Project Quality Management

8

Project Quality Management includes the processes required to ensure that the project will satisfy the needs for which it was undertaken. It includes "all activities of the overall management function that determine the quality policy, objectives, and responsibilities and implements them by means such as quality planning, quality control, quality assurance, and quality improvement, within the quality system" [1]. **Figure 8–1** provides an overview of the following major project quality management processes:

    8.1 **Quality Planning**—identifying which quality standards are relevant to the project and determining how to satisfy them.

    8.2 **Quality Assurance**—evaluating overall project performance on a regular basis to provide confidence that the project will satisfy the relevant quality standards.

    8.3 **Quality Control**—monitoring specific project results to determine if they comply with relevant quality standards and identifying ways to eliminate causes of unsatisfactory performance.

These processes interact with each other and with the processes in the other knowledge areas as well. Each process may involve effort from one or more individuals or groups of individuals based on the needs of the project. Each process generally occurs at least once in every project phase.
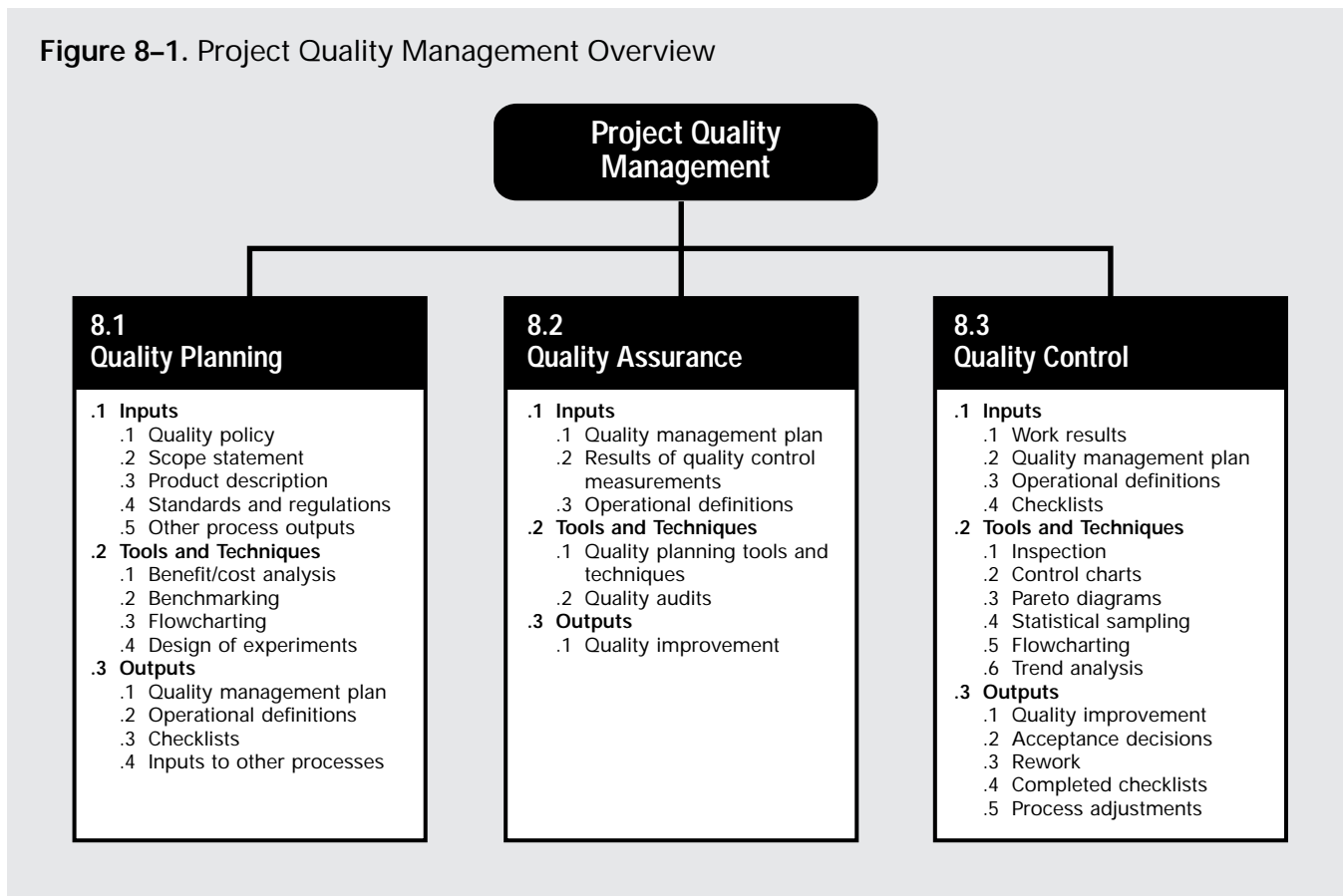
Although the processes are presented here as discrete elements with well-defined interfaces, in practice they may overlap and interact in ways not detailed here. Process interactions are discussed in detail in Chapter 3, Project Management Processes.

The basic approach to quality management described in this section is intended to be compatible with that of the International Organization for Standardization (ISO) as detailed in the ISO 9000 and 10000 series of standards and guidelines. This generalized approach should also be compatible with (a) proprietary approaches to quality management such as those recommended by Deming, Juran, Crosby, and others, and (b) non-proprietary approaches such as Total Quality Management (TQM), Continuous Improvement, and others.

Project quality management must address both the management of the project and the product of the project. Failure to meet quality requirements in either dimension can have serious negative consequences for any or all of the project stakeholders. For example:

- Meeting customer requirements by overworking the project team may produce negative consequences in the form of increased employee turnover.
- Meeting project schedule objectives by rushing planned quality inspections may produce negative consequences when errors go undetected.

FIGURE 8–1   A GUIDE TO THE PROJECT MANAGEMENT BODY OF KNOWLEDGE

Figure 8–1. Project Quality Management Overview

```
                        ┌─────────────────────┐
                        │   Project Quality   │
                        │     Management      │
                        └─────────────────────┘
```

**8.1
Quality Planning**

.1 **Inputs**
  .1 Quality policy
  .2 Scope statement
  .3 Product description
  .4 Standards and regulations
  .5 Other process outputs
.2 **Tools and Techniques**
  .1 Benefit/cost analysis
  .2 Benchmarking
  .3 Flowcharting
  .4 Design of experiments
.3 **Outputs**
  .1 Quality management plan
  .2 Operational definitions
  .3 Checklists
  .4 Inputs to other processes

**8.2
Quality Assurance**

.1 **Inputs**
  .1 Quality management plan
  .2 Results of quality control
    measurements
  .3 Operational definitions
.2 **Tools and Techniques**
  .1 Quality planning tools and
    techniques
  .2 Quality audits
.3 **Outputs**
  .1 Quality improvement

**8.3
Quality Control**

.1 **Inputs**
  .1 Work results
  .2 Quality management plan
  .3 Operational definitions
  .4 Checklists
.2 **Tools and Techniques**
  .1 Inspection
  .2 Control charts
  .3 Pareto diagrams
  .4 Statistical sampling
  .5 Flowcharting
  .6 Trend analysis
.3 **Outputs**
  .1 Quality improvement
  .2 Acceptance decisions
  .3 Rework
  .4 Completed checklists
  .5 Process adjustments

Quality is "the totality of characteristics of an entity that bear on its ability to satisfy stated or implied needs" [2]. A critical aspect of quality management in the project context is the necessity to turn implied needs into stated needs through project scope management, which is described in Chapter 5.

The project management team must be careful not to confuse *quality* with *grade.* Grade is "a category or rank given to entities having the same functional use but different requirements for quality" [3]. Low quality is always a problem; low grade may not be. For example, a software product may be of high quality (no obvious bugs, readable manual) and low grade (a limited number of features), or of low quality (many bugs, poorly organized user documentation) and high grade (numerous features). Determining and delivering the required levels of both quality and grade are the responsibilities of the project manager and the project management team.

The project management team should also be aware that modern quality management complements modern project management. For example, both disciplines recognize the importance of:

- Customer satisfaction—understanding, managing, and influencing needs so that customer expectations are met or exceeded. This requires a combination of *conformance to specifications* (the project must produce what it said it would produce) and *fitness for use* (the product or service produced must satisfy real needs).
- Prevention over inspection—the cost of avoiding mistakes is always much less than the cost of correcting them.

84

- Management responsibility—success requires the *participation* of all members of the team, but it remains the *responsibility* of management to provide the resources needed to succeed.
- Processes within phases—the repeated plan-do-check-act cycle described by Deming and others is highly similar to the combination of phases and processes discussed in Chapter 3, Project Management Processes.

In addition, quality improvement initiatives undertaken by the performing organization (e.g., TQM, Continuous Improvement, and others) can improve the quality of the project management as well as the quality of the project product.

However, there is an important difference that the project management team must be acutely aware of—the temporary nature of the project means that investments in product quality improvement, especially defect prevention and appraisal, must often be borne by the performing organization since the project may not last long enough to reap the rewards.

8.1 QUALITY PLANNING

Quality planning involves identifying which quality standards are relevant to the project and determining how to satisfy them. It is one of the key facilitating processes during project planning (see Section 3.3.2, Planning Processes) and should be performed regularly and in parallel with the other project planning processes. For example, the desired management quality may require cost or schedule adjustments, or the desired product quality may require a detailed risk analysis of an identified problem. Prior to development of the ISO 9000 Series, the activities described here as *quality planning* were widely discussed as part of *quality assurance*.

The quality planning techniques discussed here are those used most frequently on projects. There are many others that may be useful on certain projects or in some application areas.

The project team should also be aware of one of the fundamental tenets of modern quality management—quality is planned in, not inspected in.

Inputs	Tools & Techniques	Outputs
.1 Quality policy .2 Scope statement .3 Product description .4 Standards and regulations .5 Other process outputs	.1 Benefit/cost analysis .2 Benchmarking .3 Flowcharting .4 Design of experiments	.1 Quality management plan .2 Operational definitions .3 Checklists .4 Inputs to other processes
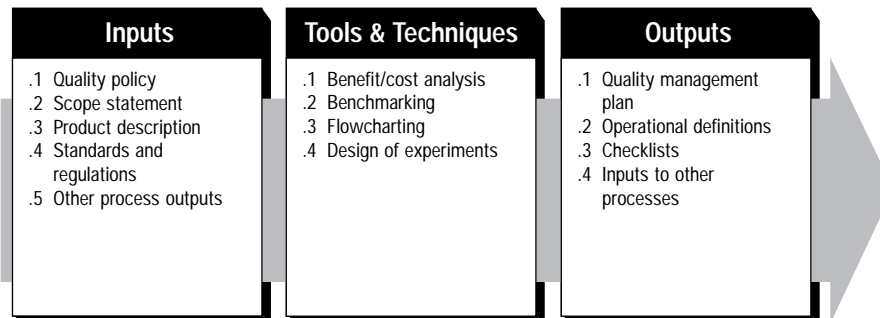
8.1.1 Inputs to Quality Planning

.1 Quality policy. Quality policy is "the overall intentions and direction of an organization with regard to quality, as formally expressed by top management" [4]. The quality policy of the performing organization can often be adopted "as is" for use by the project. However, if the performing organization lacks a formal quality policy, or if the project involves multiple performing organizations (as with a joint venture), the project management team will need to develop a quality policy for the project.

Regardless of the origin of the quality policy, the project management team is responsible for ensuring that the project stakeholders are fully aware of it (e.g., through appropriate information distribution, as described in Section 10.2).

FIGURE 8–2   A GUIDE TO THE PROJECT MANAGEMENT BODY OF KNOWLEDGE

**Figure 8–2.** Cause-and-Effect Diagram
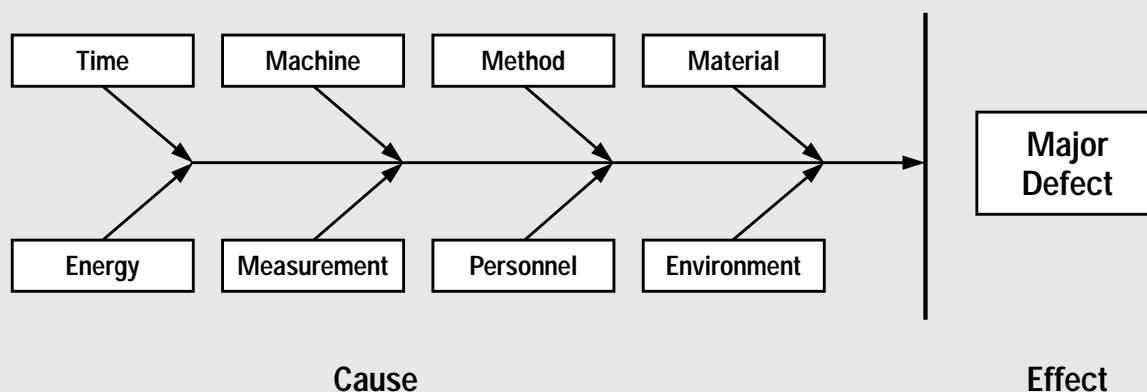
.2 ***Scope statement.*** The scope statement (described in Section 5.2.3.1) is a key input to quality planning since it documents major project deliverables as well as the project objectives which serve to define important stakeholder requirements.

.3 ***Product description.*** Although elements of the product description (described in Section 5.1.1.1) may be embodied in the scope statement, the product description will often contain details of technical issues and other concerns that may affect quality planning.

.4 ***Standards and regulations.*** The project management team must consider any application-area-specific standards or regulations that may affect the project. Section 2.5.1 discusses standards and regulations.

.5 ***Other process outputs.*** In addition to the scope statement and product description, processes in other knowledge areas may produce outputs that should be considered as part of quality planning. For example, procurement planning (described in Section 12.1) may identify contractor quality requirements that should be reflected in the overall quality management plan.

8.1.2 Tools and Techniques for Quality Planning

.1 ***Benefit/cost analysis.*** The quality planning process must consider benefit/cost trade-offs, as described in Section 5.2.2.2. The primary benefit of meeting quality requirements is less rework, which means higher productivity, lower costs, and increased stakeholder satisfaction. The primary cost of meeting quality requirements is the expense associated with project quality management activities. It is axiomatic of the quality management discipline that the benefits outweigh the costs.

.2 ***Benchmarking.*** Benchmarking involves comparing actual or planned project practices to those of other projects in order to generate ideas for improvement and to provide a standard by which to measure performance. The other projects may be within the performing organization or outside of it, and may be within the same application area or in another.

.3 ***Flowcharting.*** A flowchart is any diagram which shows how various elements of a system relate. Flowcharting techniques commonly used in quality management include:

   • *Cause-and-effect diagrams,* also called *Ishikawa diagrams* or *fishbone diagrams,* which illustrate how various causes and subcauses relate to create potential problems or effects. **Figure 8–2** is an example of a generic cause-and-effect diagram.

Figure 8–3. Sample Process Flowchart
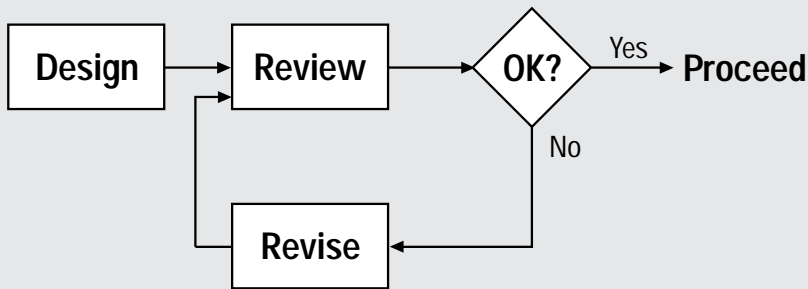
- *System* or *process flowcharts,* which show how various elements of a system interrelate. **Figure 8–3** is an example of a process flowchart for design reviews.

  Flowcharting can help the project team anticipate what and where quality problems might occur and thus can help to develop approaches to dealing with them.

  .4 Design of experiments. Design of experiments is an analytical technique which helps identify which variables have the most influence on the overall outcome. The technique is applied most frequently to product of the project issues (e.g., automotive designers might wish to determine which combination of suspension and tires will produce the most desirable ride characteristics at a reasonable cost).

  However, it can also be applied to project management issues such as cost and schedule trade-offs. For example, senior engineers will cost more than junior engineers, but can also be expected to complete the assigned work in less time. An appropriately designed "experiment" (in this case, computing project costs and durations for various combinations of senior and junior engineers) will often allow determination of an optimal solution from a relatively limited number of cases.

8.1.3 Outputs from Quality Planning

.1 Quality management plan. The quality management plan should describe how the project management team will implement its quality policy. In ISO 9000 terminology, it should describe the *project quality system*: "the organizational structure, responsibilities, procedures, processes, and resources needed to implement quality management" [5].

The quality management plan provides input to the overall project plan (described in Section 4.1, Project Plan Development) and must address quality control, quality assurance, and quality improvement for the project.

The quality management plan may be formal or informal, highly detailed, or broadly framed, based on the needs of the project.

.2 Operational definitions. An operational definition describes, in very specific terms, what something is, and how it is measured by the quality control process. For example, it is not enough to say that meeting the planned schedule dates is a measure of management quality; the project management team must also indicate whether every activity must start on time, or only finish on time; whether individual activities will be measured or only certain deliverables, and if so, which ones. Operational definitions are also called *metrics* in some application areas.
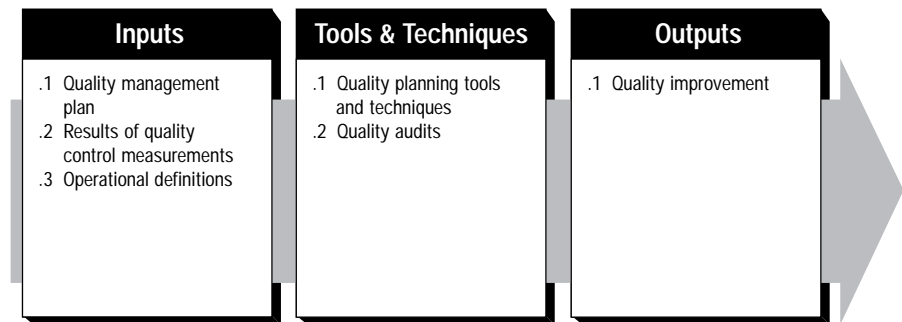
.3 ***Checklists.*** A checklist is a structured tool, usually industry- or activity-specific, used to verify that a set of required steps has been performed. Checklists may be simple or complex. They are usually phrased as imperatives ("Do this!") or interrogatories ("Have you done this?"). Many organizations have standardized checklists available to ensure consistency in frequently performed activities. In some application areas, checklists are also available from professional associations or commercial service providers.

.4 ***Inputs to other processes.*** The quality planning process may identify a need for further activity in another area.

8.2 QUALITY ASSURANCE

Quality assurance is all the planned and systematic activities implemented within the quality system to provide confidence that the project will satisfy the relevant quality standards [6]. It should be performed throughout the project. Prior to development of the ISO 9000 Series, the activities described under *quality planning* were widely included as part of quality assurance.

Quality assurance is often provided by a Quality Assurance Department or similarly titled organizational unit, but it does not have to be.

Assurance may be provided to the project management team and to the management of the performing organization (internal quality assurance) or it may be provided to the customer and others not actively involved in the work of the project (external quality assurance).

Inputs	Tools & Techniques	Outputs
.1 Quality management plan .2 Results of quality control measurements .3 Operational definitions	.1 Quality planning tools and techniques .2 Quality audits	.1 Quality improvement

8.2.1 Inputs to Quality Assurance

.1 ***Quality management plan.*** The quality management plan is described in Section 8.1.3.1.

.2 ***Results of quality control measurements.*** Quality control measurements are records of quality control testing and measurement in a format for comparison and analysis.

.3 ***Operational definitions.*** Operational definitions are described in Section 8.1.3.2.

8.2.2 Tools and Techniques for Quality Assurance

.1 ***Quality planning tools and techniques.*** The quality planning tools and techniques described in Section 8.1.2 can be used for quality assurance as well.

.2 ***Quality audits.*** A quality audit is a structured review of other quality management activities. The objective of a quality audit is to identify lessons learned that can improve performance of this project or of other projects within the performing organization. Quality audits may be scheduled or random, and they may be carried out by properly trained in-house auditors or by third parties such as quality system registration agencies.
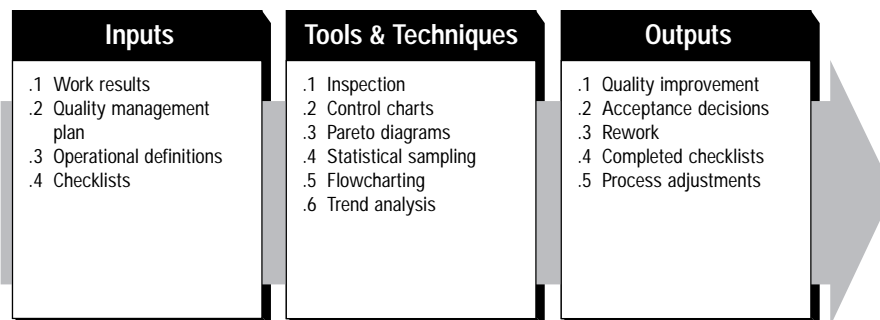
8.2.3 Outputs from Quality Assurance

.1 Quality improvement. Quality improvement includes taking action to increase the effectiveness and efficiency of the project to provide added benefits to the project stakeholders. In most cases, implementing quality improvements will require preparation of change requests or taking of corrective action and will be handled according to procedures for overall change control, as described in Section 4.3.

8.3 QUALITY CONTROL

Quality control involves monitoring specific project results to determine if they comply with relevant quality standards and identifying ways to eliminate causes of unsatisfactory results. It should be performed throughout the project. Project results include both *product* results such as deliverables and *management* results such as cost and schedule performance. Quality control is often performed by a Quality Control Department or similarly titled organizational unit, but it does not have to be.
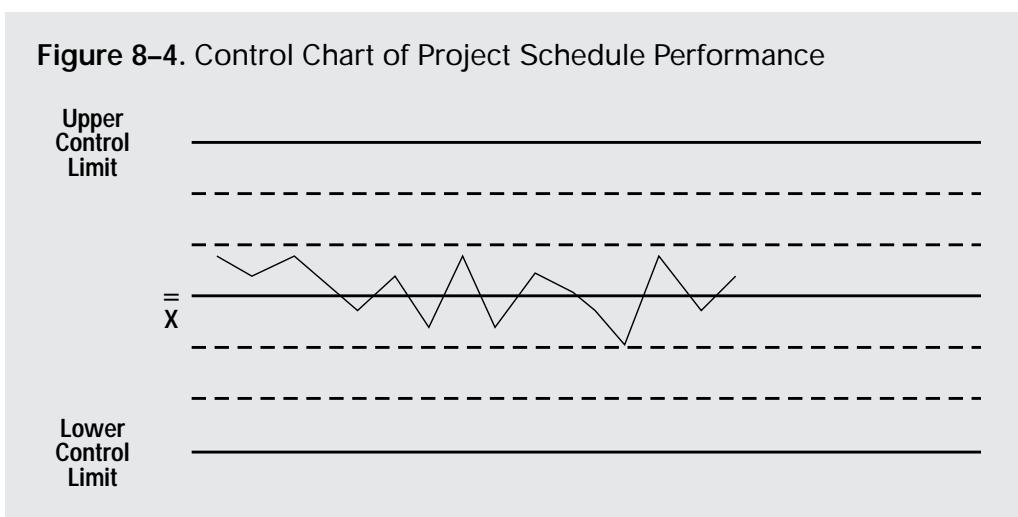
The project management team should have a working knowledge of statistical quality control, especially sampling and probability, to help them evaluate quality control outputs. Among other subjects, they should know the differences between:

- Prevention (keeping errors out of the process) and inspection (keeping errors out of the hands of the customer).
- Attribute sampling (the result conforms or it does not) and variables sampling (the result is rated on a continuous scale that measures the degree of conformity).
- Special causes (unusual events) and random causes (normal process variation).
- Tolerances (the result is acceptable if it falls within the range specified by the tolerance) and control limits (the process is in control if the result falls within the control limits).

| Inputs	Tools & Techniques	Outputs
.1 Work results .2 Quality management plan .3 Operational definitions .4 Checklists	.1 Inspection .2 Control charts .3 Pareto diagrams .4 Statistical sampling .5 Flowcharting .6 Trend analysis	.1 Quality improvement .2 Acceptance decisions .3 Rework .4 Completed checklists .5 Process adjustments

8.3.1 Inputs to Quality Control

.1 Work results. Work results (described in Section 4.2.3.1) include both *process* results and *product* results. Information about the planned or expected results (from the project plan) should be available along with information about the actual results.

.2 Quality management plan. The quality management plan is described in Section 8.1.3.1.

.3 Operational definitions. Operational definitions are described in Section 8.1.3.2.

.4 Checklists. Checklists are described in Section 8.1.3.3.

FIGURE 8–4   A GUIDE TO THE PROJECT MANAGEMENT BODY OF KNOWLEDGE

Figure 8–4. Control Chart of Project Schedule Performance

8.3.2 Tools and Techniques for Quality Control

.1 ***Inspection.*** Inspection includes activities such as measuring, examining, and testing undertaken to determine whether results conform to requirements. Inspections may be conducted at any level (e.g., the results of a single activity may be inspected or the final product of the project may be inspected). Inspections are variously called reviews, product reviews, audits, and walk-throughs; in some application areas, these terms have narrow and specific meanings.

.2 ***Control charts.*** Control charts are a graphic display of the results, over time, of a process. They are used to determine if the process is "in control" (e.g., are differences in the results created by random variations or are unusual events occurring whose causes must be identified and corrected?). When a process is in control, the process should not be adjusted. The process may be *changed* in order to provide improvements but it should not be adjusted when it is in control.

Control charts may be used to monitor any type of output variable. Although used most frequently to track repetitive activities such as manufactured lots, control charts can also be used to monitor cost and schedule variances, volume and frequency of scope changes, errors in project documents, or other management results to help determine if the "project management process" is in control. **Figure 8–4** is a control chart of project schedule performance.

.3 ***Pareto diagrams.*** A Pareto diagram is a histogram, ordered by frequency of occurrence, that shows how many results were generated by type or category of identified cause (see **Figure 8–5**). Rank ordering is used to guide corrective action—the project team should take action to fix the problems that are causing the greatest number of defects first. Pareto diagrams are conceptually related to Pareto's Law, which holds that a relatively small number of causes will typically produce a large majority of the problems or defects.

.4 ***Statistical sampling.*** Statistical sampling involves choosing part of a population of interest for inspection (e.g., selecting ten engineering drawings at random from a list of 75). Appropriate sampling can often reduce the cost of quality control. There is a substantial body of knowledge on statistical sampling; in some application areas, it is necessary for the project management team to be familiar with a variety of sampling techniques.

.5 ***Flowcharting.*** Flowcharting is described in Section 8.1.2.3. Flowcharting is used in quality control to help analyze how problems occur.

90

FIGURE 8–5

Figure 8–5. Pareto Diagram
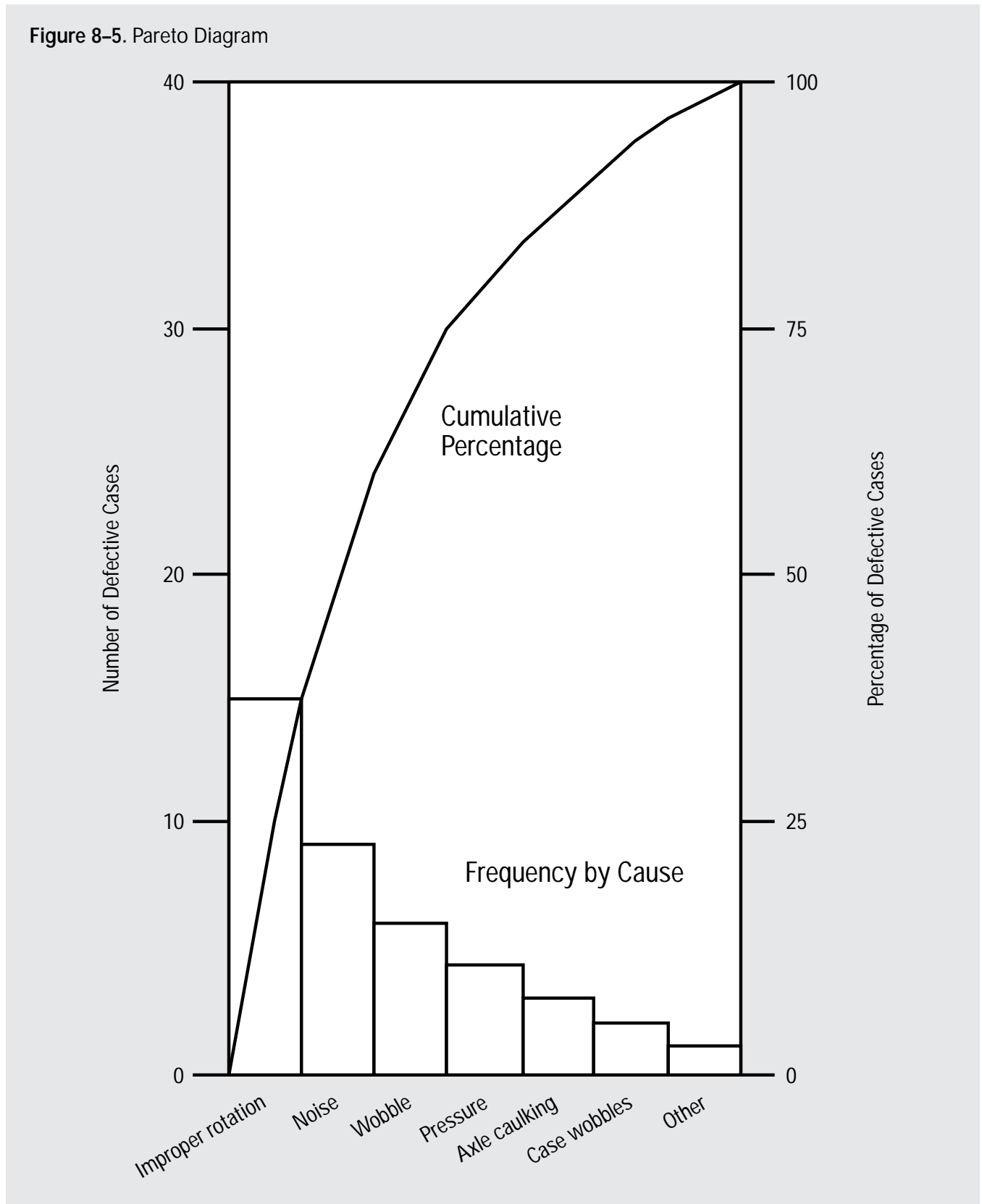
.6 ***Trend analysis.*** Trend analysis involves using mathematical techniques to forecast future outcomes based on historical results. Trend analysis is often used to monitor:

- Technical performance—how many errors or defects have been identified, how many remain uncorrected.
- Cost and schedule performance—how many activities per period were completed with significant variances.

8.3.3 Outputs from Quality Control

.1 ***Quality improvement.*** Quality improvement is described in Section 8.2.3.1.

.2 ***Acceptance decisions.*** The items inspected will be either accepted or rejected. Rejected items may require rework (described in Section 8.3.3.3).

.3 ***Rework.*** Rework is action taken to bring a defective or non-conforming item into compliance with requirements or specifications. Rework, especially unanticipated rework, is a frequent cause of project overruns in most application areas. The project team should make every reasonable effort to minimize rework.

.4 ***Completed checklists.*** See Section 8.1.3.3. When checklists are used, the completed checklists should become part of the project's records.

.5 ***Process adjustments.*** Process adjustments involve immediate corrective or preventive action as a result of quality control measurements. In some cases, the process adjustment may need to be handled according to procedures for overall change control, as described in Section 4.3.