PART TWO

Tailor Measures

Part 1 of the Guide provided an overview of the *Tailor Measures* activity in the PSM process. This part of the Guide contains detailed guidance for implementing tailoring tasks.

Part 2 of the Guide is organized into five chapters:

- **Chapter 1, *Tailor Measures* Overview,** provides an overview of the tailoring process.
- **Chapter 2, *Identify and Prioritize Project Issues*,** explains how project-specific issues are identified, organized, and prioritized.
- **Chapter 3, *Select and Specify Project Measures*,** explains how measures are selected to address project issues.
- **Chapter 4, *Integrate Into the Technical and Management Processes*,** explains how collecting and analyzing data for the selected measures is integrated into the technical and management processes.
- **Chapter 5, Measurement Tailoring Example,** illustrates an implementation of the *Tailor Measures* activity in a typical project scenario.

[This page intentionally left blank.]

1

Tailor Measures Overview

PSM provides a systematic method for identifying project issues, selecting and specifying measures, and integrating them into the project's technical and management processes. The objective of the *Tailor Measures* activity is to define the measures that provide the greatest insight into project issues at the lowest cost. The PSM tailoring approach focuses effort and resources on getting the most important project information first.

Figure 2-1 illustrates the *Tailor Measures* activity. Project objectives and issues drive the entire measurement process. The first task in tailoring is the identification and prioritization of project-specific issues. Issues are derived from project-context information, management experience, and risk assessment results. Priorities are assigned to each issue to establish its relative importance in selecting appropriate measures.

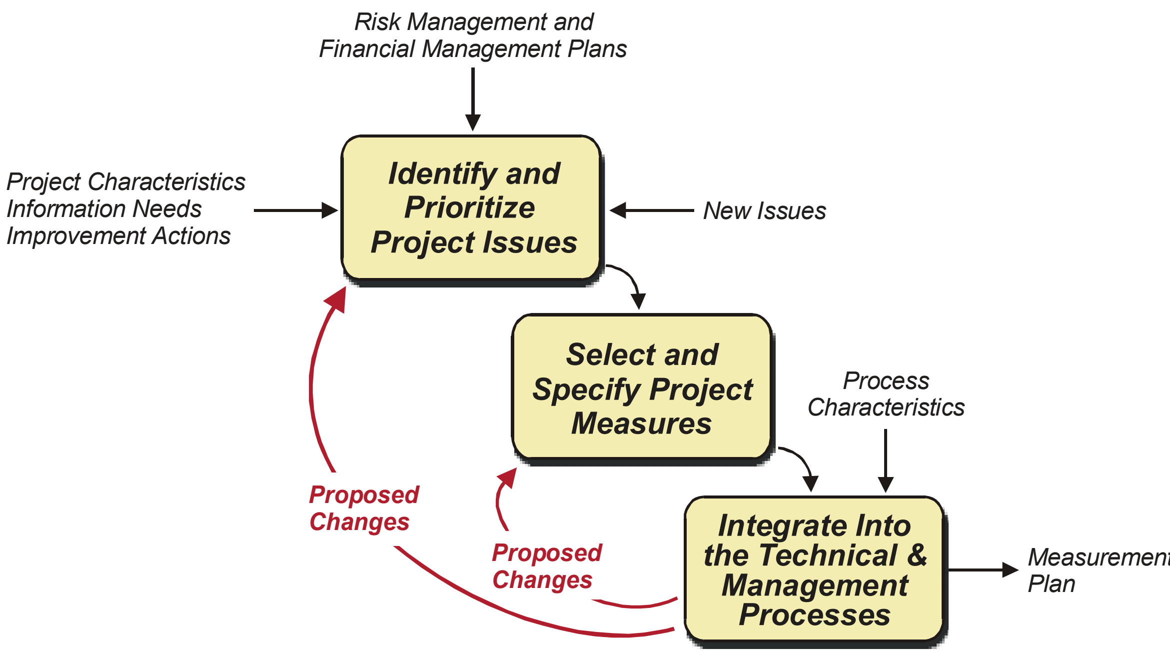

Figure 2-1. The *Tailor Measures* Activity

The second tailoring task is the selection and specification of appropriate measures to address the project-specific issues. The selection task employs a PSM-defined framework that maps selected project issues to common issue areas, measurement categories, and measures. Detailed tables in Part 3 of the Guide provide criteria for making these selections. Once a measure is selected, its detailed specifications must be developed.

The third and final task in tailoring is the integration of the measures into the technical and management processes. Be sure to examine the suitability of the selected measures in the context of the actual project processes and the overall technical approach. Measurement requirements should not be used to change the life-cycle processes, but to understand them. When implementing measurement on an existing project, pay special consideration to existing data sources and ongoing measurement activities.

The results of the tailoring activity are documented in a project measurement plan. The plan may be formal or informal, depending on the nature of the project and the relationship between the supplier and the acquirer. The plan may also be incorporated as part of another plan, such as a software development plan or systems engineering management plan. In an acquisition or outsourcing scenario, the supplier's proposed measurement approach may be a factor in source selection. In this case, negotiate the final measurement requirements through the contracting process.

Figure 2-1 shows that the tailoring activity is iterative. New issues may be discovered or refinements may be proposed in the course of examining the life-cycle processes. Alternative measures may be proposed to satisfy the project manager's information needs while minimizing costs. Tailoring may also occur after the initial measurement plan has been developed. New issues and new opportunities for measurement may be discovered as the project matures. Previously identified issues may change in priority.

The PSM tailoring guidance focuses on selecting the "best" measures to address the identified project issues. Each measure is initially associated with a single issue to help simplify the selection task. However, most measures are used in conjunction with other measures to provide insight into a wide set of project issues. The use of multiple measures and the relationships among typical project issues are discussed in Part 4 of the Guide.

The following chapters describe each of the three tailoring tasks in more detail.

2

Identify and Prioritize Project Issues

An effective measurement process helps the project manager identify and manage problems or risks that could adversely impact the project. PSM refers to these obstacles as *issues*. The PSM tailoring process begins with identifying project-specific issues.

Figure 2-2 shows the detailed steps to *Identify and Prioritize Project Issues*. First, identify potential issues using all available project information. Next, map the identified project issues to the PSM common issue areas. Mapping project issues to the common issue areas helps in selecting appropriate measures for each issue from the tables in Part 3 of the Guide. Finally, prioritize the project-specific issues. The priority determines the emphasis to place on measuring and tracking the issue through the measurement process.

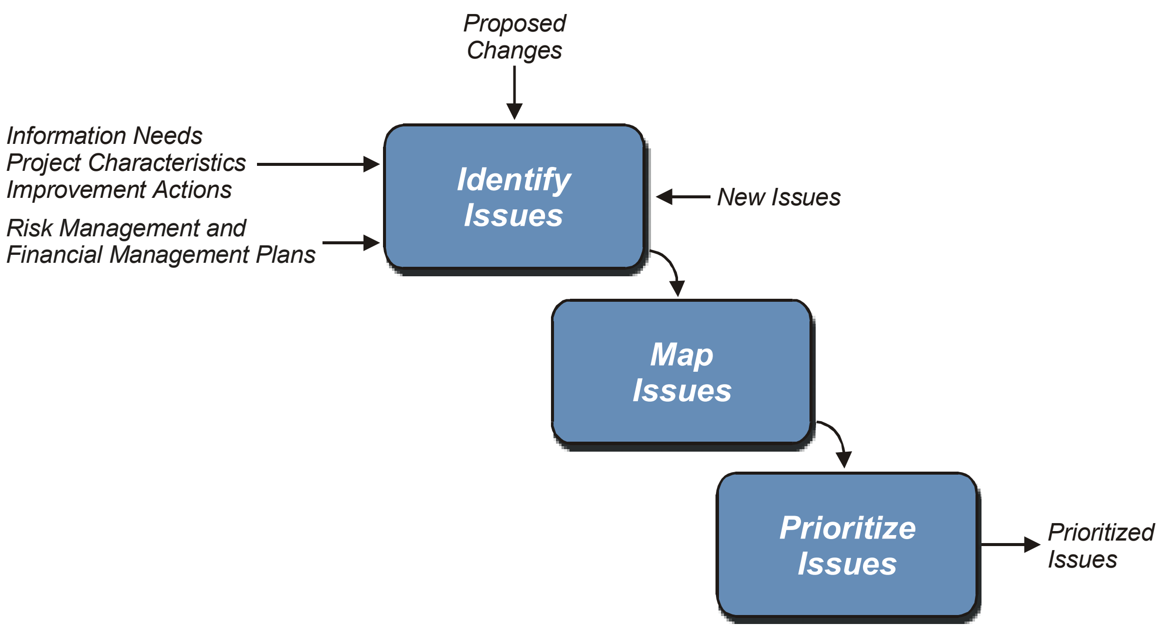

Figure 2-2. ***Identify and Prioritize Project Issues***

These steps and the interface to the risk management process are described in more detail in the following subsections.

2.1 *Identify Issues*

In order to identify project-specific issues, it is necessary to understand what issues are and how they are identified. As indicated in Figure 2-2, risk assessment activities are key contributors to issue identification, but a formal risk assessment process is not required to identify a valid set of project issues.

Most projects begin with ***objectives***. Objectives may be directed downward by executive management or defined by the project manager in conjunction with the prospective system user. These objectives are typically defined in terms of budgets allocated, scheduled milestones, required quality levels, business or mission performance targets, or overall system capability. Project success depends on achieving the defined objectives. Measurements provide insight for making decisions that help to achieve these objectives and to assure project success.

Issues are areas of concern that may impact the achievement of a project objective. Issues include problems, risks, and lack of information. These terms are defined as:

- **Problem** - an area of concern that a project is currently experiencing or is relatively certain to experience
- **Risk** - an area of concern that could occur, but is not certain
- **Lack of information -** an area where the available information is inadequate to reliably predict project impact

Identifying something as an issue does not necessarily mean that it is a problem. In fact, thorough identification of issues and careful tracking minimizes the potential for serious problems that could negatively impact project success.

In addition to issues identified at the start of the project, new issues may also arise as the project progresses. New or evolving requirements, changes in technology, and other factors usually help to identify additional issues as the project progresses. Revisit the measurement process periodically during the project life cycle to keep project issues up to date.

Issue Sources

Multiple sources of information ensure that a comprehensive set of issues is defined for measurement purposes. Useful sources include:

- **Risk assessments** - Always consider the results of technical and management risk assessments when identifying project-specific issues. Risk assessment may point to requirements, technology, process, cost, and schedule issues. Risks may be identified informally in the absence of a structured risk management process.
- **Project constraints and assumptions** - The project plan is usually based on many assumptions, such as the performance of the supplier or the availability of test facilities. Lack of information that impacts effort, schedule, and quality estimates should be treated as an issue. Moreover, schedules and budgets may have inflexible or conflicting constraints. If deviations from these constraints could threaten project success, identify these areas as issues.
- **Leveraged technologies** - Project success may depend on leveraging certain technologies such as COTS components, common domain architectures, or advanced programming languages. If meeting project

objectives depends on obtaining benefits from specific technologies, identify the effectiveness of these technologies as an issue.

- **Product acceptance criteria** - Users may impose stringent milestone or acceptance criteria on the system. If there is significant doubt about the system's ability to meet defined acceptance criteria, advertised objectives, or other external criteria, identify the satisfaction of these criteria as an issue.

- **External requirements** - Many project issues are related to requirements and concerns that are external to the project. For example, the need to address operational test readiness or milestone decision information requirements may necessitate that certain issues be identified and tracked within a project. Aggressive or unrealistic organizational goals might also need to be treated as project issues.

- **Experience** - The project team's experience with similar projects may identify potential problem areas as issues.

Each project-specific issue should be stated in appropriate project terminology. Focus on those aspects of the issue that are most important to the project. For example, a schedule or progress issue for a systems maintenance release could be stated in terms of individual change requests and integration progress. Productivity, in terms of lines of code produced or hardware components manufactured is often a concern for new system projects.

Issue identification is likely to be more complete if those organizations with a significant stake in the project's outcome are included in the identification process. A joint identification process, in which the user, acquirer, and supplier participate, is an effective way to elicit issues and to reach consensus on priorities. Broad participation also helps promote commitment to the measurement process.

Consider project plans, risk assessment results, estimation results, and the experience of participants as sources of issues. In the absence of other information, the PSM common issue areas (discussed in Chapter 2.2) can stimulate thinking about project-specific issues. While these common issue areas apply to all projects, their exact nature and priority are often specific to each project.

Risk Management

Risk management is instrumental to success on any complex project. Risk management and measurement processes are implemented in parallel, but are directly connected. Risk management consists of risk analysis (identifying, estimating, and evaluating project risks) as well as risk mitigation (planning mitigations, resourcing the plans, monitoring risk status, and controlling risk actions).

Identifying, estimating, and evaluating risks are closely associated with tailoring measures. As depicted in Figure the risk management process provides prioritized risk information to the measurement tailoring activity. Risk analysis may point to potential issues related to requirements, technology, process, organization, cost, or schedule, among others.

Even if a formal risk analysis has not been performed, issues still can be identified. Not all risks are quantifiable, and not all issues are risks. Therefore, risk analysis techniques alone may not be adequate to effectively tailor a measurement process.

Risk analysis results feed into the issue identification step (as discussed in the issue identification section below). Risk analysis results typically include a list of risk items that are quantified by:

- **Probability** - How likely is it that a risk will result in a problem?

- **Impact** - If the problem occurs, what impact will it have on project success?

The product of probability and impact is commonly referred to as risk exposure. The magnitude of exposure provides the basis for prioritizing risks.

Measurement and risk management are synergistic. Both disciplines emphasize the prevention and early detection of problems rather than waiting for problems to become critical. The risk management process helps to *Identify and Prioritize Project Issues*. The measurement process plays a role in risk management by providing the visibility needed to know whether risks are becoming problems and if risk mitigation steps are having the desired effect. Risk management usually addresses more issues than can be quantified using measurement. For example, environmental and political risks may be included in the risk management process, but are not generally applicable to project-level measurement.

2.2 Map Project Issues to Common Issue Areas

Once the project-specific issues have been identified, the next step is to map them to the PSM common issue areas. Experience shows that most project-specific issues can be grouped into general “issue areas” that are basic to almost all projects. The seven common issue areas included in PSM are:

- **Schedule and Progress** - This issue relates to the completion of major milestones and individual work components. A project that falls behind schedule may have to eliminate functionality or sacrifice quality to maintain the delivery schedule.

- **Resources and Cost** - This issue relates to the balance between the work to be performed and personnel resources assigned to the project. A project that exceeds the budgeted effort may recover by reducing functionality or sacrificing quality.

- **Product Size and Stability** - This issue relates to the stability of the functionality or capability. It also relates to the system’s product size or volume. Stability includes changes in scope or quantity. An increase or instability in system size usually requires increasing resources or extending the project schedule.

- **Product Quality** - This issue relates to the product’s ability to support the user’s needs within defined quality or performance parameters. Once a poor-quality product is delivered and accepted by the user, the burden of making it work usually falls on the operations and maintenance organization.

- **Process Performance** - This issue relates to the capability of the supplier and the life-cycle processes to meet the project's needs. A supplier with poor management and technical processes or low productivity may have difficulty meeting aggressive project schedule, quality, and cost objectives.

- **Technology Effectiveness** - This issue relates to the viability of the proposed technical approach, including component reuse, maturity and suitability of COTS components. It also refers to the project’s reliance on advanced systems development technologies. Cost increases and schedule delays may result if key aspects of the proposed technical approach are not met, or if key technological assumptions are inaccurate.

- **Customer Satisfaction** - This issue relates to the customer’s perception of product value. Customers are likely to be satisfied when products and services are delivered on time, within budget, and with high quality. However, the customer’s perceptions of cost, timeliness, and quality are influenced by marketing, historical use, and the competition.

Common issue areas help in selecting appropriate measures to address project-specific issues. This is accomplished by allocating each project-specific issue to one (or more) of the seven common issue areas, then selecting measures based on the information provided in Part 3. This information links the common issue areas to measurement categories and then to individual measures. Grouping related project-specific issues also helps prioritization. The groups make it easy to recognize high-priority issue areas.

Some project-specific issues may not map to a PSM common issue area. In these cases, define appropriate measures by applying the general principles that are outlined in this Guide. Part 3 discusses this topic in more detail.

If no formal risk analysis was performed, then the seven common issue areas can be used during measurement planning to help ensure that all important information needs have been considered.

2.3 Prioritize Project Issues

Software and system projects typically have many issues. The issues must be prioritized in order to ensure that the measurement process focuses on issues with the greatest impact on meeting project objectives. For example, a project that plans to make extensive use of COTS components may be more concerned with the schedule and progress of integration than with the quality of the COTS components (assuming that the COTS component was selected because it met user requirements). On the other hand, a safety-critical system might have COTS quality at the top of its priority list.

There are several ways to establish priorities. The most important considerations are that the issues are prioritized using well-defined criteria and that the major project participants reach consensus on priorities. One approach is similar to calculating risk exposure in the risk assessment process. In this approach, the identified issues are each subjectively ranked in terms of overall project impact and probability of occurrence. Numeric weights are assigned to each factor. The weights are then multiplied, and the issues are ordered by the total exposure results. Figure 2-3 is an example of this approach. In addition to the impact of each individual issue, other factors to consider include: 1) whether or not the issue is already impacting the project, 2) the relationship of the issue in question to others in the prioritized set, and 3) the visibility of the issue within the overall project structure.

Project-Specific Issues	*Probability of Occurrence*	*Relative Impact*	*Project Exposure*
Aggressive Schedule	1.0	10	10.0
Budget Constraints	1.0	10	10.0
Unstable Requirements	1.0	8	8.0
Subcontractor Integration	0.7	6	5.6
Staff Turnover	1.0	6	6.0
Staff Experience	1.0	5	5.0
Changing Mission	0.7	6	4.2
Critical Dependencies	0.5	7	3.5
Reliability Requirements	1.0	3	3.0
Concurrent Activities	1.0	2	2.0
COTS Performance	0.2	9	1.8
Questionable Size Estimates	1.0	1	1.0

Figure 2-3. Quantitative Issue Prioritization

In this example, twelve project-specific issues have been identified. The probability of occurrence (expressed on a scale of 0 to 1) and the relative project impact (estimated on a relative scale of 1 to 10) have been assigned by the project team participants, and the overall project exposure for each issue has been calculated. Known problems are assigned a probability of 1.0.

Prioritization results in Figure 2-3 clearly indicate that the issues of aggressive schedule, constrained budget, and unstable requirements are of top concern to the project team. The measurement process should address these issues first.

If a risk management process exists, the results of a formal risk assessment, combined with known problems, can drive issue prioritization. When inputs from a formal risk management process are used, estimate the impact of risks, problems, and other concerns, applying the same prioritization scale.

Priorities established always reflect a degree of subjectivity. Some planners may be tempted to diminish measurement requirements by minimizing the estimated impact or by reducing the priority of issues inappropriately. This must be avoided. No matter how the issues are prioritized, similar issues should be grouped. This makes it easier to select measures that address multiple issues.

Remember that the prioritization of the project issues is dynamic. Additional issues may be identified once the project is underway. The probability and impact of risks change as the project matures. Timing is also important. Priorities and mitigation tactics will change as the estimated date of a projected impact nears. Risks must be managed continuously. Thus, the measurement process has to change to keep pace with changing priorities.

3

Select and Specify Project Measures

This chapter describes how the PSM approach leads to the selection of the best set of measures to address the identified project issues. The steps in this task are depicted in Figure 2-4. These include identifying appropriate measurement categories for the identified issues, selecting the most appropriate measures within the categories, and specifying data requirements so that the measures can be defined and implemented. These tasks are discussed in more detail in the following sections.

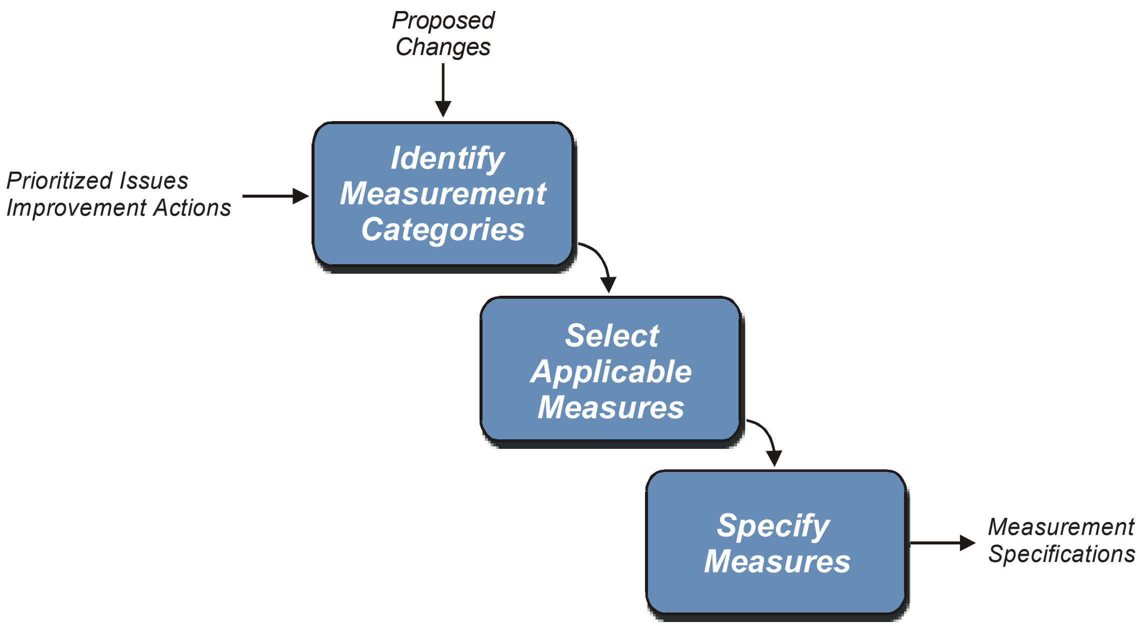

Figure 2-4. ***Select and Specify Project Measures***

Although project issues are key to measurement selection, the overall characteristics of the project and its life-cycle approach are also important. The types of analysis and models used also affect measurement choices. For example, most parametric estimation models require a defined set of measurement inputs. Thus, selecting a specific estimation model implies selecting the associated measures. Anticipating the types of analyses, indicators, and reports that will be needed helps to define the measures and data attributes that are required.

3.1 Measurement Selection Mechanisms

PSM facilitates measurement selection by mapping project-specific issues to common issue areas, measurement categories, and individual measures. Figure 2-5 illustrates this relationship. The common issue areas, measurement categories, and measures help focus the measurement selection task. Each common issue area has one or more associated measurement categories. Each measurement category contains one or more measures. Selecting a common issue area narrows the range of categories that must be considered. Selecting a category narrows the range of measures that must be considered.

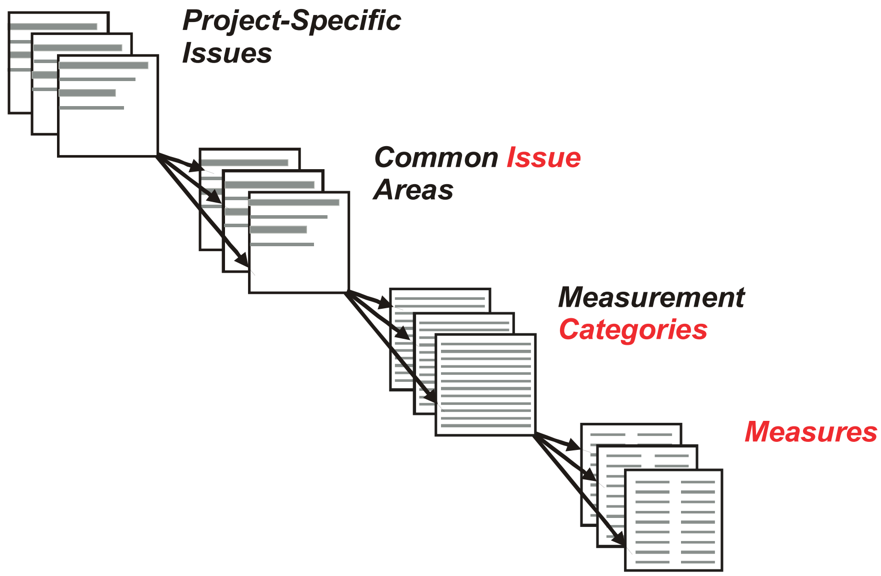

Figure 2-5. PSM Measurement Selection Mechanisms

The PSM mechanisms provide a starting point for measurement selection and specification. Modify and adapt them to meet individual project needs. The PSM mechanisms include:

- **Common issue areas** - As noted earlier, PSM defines seven common issue areas. Project-specific issues are mapped to the common issue areas at the start of the measurement selection task.

- **Measurement categories** - Most issues can be approached from several different viewpoints. Measurement categories define groups of related measures. The measures within a category provide similar information about an issue; they address related project characteristics and answer similar questions.

- **Measures -** Several candidate measures are usually available for each project-specific issue. *A measure is the quantification of a characteristic of a process or product.* In Part 3, the Guide describes criteria for selecting the measures that provide the best information for insight. Specifying a measure involves selecting the measure and making decisions such as which data items to collect, the level of data collection, and applicable exit criteria.

Part 3 of the Guide provides the complete mapping of the PSM common issue areas to measurement categories and measures in the form of an Issue-Category-Measure (ICM) table. Part 3 also includes detailed tables that describe all of the measurement categories and measures. The measures in Part 3 are widely used for project and technical management purposes and have proven effective over a wide range of projects. These measures represent examples of best practices of project managers. *However, they are not meant to define an exhaustive or required set of categories and measures.* No project should implement all of the measures listed in PSM. Augment the lists with issues and measures based on personal experience and requirements. The PSM tailoring process applies to any measure, whether or not it is included in the Part 3 tables. Part 3 also contains additional guidance on defining new issues, categories, or measures.

3.2 Select the Measurement Categories

The first step in selecting and specifying project measures is to review the groupings of the project-specific issues into common issue areas. Once the common issue areas have been identified, the next step is to select one or more measurement categories that best address a given area. As an example, consider the common issue area of Schedule and Progress. Three different measurement categories (Milestone Performance, Work Unit Progress, and Incremental Capability) are mapped to this issue. The measures in all of these categories address schedule and progress related concerns, but they do so with different types of information at different levels of detail.

Milestone Performance measures provide basic start and end dates for project activities and events. This is adequate for developing and reviewing Gantt charts, but the measures do not address the degree of completion for individual activities and products at any point in time. The measures in the Work Unit Progress measurement category provide more detailed schedule and progress information. Lastly, the measures in the Incremental Capability category show whether system components or functions are being completed as planned for each build or release in an incremental project life-cycle approach.

One way to determine whether a category addresses an issue is to consider the types of questions that the measures in that category answer. Figure 2-6 provides typical questions that are addressed by each of the PSM measurement categories.

Common Issue Area	*Measurement Category*	*Questions Addressed*
Schedule and Progress	Milestone Performance	Is the project meeting scheduled milestones? Are critical tasks or delivery dates slipping?
	Work Unit Progress	How are specific activities and products progressing?
	Incremental Capability	Is capability being delivered as scheduled in incremental builds and releases?
Resources and Cost	Personnel	Is effort being expended according to plan? Is there enough staff with the required skills?
	Financial Performance	Is project spending meeting budget and schedule objectives?
	Environment and Support Resources	Are needed facilities, equipment, and materials available?
Product Size and Stability	Physical Size and Stability	How much are the product's size, content, physical characteristics, or interfaces changing?
	Functional Size and Stability	How much are the requirements and associated functionality changing?
Product Quality	Functional Correctness	Is the product good enough for delivery to the user? Are identified problems being resolved?
	Supportability - Maintainability	How much maintenance does the system require? How difficult is it to maintain?
	Efficiency	Does the target system make efficient use of system resources?
	Portability	To what extent can the functionality be re-hosted on different platforms?
	Usability	Is the user interface adequate and appropriate for operations? Are operator errors within acceptable bounds?
	Dependability - Reliability	How often is service to users interrupted? Are failure rates within acceptable bounds?
Process Performance	Process Compliance	How consistently does the project implement the defined processes?
	Process Efficiency	Are the processes efficient enough to meet current commitments and planned objectives?
	Process Effectiveness	How much additional effort is being expended due to rework?
Technology Effectiveness	Technology Suitability	Can technology meet all allocated requirements, or will additional technology be needed?
	Impact	Is the expected impact of the leveraged technology being realized?
	Technology Volatility	Does new technology pose a risk due to too Many changes?
Customer Satisfaction	Customer Feedback	How do our customers perceive the performance on this project? Is the project meeting user expectations?
	Customer Support	How quickly are customer support requests being addressed?

Figure 2-6. Measurement Categories and Related Questions

This table may be used to find the measurement category or categories that most closely align with a project-specific issue. For example, if a project-specific issue is "progress of COTS integration," then the Work Unit Progress category is appropriate because the issue involves the progress of a specific activity, namely integration. If the project-specific issue is "budget overruns to fix unanticipated problems," then the rework category is pertinent because it concerns the extra amount of effort applied to correct latent defects.

The Measurement Category Tables in Part 3 describe each PSM measurement category in detail, including what information is provided by the measures and the applicability of the measures to different types of projects, products, and life-cycle approaches. The tables also identify limitations of measures in each category. The tables help to determine which measurement categories best satisfy the issue information needs.

The Measurement Category Tables in Part 3 are grouped with tables that describe the individual measures within each category. Review the category and associated measurement tables together. Always choose the measurement category that provides the best fit for the prioritized issues. For critical or high-priority issues, consider selecting more than one measurement category. This will lead to different types of measures and measurement information, allowing for more in-depth analysis.

3.3 *Select Applicable Measures*

The second step in *Select and Specify Project Measures* is to choose measures that best address the project-specific issues. Many different measures may apply to an issue. In most cases, it is not practical to collect all or even most of the possible measures for an issue. Generally, more measures should be collected to track high-priority issues. Identifying the "best" set of measures for a project depends on an evaluation of the potential measures with respect to the issues and relevant project characteristics.

For example, if product size and stability is an issue, then requirements and product-oriented size measures are needed to track it. The appropriate measure depends on the nature of the project. For software components of a system, programming language and application domain influence the choice of a product size measure, such as function points or lines of code. For hardware components, a count of custom designed versus reused components may be used, or measures based on physical characteristics such as weight, dimensions, or power consumption.

Once a measurement category has been selected, the measurement selection criteria (defined below) can help identify the best measures for the project. The measurement description tables in Part 3 explain each PSM measure in detail with respect to these criteria. Measures are selected based on:

- **Measurement effectiveness** - How effective is the measure in providing the desired insight? Is it a direct measure of the process or product characteristic in question? Does the measure provide insight that relates to more than one issue?

- **Domain characteristics** - Are certain measures better in a given domain? For example, response time is widely used to measure target computer resource utilization in information systems, while memory utilization is more widely used in embedded systems (e.g., flight control for aircraft).

- **Project management practices** - Can existing management practices be leveraged to support the measurement requirements? For example, is there a scheduling system in use that provides one or more of the desired measures? Is there an estimation model in use that requires specific measurement inputs?

- **Cost and availability** - What data should be readily available in the context of the project? How much effort will be required to extract and package the data for analysis? Electronic data collection usually costs less than manual collection.

- **Life-cycle coverage** - Does the measure apply to the life-cycle phase under consideration? Does it apply to multiple life-cycle phases?

- **External requirements** - Has the overall organization or enterprise imposed any related measurement requirements?

- **Size/origin of system components** - Does the size of the project justify a greater investment in measurement? Does this measure make sense if much of the system involves externally supplied components such as software reuse, purchased components, or integration efforts?

In most cases, the selection activity will require tradeoffs among the measurement selection criteria. For example, a given measure may directly address a high-priority project issue, but may be too costly to implement in terms of time and resources. Some measures support multiple analysis needs when used in conjunction with other specific measures. For example, the lines of code measure is used to calculate and analyze software development performance in terms of productivity, and quality in terms of defect density. This measure may therefore be important even if product size and stability is not a high priority issue.

In general, measures from different measurement categories within the same common issue area can be substituted with some degree of effectiveness. Also, measures that are categorized under different common issue areas may provide additional insight into the issue in question. Obviously, it is better to use a substitute measure than one that cannot be implemented.

After the initial measures are selected, they should be reviewed to ensure that the high-priority issues are addressed. For some unique issues, none of the measures included in the PSM tables may provide adequate information. In these cases, more advanced or different measures than those provided should be defined and specified. The bibliography contained in Part 9 provides potential sources for other measures.

3.4 *Specify Measures*

Once the measures have been selected, a number of details for each measure must be specified. Developing and disseminating clear definitions of the selected measures helps to ensure consistent data. Even obvious terms, like components, lines of code, staff months of effort, defects, and failures, are defined differently by different organizations. For example, lines of code may be interpreted to mean physical lines, non-comment lines, executable statements, or other variations. Similarly, failures may be interpreted to mean inability to meet a specific requirement, operating in a degraded state, totally inoperable, or other variations.

When there is a contract between a supplier and an acquirer, the measurement specifications form the basis of an agreement between the two parties, greatly facilitating communication about relevant issues. (See the PSM Addendum, *DoD Implementation Guide*, for more information about how to implement a measurement program contractually. The Addendum includes sample wording for Request for Proposals [RFPs] and a discussion of evaluating measurement plans as part of source selection.)

Even when the project is an internal development, a clear set of measurement specifications is important.

The tables in Part 3 define typical considerations for specifying commonly used measures. These are discussed in more detail below.

Data Items

An important step in specifying a measure is to list the specific data items (or quantities) to collect. For milestone dates, data items may include the start date and end date for an activity. For effort, the data item might be labor hours. For lines of code, the data items could be terminal semicolons. The measurement tables in Part 3 list typical data items for each measure.

Attributes

An attribute is a characteristic or property associated with a measure or with the entity being measured. An example of an attribute is Plan or Actual. Other examples of data attributes include:

- Name of the organization
- Incremental version of the system
- Priority or cause of a problem report or defect
- Name of a test sequence

Attributes are used to sort and correlate data items. For example, priorities are frequently used to classify problem reports, rather than just generating a total number. Define the necessary attributes during measure specification. The measurement tables in Part 3 list typical attributes for each measure.

Aggregation Structure

Measurement data is usually generated at a relatively low level of detail within the project. For example, it is more common to measure the size of an individual component (such as a software unit) than to measure the system as a whole. Total system size is then computed by adding up the sizes of the components. Similarly, system weight or power is obtained by summing measures or estimates of the weight or power consumption of individual components. Although data should be collected at the level it is generated, data is often aggregated to higher-level component and organizational structures for analysis and reporting purposes. Aggregation structures refer to different ways of accumulating measurement data.

There are three types of measurement aggregation structures, as depicted in Figure 2-7:

- **Component-based aggregation structures** - These structures are derived from the relationship of the system components within a particular architecture or design. Component structures vary based on the overall system design process. For projects that implement an incremental development approach, or for operations and maintenance efforts that deliver periodic system releases, lower-level components (such as units and configuration items) are usually mapped to the incremental delivery products as part of the aggregation structure.

- **Functional-based aggregation structures** - These structures define the functional decomposition of system requirements. They are often mapped to the system design components. If they are mapped to design components, then measures of the requirements (such as the number of requirements tested) can be aggregated and evaluated for a particular function.

- **Activity-based aggregation structures** - These structures are based on the hierarchy of life-cycle activities that define the complete activity structure for a project. Activities generally include requirements analysis, design, implementation, and integration and test (as well as other activities that need to be performed to complete the project).

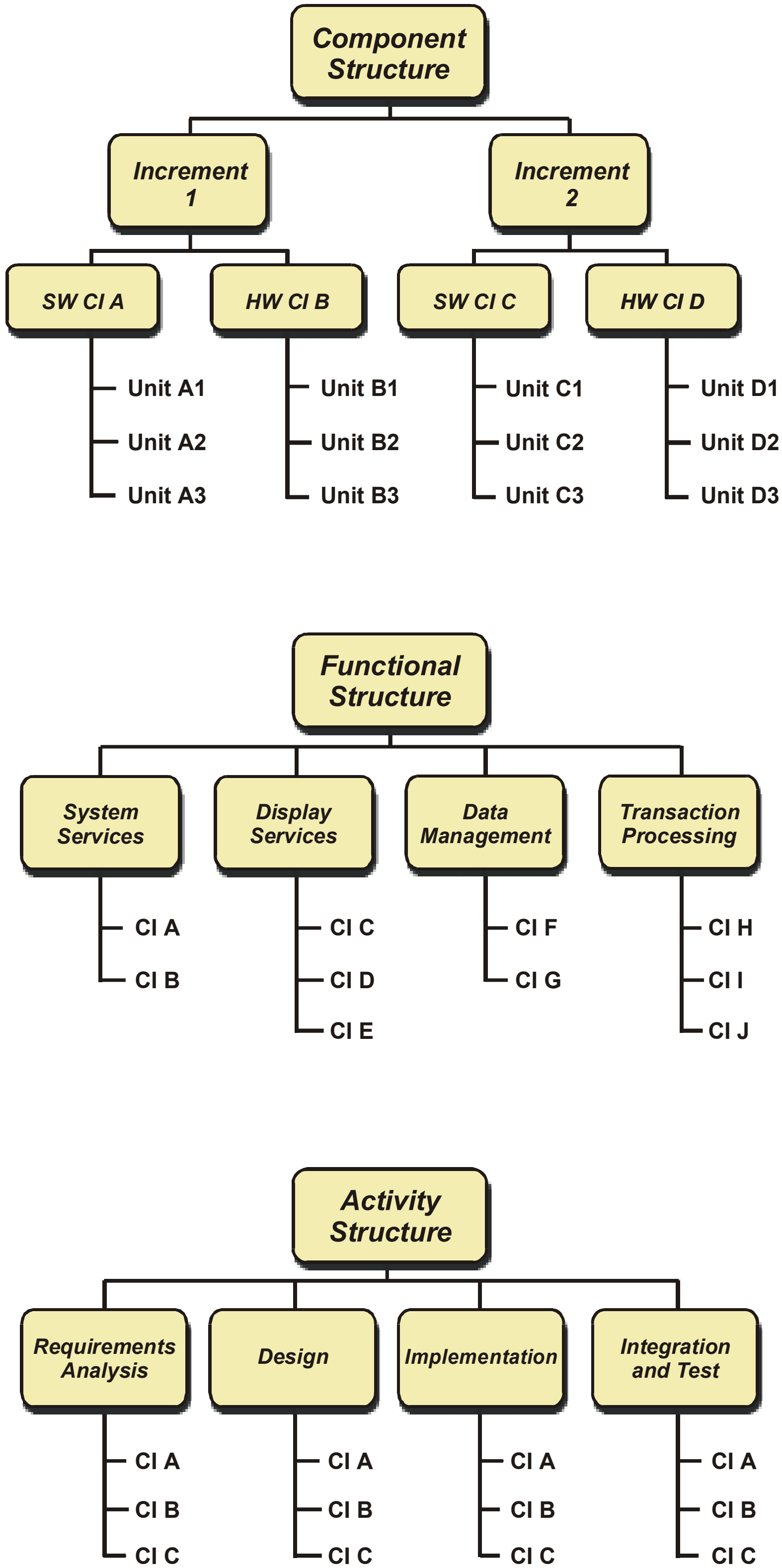

Figure 2-7. Sample Measurement Aggregation Structures

In general, measurement aggregation structures are related to either the management structure of the project or the physical design of the system. The project Work Breakdown Structure (WBS) and the system design information are key reference tools for defining applicable measurement aggregation structures, since they respectively describe the project management and technical relationships.

The aggregation structure is a basic tool to help specify, collect, process, and analyze data. Attributes that describe how the measures relate to existing project structures must be defined to combine, and later analyze, the measurement results into meaningful pieces of information. For example, it may be necessary to track the amount of effort applied to requirements analysis, design, implementation, and integration and test activities on a separate basis. If the effort data collected for each project activity includes an attribute that links it to a particular activity, the aggregations can be made easily. Such data could show where improvements are needed within a project, or could predict final costs based on the remaining work to be done. The measurement tables in Part 3 list typical aggregation structures for each measure.

Aggregation structures have some limitations. The calculation of software productivity is a good example. Productivity is generally only valid within a single organization and life-cycle process. To calculate productivity, both product size and effort data are required for the same component (or set of components). Software components are unique enough in size and other characteristics to make productivity comparisons at the component level difficult. Thus, size and effort should be aggregated to the configuration item or project level. On the other hand, productivity usually cannot be calculated meaningfully for the entire project if there is more than one software development organization or subcontractor.

Collection Level

In order to support the measurement analysis process, data must be collected at a level of detail that allows problems to be isolated and understood. The collection level describes the lowest level at which data is collected. It can then be rolled up using the aggregation structure.

Different types of data may be collected at different levels of detail using different aggregation structures. If data is to be compared, it must roll up within the same aggregation structure. For example, it is hard to analyze productivity when effort data is collected by categories that do not map to the component structure used to collect size measures. When selecting and specifying project measures, remember to consider the ability of the supplier's cost accounting system to support detailed effort and cost reporting.

In determining the appropriate level of detail, the cost of collecting, processing, and analyzing data must all be balanced against the need for detailed insight into project issues. More detailed data allows greater flexibility in analysis, to define new indicators and to determine the source of potential problems. However, a greater level of detail also implies a greater volume of data and a greater cost for the measurement process. Use detailed data to track critical issues. These recommendations for selecting measures and their level of detail must be tempered with an understanding of the technical and management processes. The measurement tables in Part 3 list the level at which a measure is typically collected.

Counting Criteria

Finally, each measure must specify when a data item is counted. For example, in counting the number of lines of code written, the criteria for "written" code may be that the code has passed unit test and has entered formal configuration control. In counting the number of problem reports closed, the criterion for "closed" might be that the report has been signed off by Software Quality Assurance (SQA). The measurement tables in Part 3 provide typical counting criteria for each measure.

3.5 Selecting and Specifying Measures for Existing Projects

The PSM measurement selection and specification guidance is structured to support sequential tailoring in the measurement process. In some instances, a significant project event or issue that must be immediately supported by objective information drives the need to implement a measurement process. In other cases, new policy guidance or another external requirement (such as a major milestone review) may make it necessary to implement measurement on a project that is underway.

With existing projects, the tailoring activity still begins with identifying and prioritizing project-specific issues. In all likelihood, key issues have already been identified, and the immediate objective is to determine what data can be used to provide meaningful information. Place less emphasis on defining data requirements and more emphasis on identifying existing measurement opportunities. Once existing measures have been identified, the task becomes one of understanding and documenting the data specifications. All of the specification details discussed in Section 3.4 should be documented. This is just as important for existing data as it is for tailoring a new set of measures. In both cases, specifications support objective communication and interpretation.

Take advantage of existing measurement opportunities on a current project. The necessary data usually exists, but has not been mapped to issues or collected in any systematic way. Section 4.2 discusses potential sources of data to be found in an existing project.

4

Integrate Into the Technical and Management Processes

Up to this point, the measurement selection process has been driven largely by "what" the project manager needs to know about the issues. The next task is to examine "how" the measurement process actually functions within the project technical and management processes. Readily available data may not map exactly to the ideal measurement requirements.

This final tailoring task includes three steps, as depicted in Figure 2-8. First, characterize the project's process and life-cycle environment. Next, identify opportunities for measurement within that environment. Finally, develop the measurement specifications and document them in a measurement plan. These steps apply regardless of whether the system is an in-house or an outsourcing project.

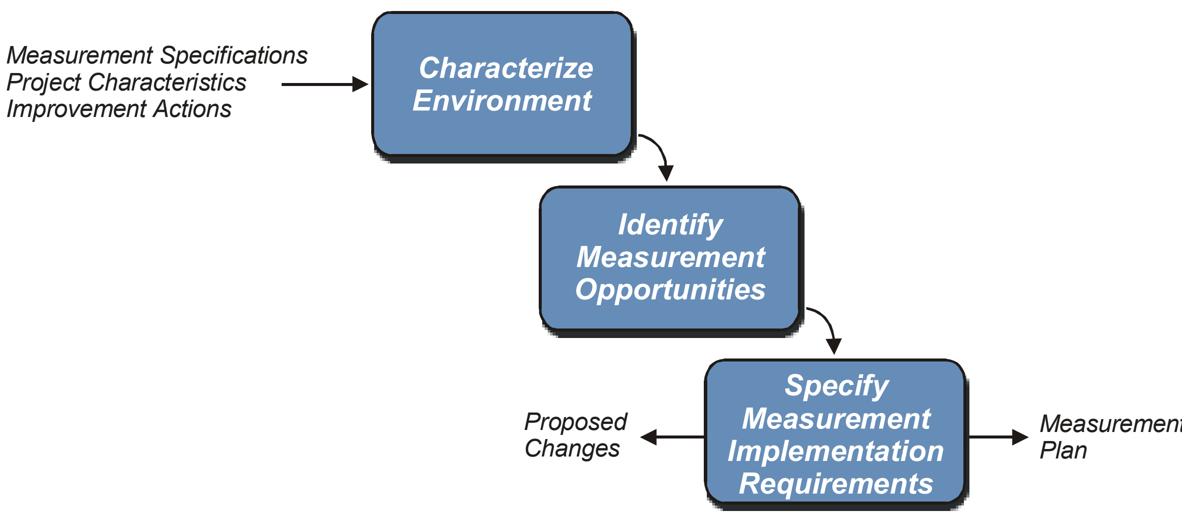

Figure 2-8. ***Integrate Into the Technical and Management Processes***

In an acquisition or outsourcing scenario, the supplier should propose changes to the project measurement requirements to better integrate the measures into their process. Selected measures and data specifications from the previous tailoring task form the basis for agreements between the acquirer and the supplier about specific data items for analysis. This agreement may be accomplished via a formal contracting process for outsourcing contracts. The final result is a written statement of the measurement approach to be followed, often documented in a measurement plan or incorporated into other project plans (e.g., software development plan).

The PSM Addendum, *DoD Implementation Guide*, provides sample contract wording that helps to implement a formal agreement. A "contract" may be a formal contract, a Memorandum of Agreement (MOA), an Inter-Service Support Agreement (ISSA), or some other written agreement. The technical concepts discussed in this Guide are applicable to all types of contracts and can be adapted to outsourcing in commercial environments as well.

4.1 *Characterize Environment*

The definition of a measurement process cannot be based solely on the information needs of management. The environment as well as technical and management processes must be considered. Project issues identify the information that the measurement process must derive from the data. The various project technical and management processes determine what specific data items may be collected and how to collect them.

One purpose of the measurement process is to provide insight into performance. Collected measures must objectively represent the activities and products of the life-cycle processes. Consider subcontractors as well as the primary supplier.

Some key factors to consider are:

- The life-cycle model or activity structure used
- The end-product structure, including increments defined and allocation of various tasks to subcontractors
- Current measurement activities employed
- System and software technology, including design techniques, software programming languages, and tools used
- Planned sources of software and hardware components, such as COTS, newly developed, and reused
- Management, coordination, review, test, and inspection practices
- Engineering and management standards to be applied
- Process maturity of the organizations
- Project organization and teaming structure

The engineering process has a major impact on the cost and effectiveness of the measurement process. Whenever possible, use current practices and existing data collection mechanisms. Minimize new measurement requirements. The project's WBS, including product structure and activities, can provide the basis for collecting and aggregating data. To the extent that the activities of the process are well defined, review them for useful information. An ad hoc or ill-defined process makes it difficult to tell exactly what is being measured. Consequently, the maturity of a process (e.g., Capability Maturity Model level) affects the efficiency and accuracy of measurement. As an organization's process matures, its management process elements are defined first and then its technical process elements are defined. Therefore, high-level management data becomes available first, before more detailed data on technical activities. Furthermore, an acquirer with ad hoc or ill-defined processes may not be able to make full use of measurement data. Thus, agreements on the measurement process should consider the acquirer's process maturity.

For many issues, the data that is available changes across life-cycle activities. For example, during implementation, progress may be measured in terms of units specified, designed, and built. During integration and test, progress may be measured in terms of test procedures ran and passed. The measurement analyst must ensure that relevant measures and indicators are provided throughout the project's life cycle, making modifications as appropriate.

Before measurement requirements are agreed to in an outsourcing arrangement, the acquirer should understand the supplier's processes and obtain feedback from the supplier on the proposed measures. The measurement process should not be used to force process changes on the supplier. Give appropriate consideration to the life-cycle process to ensure that useful data is provided with the lowest impact and cost.

4.2 *Identify Measurement Opportunities*

During measurement planning, place a high priority on identifying and exploiting any measurement mechanisms already in place within an organization. *This is especially important when implementing measurement on an existing project.* The use of existing data sources offers the advantage of familiarity, and potentially lowers the cost of implementing the measurement program. A measurement plan can be implemented more quickly when some elements of the measurement process are already known to the data providers and decision makers.

Measurement data potentially comes from many sources. Give special attention to databases and tools supporting project management, quality assurance, and configuration management. Extracting and delivering data from electronic sources is usually more cost effective than manual collection methods. In a contractual or outsourcing scenario, most actual performance data originates with the supplier. However, the acquirer often produces the initial planning data.

Three primary forms of data are:

- **Historical data** - This includes data collected from past projects. This data helps in generating estimates and in determining the feasibility of plans.

- **Planning data** - This data typically contains the budgets and schedules against which progress and expenditures will be compared. Data must be collected both from initial plans and re-plans, including incremental changes to plans.

- **Actual performance data -** As a project evolves, actual data will become available. Many sources of data exist within the life-cycle process. Problem reports by priority can be obtained from problem tracking systems. Defect counts can be obtained from configuration management systems (if they are properly structured). Counts of hours expended by activity can be obtained from financial management records. Progress data usually comes from the detailed work plans maintained by technical managers and team leaders. Consistent use of project management tools facilitates data collection.

Counts of system components, software units or lines of code, and changes to other deliverables or documentation are usually obtained from configuration management records and reports. A bill of materials may be used for counts of hardware components. A source code analyzer may be used for counts of software lines of code. Product information, such as requirements, components, or number of pages, can also be captured from requirements and design tools, and during reviews and inspections. Note that in all these cases, the most efficient method of collecting the desired data depends on the nature of the life-cycle process. To the maximum extent possible, data collection should be automated and should be the by-product of normal project activities. Figure 2-9 shows some examples of data sources.

For important issues, look for sources of data that are available early. For example, if quality is a major concern, try to identify sources of inspection data during design, rather than waiting for problem report data from tests.

Measurement Category	Electronic Source	Hard - Copy Source
Milestone Performance	Project Management System / Project Scheduling Tools	Schedule
Work Unit Progress	Project Schedule Tools Configuration Management System	Status Reports
Incremental Capability	Configuration Management System	Build Reports Status Accounting Records
Personnel	Cost Accounting System Time Reporting System Estimation Tools	Time Sheets
Financial Performance	Performance Management System Financial System	Earned Value Reports Financial Records
Physical Size and Stability	Static Analysis Systems Configuration Management System Computer Models Parts Management System	Product Listing Product Spec Sheets Laboratory Test Records Bill of Materials
Functional Size and Stability	Function Point Counting Systems Change Request Tracking System Configuration Management System Computer-Aided Software Engineering (CASE) Tools	Requirements & Design Specifications Change Requests
Functional Correctness	Defect/Problem Tracking System Configuration Management System Case Tools Test Automation Tools	Test Incident Reports Review / Inspection Reports Design Review Notes and Actions
Supportability - Maintainability	Static Analysis Tools Corrective Action Reporting Problem or Failure Tracking System	Review / Inspection Reports Problem Reports Maintenance Reports Corrective Action Reports
Efficiency	Dynamic Analysis Tools System Monitoring Tools	Performance Analysis Reports
Usability & Dependability	Problem or Failure Tracking System Help Desk System	Operator Problem Reports
Process Compliance	Process Enactment Tools	Assessment Findings Audit Reports
Process Efficiency	Project Management System Time Reporting System	Time Sheets Process Reviews Findings
Process Effectiveness	Defect/Problem Tracking System Time Reporting System	Test Incident Reports Review / Inspection Reports Time Sheets
Customer Feedback	On-line Feedback Systems	Survey Results Comment Forms

Figure 2-9. Examples of Data Sources

4.3 *Specify Measurement Implementation Requirements*

The actual procedures for collecting and processing the data need to be defined before the measurement plan can be produced and the tailoring activity completed. This step involves developing a combination of operational definitions and procedures that guide the *Apply Measures* activity. Focus on the following items:

- **Measurement Definitions -** First, review the measurement specifications already developed (as described in Section 3.4) and update them to better accommodate the project environment and processes (characterized per Section 4.1) and take advantage of existing data (identified as suggested in Section 4.2). The measurement definitions must be developed to a level that is concise but unambiguous. Be sure to describe the measurement method, including counting criteria for actual data and estimation approach for plan data. Document these definitions in one place for easy reference. In some cases, different project organizations may employ different processes or technology that result in different measurement definitions to implement the same measurement concept. For example, Ada lines of code may be counted differently by different organizations within the project team. While this is undesirable, be sure to define each measurement variation separately if it does occur.

- **Measurement Scope -** While some measures may be applicable to all organizations within a project team throughout the life cycle, most will have a more limited scope. For each measure describe the life cycle phases or activities in which it will be applied. Define the specific organizations involved, e.g., prime contractor, subcontractors, program office, and engineering departments. The scope of actual and plan data may be offset - plan data usually becomes available before actual data. Including data collection activities as tasks or milestones on the project's master schedule helps to ensure that measurement needs are not overlooked.

- **Data Collection -** Describe the process or procedure for collecting each measure and storing it in a place that is accessible for analysis. This includes defining the measurement source (work product or activity measured), responsibility for conducting the measurement, and periodicity of data collection, as well as the tools, forms, and databases used to collect and store the data. This information must be specified for each organization to be measured. Most organizations usually begin data collection on a monthly or milestone-driven basis. The frequency of data collection may be affected by the phase of the project. For example, the frequency of problem report data collection and reporting may increase from monthly during implementation to weekly during the final stages of integration and test.

- **Data Analysis -** Define the basic indicators to be generated from the measures available. The basic indicators are those that are intended to be analyzed regularly. Other indicators may be produced in response to management questions or to investigate anomalies suggested by the basic indicators. Part 4 explains the construction of indicators. Describe the process or procedure for generating and analyzing each indicator. This includes defining the periodicity and responsibility for conducting the analysis as well as any tools or other aids used in the analysis. These definitions may be revised once analysis begins.

- **Results Reporting -** Describe the process or procedure for reporting analysis results to decision-makers within the technical and management processes being supported. This includes selecting the analyses to be reported or summarized, responsibility for preparing the reports, format, and periodicity of reporting, as well as the tools, forms, and databases used to generate reports. Multiple levels of reporting may be required. Customer, project-level, and enterprise-level reporting requirements are common. Usually less detail is appropriate for reports to higher levels of management.

- **Measurement Evaluation -** The measurement process and measures themselves need to be evaluated periodically. Part 7 provides more detail on performing this activity and suggests appropriate criteria to use. During tailoring the criteria must be selected and the evaluation activities planned. A quarterly or semi-annual schedule is common. Evaluation activities may include analysis of performance measures and user feedback, audits, and process capability assessments.

Many organizations implement measurement with collection, analysis, reporting, and evaluation activities marching in lockstep on a monthly schedule. However, as measurement programs mature, these activities tend to become more distinct. A common high-maturity scenario involves event-driven data collection (e.g., as each inspection occurs), weekly analysis of the data from events occurring that week, monthly reporting of a summary of the analyses performed during the month, and quarterly or semi-annual evaluations of the measurement program.

The results of the tailoring activity are documented in a project measurement plan. The project measurement plan may be formal or informal. Modify the plan as required to accommodate different information needs and life-cycle processes. The plan may be produced as a separate document, but it is commonly included in the System Engineering Management Plan, Project Management Plan, Software Development Plan, Maintenance Plan, or similar planning document.

Figure 2-10 shows a sample outline for a measurement plan.

Coordinate the project measurement plan with the risk management plan. All significant quantifiable risks should be reflected in the measurement plan. For small projects, all of this information can be included in one plan. The plan may change as processes are modified and updated. Be sure to update the plan and communicate the changes to the entire project team.

Software Measurement Plan Outline

Part 1 - Introduction
- Purpose and Scope

Part 2 - Project Description
- Technical and Project Management Characteristics

Part 3 - Measurement Roles, Responsibilities, and Communications
- How Measurement is Integrated into the Technical and Management Processes
- Measurement Points of Contact (acquirer, supplier, subcontractors)
- Measurement Responsibilities
- Organizational Communications and Interfaces
- Tools and Databases
- Phased Implementation (if applicable)
- Evaluation Criteria

Part 4 - Description of Project Issues
- Organizational Goals / Issues
- Prioritized List of Issues and Objectives

Part 5 - Measurement Specifications
- Include for Each Selected Measure (for each organization)
  - Measure Name
  - Project-specific issue the Measure Maps to
  - Data Items
  - Attributes
  - Aggregation Structures
  - Collection Level
  - Criteria for Counting Actuals
  - Data Definitions
  - Estimation Methodology, Models, and Historical Data
  - Collection and Reporting Mechanisms
  - Source of Data
  - Collection and Reporting Periodicity
  - Applicable Phases and Activities

Part 6 - Project Aggregation Structures
- Component Aggregation Structure, such as CIs, Units
- Activity Aggregation Structure, Such as Requirements Analysis, Design, Implementation, and Integration and Test
- Functional Aggregation Structure

Part 7 - Initial Indicators
- Include for Each Proposed Indicator:
  - Indicator Name
  - Project-Specific Issue the Indicator Maps to
  - Measures Used to Construct the Indicator
  - Sample Display Format
  - Interpretation and Decisions Related to the Indicator

Part 8 - Reporting Mechanisms and Periodicity
- Reporting Mechanism and Periodicity
- Content of Reports

Figure 2-10. Sample Outline for Project Measurement Plan

[This page intentionally left blank.]

5

Measurement Tailoring Example

Chapters 1 through 4 describe how to apply the PSM tailoring activity to any project. This chapter provides an example of how the PSM process was used to select a set of useful measures for a specific project.

5.1 Project Scenario

During the planning phase of a large real-time weapons system upgrade, the acquirer learned that the updated system would have to be deployed earlier than originally planned. The planning efforts completed to date had already identified some significant constraints with respect to schedule, and this change increased the schedule risk even further. The project manager decided to implement a measurement process to help guide the project through these difficult challenges.

First, the key characteristics of the project were identified and documented:

- Large real-time weapons system
- Existing system baseline
- Additional weapon and new command hardware to be implemented
- Multiple suppliers working under a prime contractor responsible for system integration
- Approximately 1.5 million lines of source code
- Multiple software languages - Ada, C, and Assembly
- Average software process maturity across all organizations
- Inconsistent systems engineering process maturity across organizations
- Constrained funding

Due to the schedule risk and the large amount of functionality to implement in a short time, the acquirer required that the supplier use COTS software components. The supplier was instructed to reuse a considerable amount of legacy software, to adopt an open-systems architecture, and to follow commercial interface standards.

The project team decided that although there were issues at the system level related to hardware integration, command design, contingency planning, and operational concept rework, the largest effort would be to upgrade the software. Hence, the measurement effort would have two focuses: systems engineering and software.

5.2 *Identify and Prioritize Project Issues*

In order to begin the PSM measurement tailoring activity, a planning workshop was held to identify and prioritize project-specific issues and then to select appropriate measures. Acquirer, prime contractor, and subcontractor representatives attended the workshop. The success of the workshop depended on getting a broad representation of perspectives, while keeping the number of participants manageable.

The workshop included the following sessions:

- Brainstorming to identify project-specific issues
- Building consensus to establish priorities
- Categorizing the project-specific issues into common issue areas
- Reviewing processes to understand measurement opportunities

After the workshop, a subset of participants formed a team to develop and implement a measurement plan based on the workshop results.

During the workshop, the participants developed a list of issues based on risks identified through a formal risk management process, project objectives, assumptions, and constraints specified in the contract, and experience from previous projects. These issues were then consolidated into a set of prioritized project-specific issues with related sub-issues, outlined in Figure 2-11.

Issue / Sub-Issue	Priority
Will the scheduled milestones be met? • What is the lead time for the required COTS hardware and software components? • Are all components and sub-components available? • Will integration and test progress be adequate to meet the delivery date? • Will any hidden design flaws produce unexpected technical challenges? • Will the incremental software builds that are synchronized with the incremental hardware deliveries provide complete functional threads?	1
Will the software productivity rate be sufficient to meet plans? • Were the size estimates used for cost and schedule plans correct? • Will the planned COTS/reuse components meet allocated requirements or will additional new code be required?	2
Are there sufficient resources to complete the development? • Has the system architecture and design been optimized to provide the most cost effective solution?	3
Are requirement changes impacting the development? • Will the software work on the new hardware as it continues to evolve?	4
Will the project meet quality requirements, as measured by number of problem reports?	5

Figure 2-11. Issues and Priorities

The primary risk to the project was the short development schedule, coupled with software and hardware being developed concurrently. The project had originally been "sold" on its new war-fighting capabilities and the use of advanced technologies. Using advanced technologies increased the overall technical risk of the systems development, and delivering the system earlier than expected increased the concern.

5.3 *Select and Specify Project Measures*

The issues were mapped to the PSM common issue areas, as shown in Figure 2-12. The PSM measurement tables were reviewed to help determine the best measurement categories and associated measures. The team also considered the availability of measures from the supplier's process. Figure 2-12 lists the project measures selected.

Project - Specific Issue	PSM Common Issue	Categories	Measures
Schedule	Schedule and Progress	Milestone Performance	Milestone Dates
		Work Unit Progress	Component Status (Integration and Test) Requirement Status
		Incremental Capability	Incremental Content-Functionality
Productivity	Process Performance	Process Efficiency	Productivity
	Product Size and Stability	Physical Size and Stability	Lines of Code
	Technical Effectiveness	Impact	Technology Impact
Resources	Resources and Cost	Personnel	Effort
Requirements	Product Size and Stability	Functional Size and Stability	Requirements
Quality	Product Quality	Functional Correctness	Defects

Figure 2-12. Measure Mapping

For the purpose of this example, only the selection of the schedule and progress measures is discussed below. The categories of Milestone Performance, Work Unit Progress, and Incremental Capability were selected to address schedule. The Milestone Performance category was selected because it provided a high-level overview of schedule progress, and because Gantt charts were already being used to manage the project.

Work Unit Progress measures were selected to track integration activities (resulting from coordinating the acquisition of COTS hardware and the amount of necessary COTS software and integration "glue" code). The focus was on selecting requirements-oriented measures and measures that provided information on integration and test progress, rather than on design and implementation progress.

The incremental content measure was selected to ensure that each of the increments incorporated all of the planned functionality. The team needed to be aware of any functionality deferment early, so that schedule impacts could be minimized and productivity could be evaluated.

The previous paragraphs describe how the measures for Schedule and Progress were selected. A similar method was used to select the measures in all other categories.

5.4 Integrate Into the Technical and Management Processes

At the completion of the measurement selection task, the measurement team had defined the list of measures, data items, attributes, and aggregation structures. The next task was for the supplier to complete the detailed measurement specification for each selected measure. As an example, the detailed specification for the lines of code measure is provided in Figure 2-13.

All of the decisions made in this tailoring workshop were documented in the project's measurement plan, including:

- Project-specific issues and their details
- PSM common issue areas and measurement categories mapped to each project-specific issue
- Measures selected to address the issues and the associated selection rationale
- Measurement specifications for each selected measure
- Descriptions of the data sources
- Data delivery mechanisms

Measure	Lines of Code
Data Items	Number of Lines of Code (LOC) Number of LOC added Number of LOC modified Number of LOC deleted
Attributes	Data Type (plan, actual) Data Collection Date Data Reporting Date Organization Source (new, reused) Language (Ada, C, Assembly) Build
Aggregation Structure	Component
Definition	LOC will be counted as logical lines of code. No blank lines or comments will be included.
Collection Level	Unit
Count Actuals Based On	A unit is counted as complete when it passes code inspection. This means that code has been completed and turned over to configuration management, unit testing has been completed, the code inspection has occurred, and all outstanding action items from the inspection are complete.
Applied During	Estimates are calculated during requirements analysis and design. Actual data is available during implementation. Updated actuals are re-measured during integration and test if a unit is modified to integrate a fix.
Data Reporting Process	Unit-level data is available from the configuration management system. The government may access this system at any time for detailed analysis. The government is provided a CI-level report of this data once a month via an ASCII export on diskette.
Periodicity	Monthly

Figure 2-13. Specification for Lines of Code