.

In situations where multiple suppliers are involved in developing the technical solution, different products or product components may be allocated to different suppliers.

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3. Design constraints¶  
4. Derived requirements¶  
5. Relationships among derived requirements¶

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3.

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Deleted: **SP 2.3 Identify Interface Requirements¶**

**Identify interface requirements.¶**  
Interfaces between functions (or between objects)

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*Refer to the Product Integration process area for more information about the management of interfaces and the integration of products and product components.¶*  
Interface requirements between products or product components identified in the product archit (... [11]

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**SG 3 Analyze and Validate Requirements**

**Requirements are analyzed and validated.**

Analyses are performed to determine the impact the intended operational environment will have on the ability to satisfy stakeholder needs, expectations, constraints, and interfaces. Considerations, such as feasibility, mission needs, cost constraints, potential market size, and acquisition strategy, must all be taken into account, depending on the product context.

The objectives of these analyses are (1) to determine candidate requirements for product concepts that will satisfy stakeholder needs, expectations, constraints, and interfaces and (2) to translate these concepts into requirements. In parallel with these activities, the parameters to be used to evaluate the effectiveness of the product are determined based on customer input and the preliminary product concept.

Requirements are validated to increase the probability that the resulting product will perform as intended in the acquirer's environment.

**SP 3.1 Establish Operational Concepts and Scenarios**

**Establish and maintain operational concepts and associated scenarios.**

Operational concepts or concepts of operations is an overall description of the problem to be solved in operational terms and the way in which the product to be acquired is intended to be used or operated.

deployed, supported (including maintenance and sustainment), and disposed. The acquirer explicitly accounts for design constraints.

For example, the operational concept for a satellite-based communications product is quite different from one based on landlines.

In contrast, an operational scenario is a description of a sequence of events that might occur in the use of the product to be acquired and makes explicit some stakeholder needs. Typically, operational scenarios are derived from business process descriptions and operational concepts.

Operational concepts and scenarios can assist in the elicitation of needs and the analysis and refinement of requirements. Operational concepts and scenarios can be further refined as solution decisions are made and more detailed requirements are developed. They are evolved to facilitate the validation of technical solutions delivered by the supplier.

**Typical Work Products**

1. Operational, maintenance, support, and disposal concepts
2. Use cases
3. New requirements

**Subpractices**

1. Develop operational concepts and scenarios that include functionality, performance, maintenance, support, and disposal, as appropriate.
2. Define the environment in which the product will operate, including boundaries and constraints.
3. Review operational concepts and scenarios to refine and discover requirements.

Operational concept and scenario development is an iterative process. Reviews should be held periodically to ensure that the operational concepts and scenarios agree with the requirements. The review may be in the form of a walkthrough.

4. Develop a detailed operational concept, as candidate solutions are identified and product and product component solutions are selected by the supplier, that defines the interaction of the product, the end user, and the environment, and that satisfies operational, maintenance, support, and disposal needs.

**Deleted:** Since the alternative solutions have not usually been defined when preparing the initial operational concepts, conceptual solutions are developed for use when analyzing the requirements. The operational concepts are refined as solution decisions are made and lower level detailed requirements are developed.

**Deleted:** Just as a design decision for a product may become a requirement for product components, the operational concept may become the scenarios (requirements) for product components. Operational concepts and scenarios are evolved to facilitate the selection of product component solutions that, when implemented, will satisfy the intended use of the product. Operational concepts and scenarios document the interaction of the product components with the environment, users, and other product components, regardless of engineering discipline. They should be documented for all modes and states within operations, product deployment, delivery, support (including maintenance and sustainment), training, and disposal. The scenarios may include operational sequences, provided those sequences are an expression of customer requirements rather than operational concepts.

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2. Product or product component installation, operational

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**Deleted:** Identify and develop scenarios, consistent with the level of detail in the stakeholder needs, expectations, and constraints in which the proposed product or product component is expected to operate.

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SP 3.2 Analyze Requirements

**Analyze requirements to ensure they are necessary and sufficient.**

As contractual requirements are defined, their relationship to customer requirements must be understood. In light of the operational concepts and scenarios, the contractual requirements are analyzed to determine whether they are necessary and sufficient to meet customer requirements. The analyzed requirements then provide the basis for more detailed and precise requirements throughout the project lifecycle.

One of the other actions is the determination of which key requirements will be used to track technical progress. For instance, the weight of a product or size of a software product may be monitored through development based on its risk.

Refer to the Acquisition Technical Management process area for more information about tracking technical progress and technical performance measures.

**Typical Work Products**

1. Requirements defects reports
2. Proposed requirements changes to resolve defects
3. Key requirements
4. Technical performance measures

**Subpractices**

1. Analyze stakeholder needs, expectations, constraints, and external interfaces to remove conflicts and to organize into related subjects.
2. Analyze requirements to determine whether they satisfy higher level requirements.
3. Analyze requirements to ensure that they are complete, feasible, realizable, and verifiable.
4. Analyze and propose the allocation of requirements to supplier deliverables.
5. Identify key requirements that have a strong influence on cost, schedule, functionality, risk, or performance.
6. Identify technical performance measures to be tracked during the acquisition.

Technical performance measures are precisely defined measures based on a product requirement, product capability, or some combination of requirements and/or capabilities. Technical performance measures are chosen to monitor requirements and capabilities that are considered key factors in a product's performance. Data for technical performance measures are provided by the supplier as specified in the supplier agreement.

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Deleted: Establish a Definition of Required Functionality¶

Establish and maintain a definition of required functionality.¶

The definition of functionality, also referred to as "functional analysis," is the description of what the product is intended to do. The definition of functionality can include actions, sequence, inputs, outputs, or other information that communicates the manner in which the product will be used.¶

Functional analysis is not the same as structured analysis in software development and does not presume a functionally oriented software design. In object-oriented software design, it relates to defining what are called "services" or "methods." The definition of functions, their logical groupings, and their association with requirements is referred to as a functional architecture. (See the definition of "functional architecture" in the glossary.)¶

Typical Work Products¶

1. Functional architecture¶
2. Activity diagrams and use cases¶
3. Object-oriented analysis with services or methods identified¶

Subpractices¶

1. Analyze and quantify functionality required by end users.¶
2. Analyze requirements to identify logical or functional partitions (e.g., subfunctions).¶

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Deleted: Verification

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Refer to the Measurement and Analysis process area for more information about specifying measures.

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- 7. Analyze operational concepts and scenarios to refine customer needs, constraints, and interfaces and to discover new requirements.

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This analysis may result in more detailed operational concepts and scenarios as well as support the derivation of new requirements.

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### SP 3.3 Analyze Requirements to Achieve Balance

#### Analyze requirements to balance stakeholder needs and constraints.

Stakeholder needs and constraints can address cost, schedule, performance, functionality, reusable components, maintainability, or risk.

Requirements are analyzed to determine whether they reflect an appropriate balance among cost, schedule, performance, and other factors of interest to relevant stakeholders. Models and simulations can be used to estimate the impacts that requirements will have on these factors. By involving stakeholders from different phases of the product's lifecycle in analyzing these impacts, risks can be determined. If the risks are considered unacceptable, the requirements may be revised or reprioritized to improve the balance of cost, schedule, and performance.

#### Typical Work Products

- 1. Assessment of risks related to requirements

#### Subpractices

- 1. Use proven models, simulations, and prototyping to analyze the balance of stakeholder needs and constraints.

Results of analyses can be used to reduce the cost of the product and the risk in acquiring and using the product.

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- 2. Perform a risk assessment on requirements and design constraints.

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Refer to the Risk Management process area for more information about performing a risk assessment on customer and contractual requirements and design constraints.

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- 3. Examine product lifecycle concepts for impacts of requirements on risks.

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### SP 3.4 Validate Requirements

#### Validate requirements to ensure the resulting product performs as intended in the user's environment.

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Requirements validation is performed early in the acquisition with end users or their representatives to gain confidence that the requirements are capable of guiding a development that results in successful final

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validation. This activity should be integrated with risk management activities. Mature organizations typically perform requirements validation in a more sophisticated way using multiple techniques and broaden the basis of the validation to include other stakeholder needs and expectations. These organizations typically perform analyses, prototyping, and simulations to ensure that requirements will satisfy stakeholder needs and expectations.

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Examples of techniques used for requirements validation include the following:

- Analysis
- Simulations
- Prototyping
- Demonstrations

**Typical Work Products**

1. Records of analysis methods and results

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**Typical Supplier Deliverables**

1. Requirements and validation methods (e.g., prototypes and simulations)

**Subpractices**

1. Analyze the requirements to determine the risk that the resulting product will not perform appropriately in its intended-use environment.
2. Explore the adequacy and completeness of requirements by developing product representations (e.g., prototypes, simulations, models, scenarios, and storyboards) and by obtaining feedback about them from relevant stakeholders.

*Refer to the Acquisition Validation process area for more information about preparing for and performing validation on products and product components.*

3. Assess product and product component solutions as they are developed by the supplier in the context of the validation environment to identify issues and expose unstated needs and customer requirements.

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~~1.4~~ Acquisition Requirements Development (ARD)

All development projects have requirements. In the case of a project that is focused on maintenance activities, the changes to the product or product components are based on changes to the existing requirements, design, or implementation. The requirements changes, if any, might be documented in change requests from the customer or users, or they might take the form of new requirements received from the requirements development process. Regardless of their source or form, the maintenance activities that are driven by changes to requirements are managed accordingly.

the customer requirements  
Establishment of initial product and product component

This process area addresses all customer requirements rather than only product-

requirements because the customer may also provide specific design requirements.

Customer requirements are further refined into product and product component requirements. In addition

customer requirements, product and product component requirements are derived from the selected design solutions. Throughout the process areas, where we use the terms product and product component, their intended meanings also encompass services and their components.

Requirements are identified and refined throughout the phases of the product lifecycle. Design decisions, subsequent corrective actions, and feedback during each phase of the product's lifecycle are analyzed for impact on derived and allocated requirements.

The Requirements Development process area includes three specific goals. The Develop Customer Requirements specific goal addresses defining a set of customer requirements to use in the development of product requirements. The Develop Product Requirements specific goal addresses defining a set of product or product component requirements to use

design of products and product components. The Analyze and Validate Requirements specific goal addresses the necessary analysis of customer, product, and product component requirements to define, derive, and understand the requirements. The specific practices of the third specific goal are intended to assist the specific practices in the first two specific goals. The processes associated with the Requirements Development process area and those associated with the Technical Solution process area may interact recursively with one another.

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Analyses are used to understand, define, and select the requirements at all levels from competing alternatives. These analyses include the following:

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- Constraints of various types
- Technological limitations
- Cost and cost drivers
- Time constraints and schedule drivers
- Risks
- Consideration of issues implied but not explicitly stated by the customer or end user
- Factors introduced by the developer's unique business considerations, regulations, and laws

A hierarchy of logical entities (functions and subfunctions, object classes and subclasses) is established through iteration with the evolving operational concept. Requirements are refined, derived, and allocated to these logical entities. Requirements and logical entities are allocated to products, product components, people, or associated processes.

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*Refer to the Technical Solution process area for more information about how the outputs of the requirements development processes are used, and the development of alternative solutions and designs used in refining and deriving requirements.*

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*interface requirements and interface management.*

*Refer to the Verification process area for more information about verifying*

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development of alternative solutions described in the Technical Solution process area.

*Refer to the Product Integration process area for more information about the management of interfaces and the integration of products and product components.*

Interface requirements between products or product components identified in the product architecture are defined. They are controlled as part of product and product component integration and are an integral part of the architecture definition.

#### **Typical Work Products**

1. Interface requirements

#### **Subpractices**

1. Identify interfaces both external to the product and internal to the product (i.e., between functional partitions or objects).

As the design progresses, the product architecture will be altered by

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processes, creating new interfaces between product components and components external to the product.

Interfaces with product-related lifecycle processes should also be identified.

Examples of these interfaces include interfaces with test equipment, transportation systems, support systems, and manufacturing facilities.

2. Develop the requirements for the identified interfaces.

*Refer to the Technical Solution process area for more information about generating new interfaces during the design process.*

Requirements for interfaces are defined in terms such as origination, destination, stimulus, data characteristics for software, and electrical and mechanical characteristics for hardware

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The specific practices of the Analyze and Validate Requirements specific goal support the development of the requirements in both the Develop Customer Requirements specific goal and the Develop Product Requirements specific goal. The specific practices associated with this specific goal cover analyzing and validating the requirements with respect to the user's intended environment.

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A definition of required functionality is also established. All specified usage modes for the product are considered, and a

timeline analysis is generated for time-critical sequencing of functions.

A scenario is typically a sequence of events that might occur in the use of the product, which is used to make explicit some of the needs of the stakeholders. In contrast, an operational concept for a product usually depends on both the design solution and the scenario.

## **Establish a Definition of Required Functionality**

### ***Establish and maintain a definition of required functionality.***

The definition of functionality, also referred to as “functional analysis,” is the description of what the product is intended to do. The definition of functionality can include actions, sequence, inputs, outputs, or other information that communicates the manner in which the product will be used.

Functional analysis is not the same as structured analysis in software development and does not presume a functionally oriented software design. In object-oriented software design, it relates to defining what are called “services” or “methods.” The definition of functions, their logical groupings, and their association with requirements is referred to as a functional architecture. (See the definition of “functional architecture” in the glossary.)

#### **Typical Work Products**

1. Functional architecture
2. Activity diagrams and use cases
3. Object-oriented analysis with services or methods identified

#### **Subpractices**

1. Analyze and quantify functionality required by end users.
2. Analyze requirements to identify logical or functional partitions (e.g., subfunctions).
3. Partition requirements into groups, based on established criteria (e.g., similar functionality, performance, or coupling), to facilitate and focus the requirements analysis.
4. Consider the sequencing of time-critical functions both initially and subsequently during product component development.
5. Allocate customer requirements to functional partitions, objects, people, or support elements to support the synthesis of solutions.

6. Allocate functional and performance requirements to functions and subfunctions.

### SP 3.3

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As requirements are defined, their relationship to higher level requirements and the higher level defined functionality must be understood.

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While design determines the feasibility of a particular solution, this subpractice addresses knowing which requirements affect feasibility.

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**Continuous Only**

**GG 1      Achieve Specific Goals**

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*The process supports and enables achievement of the specific goals of the process area by transforming identifiable input work products to produce identifiable output work products.*

**GP 1.1      Perform Specific Practices**

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*Perform the specific practices of the requirements development process to develop work products and provide services to achieve the specific goals of the process area.*

**GG 2      Institutionalize a Managed Process**

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*The process is institutionalized as a managed process.*

**Staged Only**

**GG 3      Institutionalize a Defined Process**

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*The process is institutionalized as a defined process.*

This generic goal's appearance here reflects its location in the staged representation.

**GP 2.1      Establish an Organizational Policy**

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*Establish and maintain an organizational policy for planning and performing the requirements development process.*

Elaboration:

This policy establishes organizational expectations for collecting stakeholder needs, formulating product and product component requirements, and analyzing and validating those requirements.

**GP 2.2      Plan the Process**

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*Establish and maintain the plan for performing the requirements development process.*

Elaboration:

This plan for performing the requirements development process can be part of (or referenced by) the project plan as described in the Project Planning process area.

### **GP 2.3 Provide Resources**

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***Provide adequate resources for performing the requirements development process, developing the work products, and providing the services of the process.***

Elaboration:

Special expertise in the application domain, methods for eliciting stakeholder needs, and methods and tools for specifying and analyzing customer, product, and product component requirements may be required.

Examples of other resources provided include the following tools:

- Requirements specification tools
- Simulators and modeling tools
- Prototyping tools
- Scenario definition and management tools
- Requirements tracking tools

### **GP 2.4 Assign Responsibility**

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***Assign responsibility and authority for performing the process, developing the work products, and providing the services of the requirements development process.***

### **GP 2.5 Train People**

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***Train the people performing or supporting the requirements development process as needed.***

Elaboration:

Examples of training topics include the following:

- Application domain
- Requirements definition and analysis
- Requirements elicitation
- Requirements specification and modeling
- Requirements tracking

## **GP 2.6      Manage Configurations**

---

***Place designated work products of the requirements development process under appropriate levels of control.***

Elaboration:

Examples of work products placed under control include the following:

- Customer requirements
- Functional architecture
- Product and product component requirements
- Interface requirements

## **GP 2.7      Identify and Involve Relevant Stakeholders**

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***Identify and involve the relevant stakeholders of the requirements development process as planned.***

Elaboration:

Select relevant stakeholders from customers, end users, developers, producers, testers, suppliers, marketers, maintainers, disposal personnel, and others who may be affected by, or may affect, the product as well as the process.

Examples of activities for stakeholder involvement include the following:

- Reviewing the adequacy of requirements in meeting needs, expectations, constraints, and interfaces
- Establishing operational concepts and scenarios
- Assessing the adequacy of requirements
- Establishing product and product component requirements
- Assessing product cost, schedule, and risk

## **GP 2.8      Monitor and Control the Process**

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***Monitor and control the requirements development process against the plan for performing the process and take appropriate corrective action.***

Elaboration:

Examples of measures and work products used in monitoring and controlling include the following:

- Cost, schedule, and effort expended for rework
- Defect density of requirements specifications
- Schedule for activities to develop a set of requirements.

**GP 2.9 Objectively Evaluate Adherence**

***Objectively evaluate adherence of the requirements development process against its process description, standards, and procedures, and address noncompliance.***

Elaboration:

Examples of activities reviewed include the following:

- Collecting stakeholder needs
- Formulating product and product component requirements
- Analyzing and validating product and product component requirements

Examples of work products reviewed include the following:

- Product requirements
- Product component requirements
- Interface requirements
- Functional architecture

**GP 2.10 Review Status with Higher Level Management**

***Review the activities, status, and results of the requirements development process with higher level management and resolve issues.***

**Continuous Only**

**GG 3 Institutionalize a Defined Process**

***The process is institutionalized as a defined process.***

This generic goal's appearance here reflects its location in the continuous representation.

**GP 3.1 Establish a Defined Process**

***Establish and maintain the description of a defined requirements development process.***

**GP 3.2 Collect Improvement Information**

***Collect work products, measures, measurement results, and improvement information derived from planning and performing the requirements development process to support the future use and improvement of the organization's processes and process assets.***

Elaboration:

Examples of work products, measures, measurement results, and improvement information include the following:

- List of the requirements for a product that are found to be ambiguous
- Number of requirements introduced at each phase of the project lifecycle
- Lessons learned from the requirements allocation process

## Continuous Only

### **GG 4 Institutionalize a Quantitatively Managed Process**

***The process is institutionalized as a quantitatively managed process.***

#### **GP 4.1 Establish Quantitative Objectives for the Process**

***Establish and maintain quantitative objectives for the requirements development process, which address quality and process performance, based on customer needs and business objectives.***

#### **GP 4.2 Stabilize Subprocess Performance**

***Stabilize the performance of one or more subprocesses to determine the ability of the requirements development process to achieve the established quantitative quality and process-performance objectives.***

### **GG 5 Institutionalize an Optimizing Process**

***The process is institutionalized as an optimizing process.***

#### **GP 5.1 Ensure Continuous Process Improvement**

***Ensure continuous improvement of the requirements development process in fulfilling the relevant business objectives of the organization.***

#### **GP 5.2 Correct Root Causes of Problems**

***Identify and correct the root causes of defects and other problems in the requirements development process.***