Organization Process Focus

a key process area for Level 3: Defined

The purpose of Organization Process Focus is to establish the organizational responsibility for software process activities that improve the organization's overall software process capability.

Organization Process Focus involves developing and maintaining an understanding of the organization's and projects' software processes and coordinating the activities to assess, develop, maintain, and improve these processes.

The organization provides the long-term commitments and resources to coordinate the development and maintenance of the software processes across current and future software projects via a group such as a software engineering process group. This group is responsible for the organization's software process activities. It is specifically responsible for the development and maintenance of the organization's standard software process and related process assets (as described in the Organization Process Definition key process area), and it coordinates the process activities with the software projects.

Goals

Goal 1 **Software process development and improvement activities are coordinated across the organization.**

Goal 2 **The strengths and weaknesses of the software processes used are identified relative to a process standard.**

Goal 3 **Organization-level process development and improvement activities are planned.**

Commitment to perform

Commitment 1 **The organization follows a written organizational policy for coordinating software process development and improvement activities across the organization.**

This policy typically specifies that:

1. A group is established that is responsible for the organization-level software process activities and coordinating these activities with the projects.

2. The software processes used by the projects are assessed periodically to determine their strengths and weaknesses.

3. The software processes used by the projects are appropriately tailored from the organization's standard software process.

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Refer to Activity 1 of the Integrated Software Management key process area for practices covering tailoring of the organization's standard software process.

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4. Improvements to, and other useful information on, each project's software process, tools, and methods are available to other projects.

Commitment 2 Senior management sponsors the organization's activities for software process development and improvement.

(Commitment 2) Senior management:

1. Demonstrates to the organization's staff and managers its commitment to these software process activities.

2. Establishes long-term plans and commitments for funding, staffing, and other resources.

3. Establishes strategies for managing and implementing the activities for process development and improvement.

Commitment 3 Senior management oversees the organization's activities for software process development and improvement.

Senior management:

1. Ensures that the organization's standard software process supports its business goals and strategies.

2. Advises on setting priorities for software process development and improvement.

3. Participates in establishing plans for software process development and improvement.

   q Senior management coordinates software process requirements and issues with higher level staff and managers.

- Senior management coordinates with the organization's managers to secure the managers' and staff's support and participation.

Ability to perform

Ability 1 **A group that is responsible for the organization's software process activities exists.**

(Ability 1)

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A group is the collection of departments, managers, and individuals who have responsibility for a set of tasks or activities. A group could vary from a single individual assigned part time, to several part-time individuals assigned from different departments, to several individuals dedicated full time. Considerations when implementing a group include assigned tasks or activities, the size of the project, the organizational structure, and the organizational culture. Some groups, such as the software quality assurance group, are focused on project activities, and others, such as the software engineering process group, are focused on organization-wide activities.

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1. Where possible, this group is staffed by a core of software technical professionals who are assigned full time to the group, possibly supported by others, on a part-time basis.

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The most common example of this group is a software engineering process group (SEPG).

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2. This group is staffed to represent the software engineering discipline and software-related disciplines.

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Examples of software engineering and software-related disciplines include:

- software requirements analysis,
- software design,
- coding,
- software test,
- software configuration management, and
- software quality assurance.

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Ability 2 **Adequate resources and funding are provided for the organization's software process activities.**

(Ability 2)

1. Experienced individuals who have expertise in specialized areas are committed to support this group.

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Examples of specialized areas include:

- software reuse,
- computer-aided software engineering (CASE) technology,
- measurement, and
- training course development.

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2. Tools to support the organization's software process activities are made available.

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Examples of support tools include:

- statistical analysis tools,
- desktop publishing tools,
- database management systems, and
- process modeling tools.

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Ability 3 **Members of the group responsible for the organization's software process activities receive required training to perform these activities.**

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Examples of training include:

- software engineering practices;
- process control techniques;
- organization change management;
- planning, managing, and monitoring the software process; and
- technology transition.

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(Ability 3)

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Refer to the Training Program key process area.

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Ability 4 **Members of the software engineering group and other software-related groups receive orientation on the organization's software process activities and their roles in those activities.**

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Refer to the Training Program key process area.

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Activities performed

Activity 1 **The software process is assessed periodically, and action plans are developed to address the assessment findings.**

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Assessments are typically conducted every 1-1/2 to 3 years.

Assessments look at all software processes used in the organization, but may do this by sampling process areas and projects.

An example of a method to assess an organization's software process capability is the SEI Software Process Assessment method.

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The action plan identifies:

- which assessment findings will be addressed,
- guidelines for implementing the changes to address findings, and
- the groups or individuals responsible for implementing the changes.

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Activity 2 **The organization develops and maintains a plan for its software process development and improvement activities.**

This plan:

1. Uses the action plans from the software process assessments and other organization improvement initiatives as primary inputs.

2. Defines the activities to be performed and the schedule for these activities.

3. Specifies the groups and individuals responsible for the activities.

4. Identifies the resources required, including staff and tools.

5. Undergoes peer review when initially released and whenever major revisions are made.

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Refer to the Peer Reviews key process area.

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6. Is reviewed and agreed to by the organization's software managers and senior managers.

Activity 3 **The organization's and projects' activities for developing and improving their software processes are coordinated at the organization level.**

This coordination covers the development and improvement of:

1. The organization's standard software process.

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Refer to Activities 1 and 2 of the Organization Process Definition key process area for practices covering the organization's standard software process.

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(Activity 3) 2. The projects' defined software processes

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Refer to Activities 1 and 2 of the Integrated Software Management key process area for practices covering the project's defined software process.

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Activity 4 **The use of the organization's software process database is coordinated at the organizational level.**

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The organization's software process database is used to collect information on the software processes and resulting software products of the organization and the projects.

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Refer to Activity 5 of the Organization Process Definition key process area for practices covering the organization's software process database.

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Activity 5 **New processes, methods, and tools in limited use in the organization are monitored, evaluated, and, where appropriate, transferred to other parts of the organization.**

Activity 6 **Training for the organization's and projects' software processes is coordinated across the organization.**

1. Plans for training on subjects related to the organization's and projects' software processes are prepared.

2. Where appropriate, training may be prepared and conducted by the group responsible for the organization's software process activities (e.g., software engineering process group) or by the training group.

(Activity 6)

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Refer to the Training Program key process area.

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Activity 7 **The groups involved in implementing the software processes are informed of the organization's and projects' activities for software process development and improvement.**

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Examples of means to inform and involve these people include:

- electronic bulletin boards on process,
- process advisory boards,
- working groups,
- information exchange meetings,
- surveys,
- process improvement teams, and
- informal discussions.

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Measurement and analysis

Measurement 1 **Measurements are made and used to determine the status of the organization's process development and improvement activities.**

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Examples of measurements include:

- work completed, effort expended, and funds expended in the organization's activities for process assessment, development, and improvement compared to the plans for these activities; and
- results of each software process assessment, compared to the results and recommendations of previous assessments.

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Verifying implementation

Verification 1 The activities for software process development and improvement are reviewed with senior management on a periodic basis. XTOLERI(
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The primary purpose of periodic reviews by senior management is to provide awareness of, and insight into, software process activities at an appropriate level of abstraction and in a timely manner. The time between reviews should meet the needs of the organization and may be lengthy, as long as adequate mechanisms for exception reporting are available.

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1. Progress and status of the activities to develop and improve the software process are reviewed against the plan.

2. Conflicts and issues not resolved at lower levels are addressed.

3. Action items are assigned, reviewed, and tracked to closure.

4. A summary report from each review is prepared and distributed to the affected groups and individuals.

Organization Process Definition

a key process area for Level 3: Defined

The purpose of Organization Process Definition is to develop and maintain a usable set of software process assets that improve process performance across the projects and provide a basis for cumulative, long-term benefits to the organization.

Organization Process Definition involves developing and maintaining the organization's standard software process, along with related process assets, such as descriptions of software life cycles, process tailoring guidelines and criteria, the organization's software process database, and a library of software process-related documentation.

These assets may be collected in many ways, depending on the organization's implementation of Organization Process Definition. For example, the descriptions of the software life cycles may be an integral part of the organization's standard software process or parts of the library of software process-related documentation may be stored in the organization's software process database.

The organization's software process assets are available for use in developing, implementing, and maintaining the projects'

defined software processes. (The practices related to the development and maintenance of the project's defined software process are described in the Integrated Software Management key process area.)

Goals

Goal 1 **A standard software process for the organization is developed and maintained.**

Goal 2 **Information related to the use of the organization's standard software process by the software projects is collected, reviewed, and made available.**

Commitment to perform

Commitment 1 **The organization follows a written policy for developing and maintaining a standard software process and related process assets.**

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The organization's software process assets include:

- the organization's standard software process,
- guidelines and criteria for the projects' tailoring of the organization's standard software process,
- descriptions of software life cycles approved for use,
- the organization's software process database, and
- a library of software process-related documentation previously developed and available for reuse.

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This policy typically specifies that:

1. A standard software process is defined for the organization.

(Commitment 1) XTOLERI(
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The primary purposes of a standard software process are to maximize the sharing of process assets and experiences across the projects and to provide the ability to define and aggregate a standard set of process measurements from the projects at the organization level.

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The organization's standard software process may contain multiple software processes. Multiple software processes may be needed to address the needs of different applications, life cycles, methodologies, and tools, which the software projects may compose in multiple ways.

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2. A project's defined software process is a tailored version of the organization's standard software process.

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Refer to Activity 1 of the Integrated Software Management key process area for practices covering tailoring of the organization's standard software process.

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3. The organization's software process assets are maintained.

4. Information collected from the projects is organized and used to improve the organization's standard software process.

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Examples of collected information include:

- process and product measurements,
- lessons learned, and
- other process-related documentation.

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Ability to perform

Ability 1 **Adequate resources and funding are provided for developing and maintaining the organization's standard software process and related process assets.**

1. The development and maintenance of the organization's standard software process and related process assets is performed or coordinated by the group responsible for the organization's software process activities (e.g., software engineering process group).

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Refer to the Organization Process Focus key process area for practices covering the group responsible for the organization's software process activities.

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2. Tools to support process development and maintenance are made available.

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Examples of support tools include:

- desktop publishing tools,
- database management systems, and
- process modeling tools.

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Ability 2 **The individuals who develop and maintain the organization's standard software process and related process assets receive required training to perform these activities.**

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Examples of training include:

- software engineering practices and methods,
- process analysis and documentation methods, and
- process modeling.

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(Ability 2)

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Refer to the Training Program key process area.

XBOLERI(
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Activities performed

Activity 1 **The organization's standard software process is developed and maintained according to a documented procedure.**

This procedure typically specifies that:

1. The organization's standard software process satisfies the software policies, process standards, and product standards imposed on the organization, as appropriate.

2. The organization's standard software process satisfies the software process and product standards that are commonly imposed on the organization's projects by their customers, as appropriate.

3. State-of-the-practice software engineering tools and methods are incorporated into the organization's standard software process, as appropriate.

4. The internal process interfaces between the software disciplines are described.

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Examples of software engineering disciplines include:

- software requirements analysis,
- software design,
- coding,
- software testing,
- software configuration management, and
- software quality assurance.

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(Activity 1)

5. The external process interfaces between the software process and the processes of other affected groups are described.

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Examples of other affected groups include:

- system engineering,
- system test,
- contract management, and
- documentation support.

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6. Changes proposed for the organization's standard software process are documented, reviewed, and approved by the group responsible for the organization's software process activities (e.g., software engineering process group) before they are incorporated.

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Examples of sources for change include:

- the findings and recommendations of software process assessments,
- results of the project's tailoring of the organization's standard software process,
- lessons learned from monitoring the organization's and projects' software process activities,
- changes proposed by the organization's staff and managers, and
- process and product measurement data that are analyzed and interpreted.

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7. Plans for introducing changes to the software process of ongoing projects are defined as appropriate.

8. The description of the organization's standard software process undergoes peer review when initially developed and whenever significant changes or additions are made.

(Activity 1)

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Refer to the Peer Reviews key process area.

XBOLERI(
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9. The description of the organization's standard software process is placed under configuration management.

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Refer to the Software Configuration Management key process area.

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Activity 2 **The organization's standard software process is documented according to established organization standards.**

These standards typically specify that:

1. The process is decomposed into constituent process elements to the granularity needed to understand and describe the process.

XTOLERI(
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Each process element covers a well-defined, bounded, closely related set of activities.

Examples of process elements include:

- software estimating element,
- software design element,
- coding element, and
- peer review element.

The descriptions of the process elements may be templates to be filled in, fragments to be completed, abstractions to be refined, or complete descriptions to be modified or used unmodified.

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2. Each process element is described and addresses:

(Activity 2)

- q the required procedures, practices, methods, and technologies;
- q the applicable process and product standards;
- q the responsibilities for implementing the process;
- q the required tools and resources;
- q inputs;
- q the software work products produced;
- q the software work products that should undergo peer review;
- q the readiness and completion criteria; and
- q the product and process data to be collected.

3. The relationships of the process elements are described and address:

- q the ordering,
- q the interfaces, and

q the interdependencies.

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This relationship of the process elements is sometimes referred to as a software process architecture.

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Activity 3 **Descriptions of software life cycles that are approved for use by the projects are documented and maintained.**

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Examples of software life cycles include:

- waterfall,
- overlapping waterfall,
- spiral,
- serial build, and
- single prototype/overlapping waterfall.

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1. The software life cycles are compatible with the organization's standard software process.

2. Changes proposed for the descriptions of software life cycles are documented, reviewed, and approved by the group responsible for the organization's software process activities (e.g., software engineering process group) before they are incorporated.

(Activity 3)

3. The descriptions of the software life cycles undergo peer review when initially documented and whenever significant changes or additions are made.

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Refer to the Peer Reviews key process area.

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4. The descriptions of the software life cycles are managed and controlled.

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"Managed and controlled" implies that the version of the work product in use at a given time (past or present) is known (i.e., version control), and changes are incorporated in a controlled manner (i.e., change control).

If a greater degree of control than is implied by "managed and controlled" is desired, the work product can be placed under the full discipline of configuration management, as is described in the Software Configuration Management key process area.

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Activity 4 **Guidelines and criteria for the projects' tailoring of the organization's standard software process are developed and maintained.**

1. The tailoring guidelines and criteria cover:
   - q selecting and tailoring the software life cycle for the project,
   - q tailoring the organization's standard software process to accommodate the software life cycle and the project's characteristics, and

(Activity 4) XTOLERI(
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Examples of tailoring include:

- adapting the process for a new product line or host environment,
- customizing the process for a specific project or class of projects, and
- elaborating and adding detail to the process so that the resulting project's defined software process can be enacted.

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q standards for documenting the project's defined software process.

2. Changes proposed for the tailoring guidelines and criteria are documented, reviewed, and approved by the group responsible for the organization's software process activities (e.g., software engineering process group) before they are incorporated.

3. The tailoring guidelines and criteria are managed and controlled.

Activity 5 **The organization's software process database is established and maintained.**

1. The database is established to collect and make available data on the software processes and resulting software work products.

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Examples of process and work product data include:

- estimates of software size, effort, and cost;
- actual data on software size, effort, and cost;
- productivity data;
- quality measurements;
- peer review coverage and efficiency;
- test coverage and efficiency;
- software reliability measures;
- number and severity of defects found in the software requirements; and
- number and severity of defects found in the software code.

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(Activity 5)

2. The data entered into the database is reviewed to ensure the integrity of the database contents.

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In addition, the database also contains or references the actual measurement data and related information and data needed to understand and interpret the measurement data and assess it for reasonableness and applicability.

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3. The database is managed and controlled.

4. User access to the database contents is controlled to ensure completeness, integrity, and accuracy of the data.

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Access is limited to those who have a need to enter, change, view, analyze, or extract data.

Sensitive data are protected and access to these data is appropriately controlled.

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Activity 6 **A library of software process-related documentation is established and maintained.**

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Examples of software process-related documentation include:

- the description of a project's defined software process,
- a project's standards,
- a project's procedures,
- a project's software development plans,
- a project's measurement plans, and
- a project's process training materials.

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1. Candidate documentation items are reviewed and appropriate items that may be useful in the future are included in the library.

(Activity 6)

2. The documentation items are catalogued for easy access.

3. Revisions made to documentation items currently in the library are reviewed, and the library contents are updated as appropriate.

4. The library contents are made available for use by the software projects and other software-related groups.

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Examples of software-related groups include:

- software quality assurance
- software configuration management,
- software test, and
- documentation support.

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5. The use of each documentation item is reviewed periodically, and the results are used to maintain the library contents.

6. The library contents are managed and controlled.

Measurement and analysis

Measurement 1 Measurements are made and used to determine the status of the organization's process definition activities.

XTOLERI(
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Examples of measurements include:

- status of the schedule milestones for process development and maintenance, and
- costs for the process definition activities.

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Verifying implementation

Verification 1 **The software quality assurance group reviews and/or audits the organization's activities and work products for developing and maintaining the organization's standard software process and related process assets and reports the results.**

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Refer to the Software Quality Assurance key process area.

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At a minimum, these reviews and/or audits verify that:

1. The appropriate standards are followed in developing, documenting, and maintaining the organization's standard software process and related process assets.

2. The organization's standard software process and related process assets are controlled and used appropriately.

Training Program

a key process area for Level 3: Defined

The purpose of the Training Program key process area is to develop the skills and knowledge of individuals so they can perform their roles effectively and efficiently.

Training Program involves first identifying the training needed by the organization, projects, and individuals, then developing or procuring training to address the identified needs.

Each software project evaluates its current and future skill needs and determines how these skills will be obtained. Some skills are effectively and efficiently imparted through informal vehicles (e.g., on-the-job training and informal mentoring), whereas other skills need more formal training vehicles (e.g., classroom training and guided self-study) to be effectively and efficiently imparted. The appropriate vehicles are selected and used.

This key process area covers the practices for the group performing the training function. The practices identifying the specific training topics (i.e., knowledge or skill needed) are contained in the Ability to Perform common feature of the individual key process areas.

Goals

Goal 1 **Training activities are planned.**

Goal 2 **Training for developing the skills and knowledge needed to perform software management and technical roles is provided.**

Training Program

a key process area for Level 3: Defined

Goal 3 **Individuals in the software engineering group and software-related groups receive the training necessary to perform their roles.**

Commitment to perform

Commitment 1 **The organization follows a written policy for meeting its training needs.**

This policy typically specifies that:

1. The needed skills and knowledge for each software management and technical role are identified.

2. Training vehicles for imparting skills and knowledge are identified and approved.

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Examples of approved training vehicles include:

- classroom training,
- computer-aided instruction,
- guided self-study,
- formal apprenticeship and mentoring programs, and
- facilitated videos.

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3. Training is provided to build the skill base of the organization, to fill the specific needs of the projects, and to develop the skills of individuals.

4. Training is developed within the organization or obtained from outside the organization when appropriate.

(Commitment 1) XTOLERI(
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Examples of external sources of training include:

- customer-provided training,
- commercially available training courses,
- academic programs,
- professional conferences, and
- seminars.

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Ability to perform

Ability 1 **A group responsible for fulfilling the training needs of the organization exists.**

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The members of the training group may include full-time or part-time instructors drawn from the organization; the members may also be drawn from external sources.

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A group is the collection of departments, managers, and individuals who have responsibility for a set of tasks or activities. A group could vary from a single individual assigned part time, to several part-time individuals assigned from different departments, to several individuals dedicated full time. Considerations when implementing a group include assigned tasks or activities, the size of the project, the organizational structure, and the organizational culture. Some groups, such as the software quality assurance group, are focused on project activities, and others, such as the software engineering process group, are focused on organization-wide activities.

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Ability 2 **Adequate resources and funding are provided for implementing the training program.**

(Ability 2) XTOLERI(
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Examples of training program elements include:

- the organization's training plan,
- training materials,
- development or procurement of training,
- conduct of training,
- training facilities,
- evaluation of training, and
- maintaining records of training.

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1. A manager is designated to be responsible for implementing the organization's training program.

2. Tools to support the training program activities are made available.

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Examples of support tools include:

- workstations,
- instructional design tools,
- database programs, and
- packages for developing presentation materials.

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3. Appropriate facilities are made available to conduct training.

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Classroom training facilities should be separated from the students' work environment to eliminate interruptions.

Where appropriate, training is conducted in settings that closely resemble actual performance conditions and includes activities to simulate actual work situations.

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Ability 3 Members of the training group have the necessary skills and knowledge to perform their training activities.

(Ability 3)

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Examples of ways to provide these skills and knowledge include:

- training in instructional techniques, and
- refresher training in the subject matter.

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Ability 4 **Software managers receive orientation on the training program.**

Activities performed

Activity 1 **Each software project develops and maintains a training plan that specifies its training needs.**

The plan covers:

1. The set of skills needed and when those skills are needed.

2. The skills for which training is required and the skills that will be obtained via other vehicles.

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   Some skills are effectively and efficiently imparted through informal vehicles (e.g., informal training and presentations, reading books and journals, "chalk talks," brown-bag lunch seminars, on-the-job training, and informal mentoring); while other skills, to be effectively and efficiently imparted, need to be based on more formal training vehicles (e.g., classroom training, computer-aided instructions, guided self-study, facilitated video, and formal apprenticeship and mentoring programs).

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3. The training that is required, for whom it is required, and when it is required.

(Activity 1)

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Refer to the Ability to Perform common feature in all other key process areas for examples of specific training needs.

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Where appropriate, training for individuals is tied to their work responsibilities so that on-the-job activities or other outside experiences will reinforce the training within a reasonable time after the training.

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4. How training will be provided.

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Training may be provided by the software project, by the organization's training group, or by an external organization.

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Examples of training appropriately done by the software project include:

- training in specific applications and requirements of the project,
- training in the project's software architecture, and
- other training more effectively or efficiently performed at the project level.

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Activity 2 **The organization's training plan is developed and revised according to a documented procedure.**

This procedure typically specifies that:

1. The plan uses the software projects' training needs identified in their training plans.

2. The specific training to be provided is identified based on the skills needed by the organization and when those skills are needed.

(Activity 2)

3. The organization's training plan is revised, as appropriate, to incorporate changes.

4. The organization's training plan is reviewed by the affected individuals when it is initially released and whenever major revisions are made.

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Examples of affected individuals include:

- senior management,
- software managers, and
- managers of software-related groups.

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5. The organization's training plan is managed and controlled. XTOLERI(
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"Managed and controlled" implies that the version of the work product in use at a given time (past or present) is known (i.e., version control), and changes are incorporated in a controlled manner (i.e., change control).

If a greater degree of control than is implied by "managed and controlled" is desired, the work product can be placed under the full discipline of configuration management, as is described in the Software Configuration Management key process area.

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6. The organization's training plan is readily available to the affected groups and individuals.

(Activity 2)

XTOLERI(
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Examples of affected groups and individuals include:

- senior management,
- the training group,
- the managers of software-related groups,
- software engineering (including all subgroups, such as software design),
- software estimating,
- system engineering,
- system test,
- software quality assurance,
- software configuration management,
- contract management, and
- documentation support.

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Activity 3 **The training for the organization is performed in accordance with the organization's training plan.**

The plan covers:

1. The specific training needed within the organization and when it is needed.

2. The training that will be obtained from external sources and training that will be provided by the training group.

3. The funding and resources (including staff, tools, and facilities) needed to prepare and conduct or procure the training.

4. Standards for instructional materials used in training courses developed by the training group.

5. The schedule for developing and revising the training courses that will be developed by the training group.

6. The schedule for conducting the training, based on the projected need dates and the projected number of students.

(Activity 3)

7. The procedures for:
   - selecting the individuals who will receive the training,
   - registering and participating in the training,
   - maintaining records of the training provided, and
   - collecting, reviewing, and using training evaluations and other training feedback.

Activity 4 **Training courses prepared at the organization level are developed and maintained according to organization standards.**

These standards require that:

1. A description of each training course is developed.

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Examples of the topics addressed by the description include:

- intended audience,
- preparation for participating,
- training objectives,
- length of the training,
- lesson plans,
- criteria for determining the students' satisfactory completion,
- procedures for periodically evaluating the effectiveness of the training, and
- special considerations, such as piloting and field testing the training course, needs for refresher training, and opportunities for follow-up training.

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2. The materials for the training course are reviewed.

(Activity 4)

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Examples of individuals who review the training materials include:

- instructional experts,
- subject matter experts, and
- representative students from pilot sessions of the training course being reviewed.

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3. The materials for the training courses are managed and controlled.

Activity 5 **A waiver procedure for required training is established and used to determine whether individuals already possess the knowledge and skills required to perform in their designated roles.**

Activity 6 **Records of training are maintained.**

1. Records are kept of all students who successfully complete each training course or other approved training activity.

2. Records are kept of all students who successfully complete their designated required training.

3. Records of successfully completed training are made available for consideration in assignments of the staff and managers.

Measurement and analysis

Measurement 1 **Measurements are made and used to determine the status of the training program activities.**

(Measurement 1) XTOLERI(
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Examples of measurements include:

- actual attendance at each training course compared to the projected attendance,
- progress in providing training courses compared to the organization's and projects' training plans, and
- number of training waivers approved over time.

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Measurement 2 **Measurements are made and used to determine the quality of the training program.**

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Examples of measurements include:

- results of post-training tests,
- reviews of the courses from the students, and
- feedback from the software managers.

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Verifying implementation

Verification 1 The training program activities are reviewed with senior management on a periodic basis.

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The primary purpose of periodic reviews by senior management is to provide awareness of, and insight into, software process activities at an appropriate level of abstraction and in a timely manner. The time between reviews should meet the needs of the organization and may be lengthy, as long as adequate mechanisms for exception reporting are available.

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(Verification 1) XTOLERI(
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Refer to Verification 1 of the Software Project Tracking and Oversight key process area for practices covering the typical content of senior management oversight reviews.

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Verification 2 **The training program is independently evaluated on a periodic basis for consistency with, and relevance to, the organization's needs.**

Verification 3 **The training program activities and work products are reviewed and/or audited and the results are reported.**

At a minimum, the reviews and/or audits verify that:

1. The process for developing and revising the organization's training plan is followed.

2. The process for developing and revising a training course is followed.

3. Training records are properly maintained.

4. Individuals designated as requiring specific training complete that training.

5. The organization's training plan is followed.

Integrated Software Management

a key process area for Level 3: Defined

The purpose of Integrated Software Management is to integrate the software engineering and management activities into a coherent, defined software process that is tailored from the organization's standard software process and related process assets, which are described in Organization Process Definition.

Integrated Software Management involves developing the project's defined software process and managing the software project using this defined software process. The project's defined software process is tailored from the organization's standard software process to address the specific characteristics of the project.

The software development plan is based on the project's defined software process and describes how the activities of the project's defined software process will be implemented and managed. The management of the software project's size, effort, cost, schedule, staffing, and other resources is tied to the tasks of the project's defined software process.

Since the projects' defined software processes are all tailored from the organization's standard software process, the software projects can share process data and lessons learned.

Integrated Software Management

a key process area for Level 3: Defined

The basic practices for estimating, planning, and tracking a software project are described in the Software Project Planning and Software Project Tracking and Oversight key process areas. They focus on recognizing problems when they occur and adjusting the plans and/or performance to address the problems. The practices of this key process area build on, and are in addition to, the practices of those two key process areas. The emphasis of Integrated Software Management shifts to anticipating problems and acting to prevent or minimize the effects of these problems.

Goals

Goal 1 **The project's defined software process is a tailored version of the organization's standard software process.**

Goal 2 **The project is planned and managed according to the project's defined software process.**

Commitment to perform

Commitment 1 **The project follows a written organizational policy requiring that the software project be planned and managed using the organization's standard software process and related process assets.**

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Refer to the Organization Process Definition key process area for practices covering the organization's standard software process and related process assets.

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(Commitment 1) This policy typically specifies that:

1. Each project documents the project's defined software process by tailoring the organization's standard software process.

2. The project's deviations from the organization's standard software process are documented and approved.

3. Each project performs its software activities in accordance with the project's defined software process.

4. Each project collects and stores appropriate project measurement data in the organization's software process database.

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Refer to Activity 5 of the Organization Process Definition key process area for practices covering the organization's software process database.

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Ability to perform

Ability 1 **Adequate resources and funding are provided for managing the software project using the project's defined software process.**

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Refer to Ability 3 of the Software Project Planning key process area and Ability 3 of the Software Project Tracking and Oversight key process area for practices covering resources and funding for software project planning, tracking, and oversight.

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Ability 2 **The individuals responsible for developing the project's defined software process receive required training in how to tailor the organization's standard software process and use the related process assets.**

(Ability 2) XTOLERI(
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Examples of training include:

- using the software process database,
- using the organization's standard software process, and
- using the guidelines and criteria for tailoring the organization's standard software process to meet the needs of the software project.

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Refer to the Training Program key process areas.

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Ability 3 **The software managers receive required training in managing the technical, administrative, and personnel aspects of the software project based on the project's defined software process.**

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Refer to Ability 4 of the Software Project Planning key process area and Ability 4 of the Software Project Tracking and Oversight key process area for practices covering training for software project planning, tracking, and oversight.

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Examples of training include:

- methods and procedures for software estimating, planning, and tracking based on the project's defined software process; and
- methods and procedures for identifying, managing, and communicating software risks.

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Refer to the Training Program key process area.

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Activities performed

Activity 1 **The project's defined software process is developed by tailoring the organization's standard software process according to a documented procedure.**

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Refer to Activity 2 of Organization Process Definition key process area for practices covering the contents of the organization's standard software process.

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This procedure typically specifies that:

1. A software life cycle is:

- q selected from among those approved by the organization, to satisfy the project's contractual and operational constraints;

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Refer to Activity 3 of the Organization Process Definition key process area for practices covering approved software life cycles.

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- q modified, if necessary, in ways permitted by the organization's tailoring guidelines and criteria; and
- q documented according to the organization's standards.

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Refer to Activity 4 of the Organization Process Definition key process area for practices covering the organization's tailoring guidelines and criteria.

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2. The description of the project's defined software process is documented.

(Activity 1)

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Refer to Activity 2 of the Organization Process Definition key process area for practices covering the expected contents of a process definition.

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The tailoring uses the organization's process assets as appropriate.

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3. Tailoring of the organization's standard software process for the project is reviewed by the group responsible for coordinating the organization's software process activities (e.g., software engineering process group) and approved by senior management.

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Refer to Activity 6 of the Organization Process Definition key process area for practices covering the library of software process-related documentation.

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- Waivers for deviations from the organization's standard software process are documented and are reviewed and approved by senior management.

4. Waivers for deviations from contractual software process requirements are documented and are reviewed and approved by senior management and the software project's customer, as appropriate.

5. The description of the project's defined software process is managed and controlled.

(Activity 1) XTOLERI(
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"Managed and controlled" implies that the version of the work product in use at a given time (past or present) is known (i.e., version control), and changes are incorporated in a controlled manner (i.e., change control).

If a greater degree of control than is implied by "managed and controlled" is desired, the work product can be placed under the full discipline of configuration management, as is described in the Software Configuration Management key process area.

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Activity 2 **Each project's defined software process is revised according to a documented procedure.**

This procedure typically specifies that:

1. Changes derived from the following are documented and systematically reviewed:
   - q lessons learned from monitoring the software activities of the organization's projects,
   - q changes proposed by the software project, and
   - q process and work product measurement data.
2. Changes to the project's defined software process are reviewed and approved before they are incorporated.

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Examples of individuals who review the changes include:

- members of the groups responsible for the organization's software process activities (e.g., software engineering process group),
- the software managers, and
- the project software manager.

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(Activity 2)

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Examples of individuals who approve the changes include:

- the project software manager, and
- the project manager.

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Activity 3 **The project's software development plan, which describes the use of the project's defined software process, is developed and revised according to a documented procedure.**

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Refer to Activities 6 and 7 of the Software Project Planning key process area and Activities 1 and 2 of the Software Project Tracking and Oversight key process area for practices covering the software development plan.

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Activity 4 **The software project is managed in accordance with the project's defined software process.**

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Refer to the Software Project Planning and the Software Project Tracking and Oversight key process areas for basic practices covering managing a software project.

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The project's defined software process typically specifies that:

1. Provisions are made for gathering, analyzing, and reporting measurement data needed to manage the software project.

2. The activities for software estimating, planning, and tracking are tied to the key tasks and work products of the project's defined software process.

3. Readiness and completion criteria are established, documented, and used to authorize initiation and determine completion of key tasks.

(Activity 4)

4. Documented criteria are defined to indicate when to replan the software project.

5. Technical and management lessons learned are documented and stored in the organization's library of software process-related documentation.

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Refer to Activity 6 of the Organization Process Definition key process area for practices covering the organization's library of software process-related documentation.

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6. Technical and management lessons learned from monitoring the activities of other projects in the organization are systematically reviewed and used to estimate, plan, track, and replan the software project.

7. The staffing plan addresses the software project's needs for individuals with special skills and application domain knowledge.

8. Training needs are identified and documented to fit the specific needs of the software project.

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Refer to Activity 1 of the Training Program key process area for practices covering the identification of the project's training needs.

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9. The software plans and processes followed in interacting with other groups are adjusted to account for disparities with these groups and for other potential problems.

(Activity 4)

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Examples of disparities and problems include:

- differences in process maturity,
- process incompatibility, and
- various business factors.

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Activity 5 **The organization's software process database is used for software planning and estimating.**

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Refer to Activity 5 of the Organization Process Definition key process area for practices covering the organization's software process database.

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1. The database is used as a source of data to estimate, plan, track, and replan a software project; data for similar software projects are used when possible.

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Examples of data contained in the organization's software process database include:

- size of the software work products,
- software effort,
- software cost,
- schedule,
- staffing, and
- technical activities.

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2. Parameter values used to derive estimates for software size, effort, cost, schedule, and use of critical computer resources are compared to those of other software projects to assess their validity.

q Similarities and differences to the other projects in terms of application domain and design approach are assessed and recorded.

q Rationales for similarities and differences between the parameter values are recorded.

(Activity 5) q The reasoning used to judge the credibility of the project's estimates is recorded.

3. The software project provides appropriate software planning data, replanning data, and actual measured data for storage in the organization's software process database.

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Examples of data recorded by the software project include:

- the task description,
- the assumptions,
- the estimates,
- the revised estimates,
- the actual measured data, and
- the associated information needed to reconstruct the estimates, assess their reasonableness, and derive estimates for new work.

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Activity 6 **The size of the software work products (or size of changes to the software work products) is managed according to a documented procedure.**

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Refer to Activity 9 of the Software Project Planning key process area and Activity 5 of the Software Project Tracking and Oversight key process area for basic practices covering planning and tracking size of software work products.

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This procedure typically specifies that:

1. A group that is independent of the software engineering group reviews the procedures for estimating the size of the software work products, and provides guidance in using historical data from the organization's software process database to establish credible estimates.

(Activity 6)

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An example of an independent group is a software estimating group.

An example of a method to evaluate the credibility of software size estimates is a function-by-function comparison to a completed system.

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- The individuals who prepare the size estimates ensure that the procedures and data used in the estimates are appropriate.
- When the validity of a size estimate is questioned, a team of peers and experts reviews the estimate.

2. A contingency factor is applied to the size estimate for each software element identified as a software risk.
   - The rationale for the contingency is documented.
   - The risks associated with reducing or eliminating the contingency are assessed and documented.

3. Off-the-shelf or reusable software components are identified.
   - Reuse measurements account for the reuse of requirements, design, code, test plan, and test procedures, etc.
   - The effort to modify and incorporate reusable components is factored into the size estimates.

4. Factors which could significantly affect the size of the software work products are identified and monitored closely.

5. A size threshold is established for each managed software element which, when projected to be exceeded, requires action.

Activity 7 **The project's software effort and costs are managed according to a documented procedure.**

(Activity 7) XTOLERI(
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Refer to Activity 10 of the Software Project Planning key process area and Activity 6 of the Software Project Tracking and Oversight key process area for basic practices covering planning and tracking software efforts and costs.

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This procedure typically specifies that:

1. Software effort, cost, and staffing profile models, if used, are adapted to the project and use available historical data where appropriate.

2. Referenced productivity and cost data are adjusted to incorporate project variables.

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Examples of project variables include:

- the geographic locations of the project's groups and organizations (e.g., subcontractor),
- the size and complexity of the system,
- the stability of the requirements,
- the host environment for development,
- the target environment of the system,
- the developers' familiarity and experience with the application,
- the availability of resources, and
- other special constraints.

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3. The overall software effort and cost is allocated to individually managed tasks or stages as needed to manage the effort and cost effectively.

4. When the software effort and cost status is reviewed and the estimates are revised, actual expenditures over time and against work completed are compared to the software development plan and used to refine the effort and cost estimates for remaining work.

(Activity 7)

- q Parameter values of the models used in estimating software effort and costs are updated whenever major changes are made to the software requirements.
- q Actual data on project productivity and other new software costs are used where appropriate.

5. An effort and cost threshold is established for each individually managed software task or stage which, when projected to be exceeded, requires action.

Activity 8 **The project's critical computer resources are managed according to a documented procedure.**

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Refer to Activity 11 of the Software Project Planning key process area and Activity 7 of the Software Project Tracking and Oversight key process area for basic practices covering planning and tracking critical computer resources.

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This procedure typically specifies that:

1. Estimates for the project's critical computer resources are derived based on historical experience, simulations, prototyping, or analysis, as appropriate.
   - q Sources and rationale for estimates are documented.
   - q Similarities and differences between the project and the sources for historical data in terms of application domain and design approach are assessed and recorded.
   - q The reasoning used to judge the credibility of the estimates is recorded.
2. The planned computer resources, the system requirements allocated to software, the software requirements, and/or the software design are adjusted to achieve the project's critical computer resource requirements.
3. The available computer resources are allocated to the software components.

(Activity 8)

4. The available capacity for the critical computer resources provides for a specified reserve capacity when the initial estimates are made.
5. A threshold is established for each critical computer resource which, when projected to be exceeded, requires action.

Activity 9 **The critical dependencies and critical paths of the project's software schedule are managed according to a documented procedure.**

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Refer to Activity 12 of the Software Project Planning key process area, Activity 8 of the Software Project Tracking and Oversight key process area, and Activity 4 of the Intergroup Coordination key process area for practices covering negotiating and tracking critical dependencies.

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This procedure typically specifies that:

1. Milestones, tasks, commitments, critical dependencies, staffing, costs, and reviews are allocated in the schedule consistent with the project's defined software process.

   q The software schedule identifies specific tasks and milestones whose completion can be objectively determined (i.e., a binary or yes/no determination).

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   Different levels of schedule detail, appropriately tied to each other, are developed to accommodate the needs of different groups and individuals.

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2. Critical dependencies are defined, negotiated, and reflected in the software schedule.

(Activity 9)

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Critical dependencies include both those within the software engineering group (i.e., between subgroups) and between the software engineering group and other affected groups.

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3. Schedule critical paths are defined and reflected in the software schedule.

4. The software project's critical dependencies and schedule critical paths are tracked on a regular basis.

5. Specific documented threshold criteria are established for each critical path which, when projected to be exceeded, require action.

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Examples of actions include:

- conducting analyses and simulations to tradeoff function, quality, cost, schedule, staffing, and other resources;
- allocating contingencies and schedule slack, if available;
- evaluating the effects of contemplated actions on all critical paths; and
- making decisions visible to the affected groups.

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Activity 10 **The project's software risks are identified, assessed, documented, and managed according to a documented procedure.**

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Refer to Activity 13 of the Software Project Planning key process area and Activity 10 of the Software Project Tracking and Oversight key process area for basic practices covering identifying and tracking risk.

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(Activity 10)

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Examples of software risks that are to be managed include significant possibilities that the software project could fail to meet its objectives in areas such as:

- schedule,
- cost,
- functionality,
- throughput or real-time performance,
- reliability or availability, and
- use of critical computer resources.

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Examples of activities to manage risks include:

- early identification of high-risk project objectives;
- identification of events that could introduce or increase risks;
- prototyping or early implementation of high-risk modules; and
- close monitoring of key project risk indicators.

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This procedure typically specifies that:

1. A software risk management plan is documented and used to identify and manage the software risks.

(Activity 10) XTOLERI(
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Examples of items in a software risk management plan include:

- resources required (including staff and tools);
- risk management methods (e.g., identification, analysis, prioritization, planning, monitoring, and resolution);
- list of identified risks (including assessment, prioritization, status, and plans);
- risk management schedule;
- responsibilities and authorities;
- method and frequency of communicating risk status and activities; and
- measurements.

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2. Contingency planning is based on the project's defined software process and is performed throughout the project's software life cycle.

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Examples of areas covered by contingency planning activities include:

- identification of options,
- impact assessment of options,
- technical feasibility of options,
- allocation of management reserves, and
- decision criteria on when to pursue an option.

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3. Alternatives for each software risk are defined, where possible, along with criteria for selecting among the alternatives.

4. The initial release and major revisions to the software risk management plan undergo peer review.

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Refer to the Peer Reviews key process area.

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5. The software risk management plan is managed and controlled.

(Activity 10)

6. Software risks are tracked, reassessed, and replanned at selected project milestones, at designated risk checkpoints, and during the planning of significant changes that affect the software project.

   - Risk priorities and software risk management plans are reviewed and revised at these reassessment points.
   - Information obtained from monitoring the risks is used to refine the risk assessments and software risk management plans.

7. The software engineering group and other affected groups and individuals are included in the communications on the software risks, the software risk management plans, and the results of risk mitigation.

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Examples of affected groups and individuals include:

- customer,
- subcontractors,
- end users,
- software estimating,
- system engineering,
- system test,
- software quality assurance,
- software configuration management,
- contract management, and
- documentation support.

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Activity 11 **Reviews of the software project are periodically performed to determine the actions needed to bring the software project's performance and results in line with the current and projected needs of the business, customer, and end users, as appropriate.**

(Activity 11)

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Examples of actions include:

- accelerating the schedule,
- changing the system requirements in response to a change in market opportunities or customer and end user needs, and
- terminating the project.

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The end users referred to in these practices are the customer-designated end users or representatives of the end users.

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Measurement and analysis

Measurement 1 **Measurements are made and used to determine the effectiveness of the integrated software management activities.**

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Examples of measurements include:

- effort expended over time to manage the software project, compared to the plan;
- frequency, causes, and magnitude of replanning effort;
- for each identified software risk, the realized adverse impact compared to the estimated loss; and
- the number and magnitude of unanticipated major adverse impacts to the software project, tracked over time.

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Verifying implementation

Verification 1 **The activities for managing the software project are reviewed with senior management on a periodic basis.**

(Verification 1) XTOLERI(
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Refer to Verification 1 of the Software Project Tracking and Oversight key process area for practices covering the typical content of senior management oversight reviews.

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Verification 2 The activities for managing the software project are reviewed with the project manager on both a periodic and event-driven basis.

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Refer to Verification 2 of the Software Project Tracking and Oversight key process area for practices covering the typical content of project management oversight reviews.

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Verification 3 The software quality assurance group reviews and/or audits the activities and work products for managing the software project and reports the results.

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Refer to the Software Quality Assurance key process area.

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At a minimum, the reviews and/or audits verify:

1. The process for developing and revising the project's defined software process.

2. The process for preparing the project's software development plan and software risk management plan.

3. The processes for managing the project in accordance with the project's defined software process.

4. The processes for collecting and providing appropriate data to the organization's software process database.

(Verification 3)

5. The process for using the organization's software process database to support the software project's planning, estimating, and tracking activities

Software Product Engineering

a key process area for Level 3: Defined

The purpose of Software Product Engineering is to consistently perform a well-defined engineering process that integrates all the software engineering activities to produce correct, consistent software products effectively and efficiently.

Software Product Engineering involves performing the engineering tasks to build and maintain the software using the project's defined software process (which is described in the Integrated Software Management key process area) and appropriate methods and tools.

The software engineering tasks include analyzing the system requirements allocated to software (these system requirements are described in the Requirements Management key process area), developing the software requirements, developing the software architecture, designing the software, implementing the software in the code, integrating the software components, and testing the software to verify that it satisfies the specified requirements (i.e., the system requirements allocated to software and the software requirements).

Documentation needed to perform the software engineering tasks (e.g., software requirements document, software design document, test plan, and test procedures) is developed and

Software Product Engineering

a key process area for Level 3: Defined

reviewed to ensure that each task addresses the results of predecessor tasks and the results produced are appropriate for the subsequent tasks (including the tasks of operating and maintaining the software). When changes are approved, affected software work products, plans, commitments, processes, and activities are revised to reflect the approved changes.

Goals

Goal 1 **The software engineering tasks are defined, integrated, and consistently performed to produce the software.**

Goal 2 **Software work products are kept consistent with each other.**

Commitment to perform

Commitment 1 **The project follows a written organizational policy for performing the software engineering activities.**

This policy typically specifies that:

1. The software engineering tasks are performed in accordance with the project's defined software process.

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Refer to Activities 1 and 2 of the Integrated Software Management key process area for practices covering the project's defined software process.

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2. Appropriate methods and tools are used to build and maintain the software products.

3. The software plans, tasks, and products are traceable to the system requirements allocated to software.

(Commitment 1) XTOLERI(
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The system requirements allocated to the software are referred to as "allocated requirements" in these practices.

Refer to the Requirements Management key process area for practices covering the system requirements allocated to software.

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Ability to perform

Ability 1 **Adequate resources and funding are provided for performing the software engineering tasks.**

1. Skilled individuals are available to perform the different software engineering tasks, including:

   - q software requirements analysis,
   - q software design,
   - q coding,

- q testing, and
- q software maintenance.

2. Tools to support the software engineering tasks are made available.

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Examples of general support tools include:

- workstations,
- database management systems,
- on-line help aids,
- graphics tools,
- interactive documentation tools, and
- word processing systems.

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(Ability 1)

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Examples of support tools for software requirements analysis include:

- requirements tracking tools,
- specification tools,
- prototyping tools,
- modeling tools, and
- simulation tools.

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Examples of support tools for software design include:

- specification tools,
- prototyping tools,
- simulation tools, and
- program design languages.

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Examples of support tools for coding include:

- editors,
- compilers,
- cross-reference generators, and
- pretty printers.

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Examples of support tools for software testing include:

- test management tools,
- test generators,
- test drivers,
- test profilers,
- symbolic debuggers, and
- test coverage analyzers.

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Ability 2 **Members of the software engineering technical staff receive required training to perform their technical assignments.**

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The members of the software engineering technical staff should receive training in the application domain.

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Examples of training in software requirements analysis include:

- principles of analyzing software requirements;
- the existing software requirements for any existing software to be maintained;
- skills to interview end users and application domain experts in order to establish the software requirements (i.e., requirements elicitation); and
- the use of the tools, methods, conventions, and standards selected by the project for analyzing software requirements.

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Examples of training in software design include:

- design concepts;
- the existing design for any existing software to be maintained; and
- use of the tools, methods, conventions, and standards selected by the project for designing software.

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Examples of training in coding include:

- the selected programming language(s);
- reviewing the existing source code for any existing code to be maintained;
- use of the tools, methods, conventions, and standards selected by the project for programming; and
- unit testing techniques.

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(Ability 2)

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Examples of training in software testing and other verification techniques include:

- verification methods (analysis, demonstration, and inspection as well as test);
- test planning;
- use of the tools, methods, conventions, and standards selected by the project for testing and verifying the software;
- criteria for test readiness and completion; and
- measuring test coverage.

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Refer to the Training Program key process area.

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Ability 3 **Members of the software engineering technical staff receive orientation in related software engineering disciplines.**

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Examples of related software engineering disciplines include:

- software requirements analysis,
- software design,
- coding,
- testing,
- software configuration management, and
- software quality assurance.

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Refer to the Training Program key process area.

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Ability 4 **The project manager and all software managers receive orientation in the technical aspects of the software project.**

(Ability 4)

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Examples of orientation include:

- software engineering methods and tools,
- the application domain,
- deliverable and nondeliverable software and associated work products, and
- guidelines on how to manage the project using the chosen methods and tools.

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Refer to the Training Program key process area.

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Activities performed

Activity 1 **Appropriate software engineering methods and tools are integrated into the project's defined software process.**

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Refer to Activities 1 and 2 of the Integrated Software Management key process area for practices covering the project's defined software process.

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1. The software engineering tasks are integrated according to the project's defined software process.

2. Methods and tools appropriate for use on the software project are selected.

(Activity 1)

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Candidate methods and tools are selected based on their applicability to the organization's standards, the project's defined software process, the existing skill base, availability of training, contractual requirements, power, ease of use, and support services.

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q The rationale for selecting a particular tool or method is documented.

3. Configuration management models appropriate to the software project are selected and used.

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Examples of configuration management models include:

- check-out/check-in models,
- composition models,
- transaction models, and
- change set models.

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4. The tools used to develop and maintain the software products are placed under configuration management.

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Refer to the Software Configuration Management key process area.

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Activity 2 **The software requirements are developed, maintained, documented, and verified by systematically analyzing the allocated requirements according to the project's defined software process.**

1. The individuals involved in developing the software requirements review the allocated requirements to ensure that issues affecting the software requirements analysis are identified and resolved.

(Activity 2)

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Software requirements cover the software functions and performance, the interfaces to both hardware and software, and other system components (e.g., humans).

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2. Effective methods for requirements analysis are used to identify and derive the software requirements.

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Examples of methods for requirements analysis include:

- functional decomposition,
- object-oriented decomposition,
- tradeoff studies,
- simulations,
- modeling,
- prototyping, and
- scenario generation.

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3. The results of the requirements analysis and the rationale for the selected alternative are documented.

4. The software requirements are analyzed to ensure they are feasible and appropriate to implement in software, clearly stated, consistent with each other, testable, and complete (when considered as a set).

q Problems with the software requirements are identified and reviewed with the group responsible for the system requirements; appropriate changes are made to the allocated requirements and to the software requirements.

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Refer to the Requirements Management key process area.

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5. The software requirements are documented.

6. The group responsible for system and acceptance testing of the software analyzes each software requirement to verify it can be tested.

(Activity 2)

7. The methods for verifying and validating that each software requirement is satisfied are identified and documented.

XTOLERI(
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Examples of verification and validation methods include:

- demonstration,
- system testing,
- acceptance testing,
- analysis, and
- inspection.

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8. The software requirements document undergoes peer review before it is considered complete.

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Refer to the Peer Reviews key process area.

XBOLERI(
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9. The software requirements document is reviewed and approved.

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Examples of individuals who review and approve the software requirements document include:

- the project manager,
- the system engineering manager,
- the project software manager, and
- the software test manager.

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10. The software requirements document is reviewed with the customer and end users, as appropriate.

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The end users referred to in these practices are the customer-designated end users or representatives of the end users.

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(Activity 2)

11. The software requirements document is placed under configuration management.

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Refer to the Software Configuration Management key process area.

XBOLERI(
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12. The software requirements are appropriately changed whenever the allocated requirements change.

XTOLERI(
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Refer to the Requirements Management key process area.

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Activity 3 **The software design is developed, maintained, documented, and verified, according to the project's defined software process, to accommodate the software requirements and to form the framework for coding.**

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The software design consists of the software architecture and the detailed software design.

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1. Design criteria are developed and reviewed.

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Examples of design criteria include:

- verifiability,
- adherence to design standards,
- ease of construction,
- simplicity, and
- ease of planning.

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2. The individuals involved in the software design review the software requirements to ensure that issues affecting the software design are identified and resolved.

(Activity 3)

3. Application standards are used where appropriate.

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Examples of application standards include:

- standards for operating system interfaces,
- standards for computer-human interfaces, and
- standards for networking interfaces.

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4. Effective methods are used to design the software.

XTOLERI(
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Examples of software design methods include:

- prototyping,
- structural models,
- design reuse,
- object-oriented design, and
- essential systems analysis.

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5. The software architecture is developed early, within the constraints of the software life cycle and technology being used.

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The software architecture establishes the top-level software framework with well-defined internal and external interfaces.

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6. The software architecture is reviewed to ensure that architecture issues affecting the software detailed design are identified and resolved.

7. The software detailed design is developed based on the software architecture.

8. The software design (i.e., the software architecture and detailed design) is documented.

(Activity 3)

- The documentation of the software design covers the software components; the internal interfaces between software components; and the software interfaces to other software systems, to hardware, and to other system components (e.g., humans).

9. The software design document undergoes peer review before the design is considered complete.

XTOLERI(
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Refer to the Peer Reviews key process area.

XBOLERI(
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10. The software design document is placed under configuration management.

XTOLERI(
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Refer to the Software Configuration Management key process area.

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11. The software design document is appropriately changed whenever the software requirements change.

Activity 4 **The software code is developed, maintained, documented, and verified, according to the project's defined software process, to implement the software requirements and software design.**

1. The individuals involved in coding review the software requirements and software design to ensure that issues affecting the coding are identified and resolved.

2. Effective programming methods are used to code the software.

XTOLERI(
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Examples of programming methods include:

- structured programming, and
- code reuse.

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(Activity 4)

3. The sequence in which code units are developed is based on a plan that accounts for factors such as criticality, difficulty, integration and test issues, and needs of the customer and end users, as appropriate.

4. Each code unit undergoes peer review and is unit tested before the unit is considered complete.

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Refer to the Peer Reviews key process area.

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5. The code is placed under configuration management.

XTOLERI(
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Refer to the Software Configuration Management key process area.

XBOLERI(
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6. The code is appropriately changed whenever the software requirements or software design changes.

Activity 5 **Software testing is performed according to the project's defined software process.**

1. Testing criteria are developed and reviewed with the customer and the end users, as appropriate.

2. Effective methods are used to test the software.

3. The adequacy of testing is determined based on:

q the level of testing performed,

(Activity 5)

XTOLERI(
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Examples of levels of testing include:

- unit testing,
- integration testing,
- system testing, and
- acceptance testing.

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q the test strategy selected, and

XTOLERI(
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Examples of test strategies include:

- functional (black-box),
- structural (white-box), and
- statistical.

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q the test coverage to be achieved.

XTOLERI(
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Examples of test coverage approaches include:

- statement coverage,
- path coverage,
- branch coverage, and
- usage profile.

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4. For each level of software testing, test readiness criteria are established and used.

(Activity 5)

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Examples of criteria to determine test readiness include:

- software units have successfully completed a code peer review and unit testing before they enter integration testing,
- the software has successfully completed integration testing before it enters system testing, and
- a test readiness review is held before the software enters acceptance testing.

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5. Regression testing is performed, as appropriate, at each test level whenever the software being tested or its environment changes.

6. The test plan, test procedures, and test cases undergo peer review before they are considered ready for use.

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Refer to the Peer Reviews key process area.

XBOLERI(
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7. The test plans, test procedures, and test cases are managed and controlled.

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"Managed and controlled" implies that the version of the work product in use at a given time (past or present) must be known, and changes must be incorporated in a controlled manner.

If a greater degree of formality than is implied by "managed and controlled" is desired, the work product can be placed under configuration management, as is described in the Software Configuration Management key process area.

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8. Test plans, test procedures, and test cases are appropriately changed whenever the allocated requirements, software requirements, software design, or code being tested changes.

Activity 6 **Integration testing of the software is planned and performed according to the project's defined software process.**

(Activity 6)

1. The plans for integration testing are documented and based on the software development plan.

2. The integration test cases and test procedures are reviewed with the individuals responsible for the software requirements, software design, and system and acceptance testing.

3. Integration testing of the software is performed against the designated version of the software requirements document and the software design document.

Activity 7 **System and acceptance testing of the software are planned and performed to demonstrate that the software satisfies its requirements.**

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System testing is performed to ensure the software satisfies the software requirements.

Acceptance testing is performed to demonstrate to the customer and end users that the software satisfies the allocated requirements.

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1. Resources for testing the software are assigned early enough to provide for adequate test preparation.

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Examples of activities required to prepare for testing include:

- preparing testing documentation,
- scheduling testing resources,
- developing test drivers, and
- developing simulators.

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2. System and acceptance testing are documented in a test plan, which is reviewed with, and approved by, the customer and end users, as appropriate. The test plan covers:

(Activity 7)

- q the overall testing and verification approach;
- q responsibilities of the developing organization, subcontractors, customer, and end users, as appropriate;
- q test facility, test equipment, and test support requirements; and
- q acceptance criteria.

3. The test cases and test procedures are planned and prepared by a test group that is independent of the software developers.

4. The test cases are documented and are reviewed with, and approved by, the customer and end users, as appropriate, before the testing begins.

5. Testing of the software is performed against baselined software and the baselined documentation of the allocated requirements and the software requirements.

6. Problems identified during testing are documented and tracked to closure.

XTOLERI(
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Refer to Activity 9 of the Software Project Tracking and Oversight key process area and Activity 5 of the Software Configuration Management key process area for practices covering documenting and tracking problems.

XBOLERI(
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7. Test results are documented and used as the basis for determining whether the software satisfies its requirements.

8. The test results are managed and controlled.

Activity 8 **The documentation that will be used to operate and maintain the software is developed and maintained according to the project's defined software process.**

1. Appropriate methods and tools are used to develop the documentation.

(Activity 8)

XTOLERI(
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Examples of methods and tools include:

- word processing,
- case studies, and
- documentation reuse.

XBOLERI(
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2. Documentation specialists actively participate in planning, developing, and maintaining documentation.

3. Preliminary versions of the documentation are developed and made available early in the software life cycle for the customer, end users, and software maintainers, as appropriate, to review and provide feedback.

XTOLERI(
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Examples of documentation include:

- training documentation,
- on-line documentation,
- the user's manual,
- the operator's manual, and
- the maintenance manual.

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4. Final versions of the documentation are verified against the software baselined for software acceptance testing.

5. The documentation undergoes peer review.

XTOLERI(
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Refer to the Peer Reviews key process area.

XBOLERI(
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6. The documentation is managed and controlled.

7. The final documentation is reviewed and approved by the customer, end users, and software maintainers, as appropriate.

Activity 9 **Data on defects identified in peer reviews and testing are collected and analyzed according to the project's defined software process.**

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Examples of the kinds of data to be collected and analyzed include:

- defect description,
- defect category,
- severity of the defect,
- units containing the defect,
- units affected by the defect,
- activity where the defect was introduced,
- peer review or test cases that identified the defect,
- description of the scenario being run that identified the defect, and
- expected result and actual results that identified the defect.

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Activity 10 **Consistency is maintained across software work products, including the software plans, process descriptions, allocated requirements, software requirements, software design, code, test plans, and test procedures.**

1. Software work products are documented, and the documentation is readily available.

2. The software requirements, design, code, and test cases are traced to the source from which they were derived and to the products of the subsequent software engineering activities.

3. The documentation tracing the allocated requirements through the software requirements, design, code, and test cases is managed and controlled.

4. As understanding of the software improves, changes to the software work products, plans, process descriptions, and activities are proposed, analyzed, and incorporated as appropriate.

(Activity 10)

- The project determines the impact of the change before the change is made.
- Where changes to the allocated requirements are needed, they are approved and incorporated before any software work products or activities are changed.
- Changes to all software products, plans, process descriptions, and activities are coordinated.
- Changes are negotiated with and communicated to the affected groups.

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Examples of affected groups include:

- software engineering,
- software estimating,
- system test,
- software quality assurance,
- software configuration management,
- contract management, and
- documentation support.

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- Changes are tracked to completion.

Measurement and analysis

Measurement 1 Measurements are made and used to determine the functionality and quality of the software products.

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Examples of measurements include:

- numbers, types, and severity of defects identified in the software products tracked cumulatively and by stage; and
- allocated requirements summarized by category (e.g., security, system configuration, performance, and reliability), and traced to the software requirements and system test cases.

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Measurement 2 Measurements are made and used to determine the status of the software product engineering activities.

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Examples of measurements include:

- status of each allocated requirement throughout the life of the project;
- problem reports by severity and length of time they are open;
- change activity for the allocated requirements;
- effort to analyze proposed changes for each proposed change and cumulative totals;
- number of changes incorporated into the software baseline by category (e.g., interface, security, system configuration, performance, and usability); and
- size and cost to implement and test incorporated changes, including initial estimate and actual size and cost.

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Verifying implementation

Verification 1 **The activities for software product engineering are reviewed with senior management on a periodic basis.**

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Refer to Verification 1 of the Software Project Tracking and Oversight key process area for practices covering the typical content of senior management oversight reviews.

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Verification 2 **The activities for software product engineering are reviewed with the project manager on both a periodic and event-driven basis.**

(Verification 2)

XTOLERI(
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Refer to Verification 2 of the Software Project Tracking and Oversight key process area for practices covering the typical content of project management oversight reviews.

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Verification 3 **The software quality assurance group reviews and/or audits the activities and work products for software product engineering and reports the results.**

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Refer to the Software Quality Assurance key process area.

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At a minimum, the reviews and/or audits verify that:

1. The software requirements are reviewed to ensure that they are:
   - q complete,
   - q correct,
   - q consistent,
   - q feasible, and
   - q testable.
2. Readiness and completion criteria for each software engineering task are satisfied.
3. Software products comply with the standards and requirements specified for them.
4. Required testing is performed.
5. System and acceptance testing of the software are performed according to documented plans and procedures.
6. Tests satisfy their acceptance criteria, as documented in the software test plan.
7. Tests are satisfactorily completed and recorded.

(Verification 3)

8. Problems and defects detected are documented, tracked, and addressed.
9. Tracing of the allocated requirements through the software requirements, design, code, and test cases is performed.
10. The documentation used to operate and maintain the software is verified against the software baseline and any applicable allocated requirements before the software product is released to the customer or end users.

Intergroup Coordination

a key process area for Level 3: Defined

The purpose of Intergroup Coordination is to establish a means for the software engineering group to participate actively with the other engineering groups so the project is better able to satisfy the customer's needs effectively and efficiently.

Intergroup Coordination involves the software engineering group's participation with other project engineering groups to address system-level requirements, objectives, and issues. Representatives of the project's engineering groups participate in establishing the system-level requirements, objectives, and plans by working with the customer and end users, as appropriate. These requirements, objectives, and plans become the basis for all engineering activities.

The technical working interfaces and interactions between groups are planned and managed to ensure the quality and integrity of the entire system. Technical reviews and interchanges are regularly conducted with representatives of the project's engineering groups to ensure that all engineering groups are aware of the status and plans of all the groups, and that system and intergroup issues receive appropriate attention.

The software-specific practices related to these engineering tasks are described in the Requirements Management and Software Product Engineering key process areas.

Intergroup Coordination

a key process area for Level 3: Defined

Goals

Goal 1 **The customer's requirements are agreed to by all affected groups.**

Goal 2 **The commitments between the engineering groups are agreed to by the affected groups.**

Goal 3 **The engineering groups identify, track, and resolve intergroup issues.**

Commitment to perform

Commitment 1 **The project follows a written organizational policy for establishing interdisciplinary engineering teams.**

This policy typically specifies that:

1. The system requirements and project-level objectives for the project are defined and reviewed by all affected groups.

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Examples of affected groups include:

- software engineering,
- software estimating,
- system test,
- software quality assurance,
- software configuration management,
- contract management, and
- documentation support.

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2. The engineering groups coordinate their plans and activities.

(Commitment 1)

3. Managers are responsible for establishing and maintaining an environment to facilitate interaction, coordination, support, and teamwork between the project's engineering groups, between the project and the customer or end users, as appropriate, and throughout the organization.

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The end users referred to in these practices are the customer-designated end users or representatives of the end users.

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Ability to perform

Ability 1 **Adequate resources and funding are provided for coordinating the software engineering activities with other engineering groups.**

Ability 2 **The support tools used by the different engineering groups are compatible to enable effective communication and coordination.**

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Examples of support tools that should be compatible include:

- word processing systems,
- database systems,
- graphics tools,
- spreadsheet programs,
- problem tracking packages, and
- library management tools.

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Ability 3 **All managers in the organization receive required training in teamwork.**

(Ability 3) XTOLERI(
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Examples of training include:

- building teams;
- managing teams;
- establishing, promoting, and facilitating teamwork; and
- group dynamics.

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Refer to the Training Program key process area.

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Ability 4 **All task leaders in each engineering group receive orientation in the processes, methods, and standards used by the other engineering groups.**

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Refer to the Training Program key process area.

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Ability 5 **The members of the engineering groups receive orientation in working as a team.**

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Refer to the Training Program key process area.

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Activities performed

Activity 1 **The software engineering group and the other engineering groups participate with the customer and end users, as appropriate, to establish the system requirements.**

(Activity 1) Specifically, these groups:

1. Define the critical characteristics of the customer's and end users' requirements, as appropriate.

2. Negotiate critical dependencies.

3. Document the acceptance criteria for each product delivered to the customer or end user, as appropriate.

Activity 2 **Representatives of the project's software engineering group work with representatives of the other engineering groups to monitor and coordinate technical activities and resolve technical issues.**

1. The representatives of these groups monitor and coordinate technical activities by:

   q coordinating the specification and providing the technical review and approval of the system requirements and system design;

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The system requirements and system design are typically the responsibility of the system engineering group, but representatives of the other engineering groups are expected to have significant involvement in these tasks.

The system requirements and system design include:

- the overall system requirements,
- the system configuration (i.e., hardware, software, and other system components),
- the allocation and tracing of requirements to these system components, and
- the definitions of the interfaces between these system components.

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q providing the project-level technical review and analysis needed to manage and control changes to the system requirements and project-level objectives throughout the project's life cycle;

(Activity 2)

q tracking and reviewing the design and development activities for hardware, software, and other system components; and

q assessing, developing recommendations for, and tracking technical risks that involve more than one engineering group.

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Refer to Activity 10 of the Integrated Software Management key process area for practices covering risk management.

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2. The representatives of the groups handle technical issues by:

- q resolving project-level conflicts and clarifying system requirements and design issues;
- q developing joint recommendations to resolve problems; and
- q addressing process issues that span the engineering groups of the project.

Activity 3 **A documented plan is used to communicate intergroup commitments and to coordinate and track the work performed.**

This plan is:

1. The baseline for:
   - q the project schedule,
   - q the contractual and technical aspects of the project, and
   - q the assignment of responsibilities to the engineering groups.
2. Used to coordinate activities between the different engineering groups.
3. Readily available to the members of all engineering groups.
4. Updated to incorporate all intergroup commitments and changes to these commitments.
5. Updated as the work progresses to reflect progress and plan changes at the project level, particularly when major project milestones are completed and when plans change significantly.

(Activity 3)

6. Reviewed and agreed to by all engineering groups and the project manager.

Activity 4 **Critical dependencies between engineering groups are identified, negotiated, and tracked according to a documented procedure.**

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Refer to Activity 9 of the Integrated Software Management key process area for practices covering management of critical dependencies.

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This procedure typically specifies that:

1. Each critical dependency is explicitly defined, including:
   - q the item to be provided,
   - q who will provide it,
   - q when it will be provided, and
   - q the criteria for acceptance.
2. Critical dependencies are negotiated between the software engineering group and other engineering groups in the project and organization.
3. Need dates and availability dates of critical dependency items are tied to the project schedule and the software schedule.
4. The agreement for each critical dependency is documented, reviewed, and approved by both the receiving group and the group responsible for providing the critical dependency item.
5. Critical dependencies are tracked on a regular basis and corrective actions are taken when appropriate.
   - q Status and actual or projected completion are compared to the plan used to coordinate intergroup commitments.

- q Effects of late and early completions are evaluated for impacts on future activities and milestones.
- q Actual and potential problems are reported to the appropriate managers.

Activity 5 **Work products produced as input to other engineering groups are reviewed by representatives of the receiving groups to ensure that the work products meet their needs.**

Activity 6 **Intergroup issues not resolvable by the individual representatives of the project engineering groups are handled according to a documented procedure.**

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Examples of intergroup issues include:

- incompatible schedules,
- inadequate funding,
- technical risks,
- system-level design and requirements defects, and
- system-level problems.

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Activity 7 **Representatives of the project engineering groups conduct periodic technical reviews and interchanges.**

In these meetings, the participants:

1. Provide visibility of the needs and desires of the customer and end users, as appropriate.

2. Monitor the technical activities of the project.

3. Ensure that the groups' interpretation and implementation of the technical requirements conform to the system requirements.

4. Review the commitments to determine whether they are being met.

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Refer to the Software Project Tracking and Oversight key process area for practices covering reviews.

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5. Review the technical risks and other technical issues.

(Activity 7)

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Refer to Activity 10 of the Integrated Software Management key process area for practices covering risk management.

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Measurement and analysis

Measurement 1 **Measurements are made and used to determine the status of the intergroup coordination activities.**

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Examples of measurements include:

- actual effort and other resources expended by the software engineering group for support to other engineering groups;
- actual effort and other resources expended by the other engineering groups in support of the software engineering group;
- actual completion of specific tasks and milestones by the software engineering group to support the activities of other engineering groups; and
- actual completion of specific tasks and milestones by the other engineering groups to support the activities of the software engineering group.

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Verifying implementation

Verification 1 **The activities for intergroup coordination are reviewed with senior management on a periodic basis.**

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Refer to Verification 1 of the Software Project Tracking and Oversight key process area for practices covering the typical content of the senior management oversight reviews.

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Verification 2 **The activities for intergroup coordination are reviewed with the project manager on both a periodic and even-driven basis.**

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Refer to Verification 2 of the Software Project Tracking and Oversight key process area for practices covering the typical content of the project management oversight reviews.

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Verification 3 The software quality assurance group reviews and/or audits the activities and work products for intergroup coordination and reports the results.

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Refer to the Software Quality Assurance key process area.

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The software quality assurance responsibilities for this key process area may be subsumed into a quality assurance function that covers all the project engineering groups.

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At a minimum, the reviews and/or audits verify:

1. The procedure for identifying, negotiating, and tracking critical dependencies between the project engineering groups.

2. The handling of intergroup issues.

Peer Reviews

a key process area for Level 3: Defined

The purpose of Peer Reviews is to remove defects from the software work products early and efficiently. An important corollary effect is to develop a better understanding of the software work products and of defects that might be prevented.

Peer Reviews involve a methodical examination of software work products by the producers' peers to identify defects and areas where changes are needed. The specific products that will undergo a peer review are identified in the project's defined software process and scheduled as part of the software project planning activities, as described in Integrated Software Management.

This key process area covers the practices for performing peer reviews. The practices identifying the specific software work products that undergo peer review are contained in the key process areas that describe the development and maintenance of each software work product.

Goals

Goal 1 **Peer review activities are planned.**

Goal 2 **Defects in the software work products are identified and removed.**

Peer Reviews

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Commitment to perform

Commitment 1 **The project follows a written organizational policy for performing peer reviews.**

This policy typically specifies that:

1. The organization identifies a standard set of software work products that will undergo peer review.

2. Each project identifies the software work products that will undergo peer review.

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Refer to Activity 1 of the Integrated Software Management key process area and Activity 2 of the Organization Process Definition key process area for practices covering the identification of software products that undergo peer review.

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Examples of software work products include:

- operational software and support software,
- deliverable and nondeliverable software work products,
- software (e.g., source code) and nonsoftware work products (e.g., documents), and
- process descriptions.

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3. Peer reviews are led by trained peer review leaders.

4. Peer reviews focus on the software work product being reviewed and not on the producer.

5. Results of the peer reviews are not used by management to evaluate the performance of individuals.

Ability to perform

Ability 1 **Adequate resources and funding are provided for performing peer reviews on each software work product to be reviewed.**

Resources and funding are provided to:

1. Prepare and distribute the peer review materials.

2. Lead the peer review.

3. Review the materials.

4. Participate in the peer review and any follow-up reviews required based on the defects identified in the peer review.

5. Monitor the rework of the software work product based on the defects identified in the peer review.

6. Collect and report the data resulting from the peer reviews.

Ability 2 **Peer review leaders receive required training in how to lead peer reviews.**

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Examples of training include:

- the objectives, principles, and methods of peer reviews;
- planning and organizing a peer review;
- evaluating readiness and completion criteria for a peer review;
- conducting and facilitating a peer review;
- reporting the results of a peer review;
- tracking and confirming rework to address the actions identified in a peer review; and
- collecting and reporting the data required for the peer reviews.

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Refer to the Training Program key process area.

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Ability 3 **Reviewers who participate in peer reviews receive required training in the objectives, principles, and methods of peer reviews.**

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Examples of training include:

- types of peer reviews (e.g., reviews of software requirements, software design, code, and software test procedures);
- the objectives, principles, and methods of peer reviews;
- roles of reviewers; and
- estimating the effort for preparing and participating in peer reviews.

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Refer to the Training Program key process area.

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Activities performed

Activity 1 **Peer reviews are planned, and the plans are documented.**

These plans:

1. Identify the software work products that will undergo peer review.

   q The software work products selected include the set identified in the organization's standard software process.

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Refer to Activity 2 of the Organization Process Definition key process area for practices covering the organization's standard software process.

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2. Specify the schedule of peer reviews.

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For peer reviews that are scheduled to occur in the near future, the trained peer review leaders and the other reviewers for each peer review are identified.

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Activity 2 Peer reviews are performed according to a documented procedure.

This procedure typically specifies that:

1. Peer reviews are planned and led by trained peer review leaders.

2. Review materials are distributed to the reviewers in advance so they can adequately prepare for the peer review.

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The review materials should include the relevant inputs to the development of the software work product undergoing peer review.

Examples of relevant input include:

- the objectives of the software work product,
- the applicable standards,
- the relevant requirements for a design module, or
- the relevant detailed design for a code module.

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3. Reviewers have assigned roles in peer reviews.

4. Readiness and completion criteria for the peer reviews are specified and enforced.

   q Issues in satisfying these criteria are reported to the appropriate managers.

5. Checklists are used to identify criteria for the review of the software work products in a consistent manner.

   q The checklists are tailored to the specific type of work product and peer review.

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Examples of items addressed by tailoring the checklist include:

- compliance with standards and procedures,
- completeness,
- correctness,
- rules of construction, and
- maintainability.

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q The checklists are reviewed by the checklist developers' peers and potential users.6. Actions identified in the peer reviews are tracked until they are resolved.

(Activity 2) 7. The successful completion of peer reviews, including the rework to address the items identified in the peer reviews, is used as a completion criterion for the associated task.

Activity 3 **Data on the conduct and results of the peer reviews are recorded.**

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Examples of data include:

- identification of the software work product reviewed,
- size of the software work product,
- size and composition of the review team,
- preparation time per reviewer,
- length of the review meeting,
- types and number of defects found and fixed, and
- rework effort.

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Measurement and analysis

Measurement 1 **Measurements are made and used determine the status of the peer review activities.**

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Examples of measurements include:

- number of peer reviews performed compared to the plan,
- overall effort expended on peer reviews compared to the plan, and
- number of work products reviewed compared to the plan.

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Verifying implementation

Verification 1 **The software quality assurance group reviews and/or audits the activities and work products for peer reviews and reports the results.**

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Refer to the Software Quality Assurance key process area.

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At a minimum, the reviews and/or audits verify that:

1. The planned peer reviews are conducted.
2. The peer review leaders are adequately trained for their roles.
3. The reviewers are properly trained or experienced in their roles.

4. The process for preparing for the peer reviews, conducting the peer reviews, and performing the follow-up actions are followed.

5. Reporting of peer review data is complete, accurate, and timely.

Peer Reviews

a key process area for Level 3: Defined