CHAPTER

5

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ISO 9001:2000 and CMMI® Synergy

Chapters 3 and 4 presented several major frameworks for process improvement. The two most widely used frameworks are the CMM®-SW and ISO 9001:1994. As of this writing, more than 1,600 organizations and 9,000 projects have conducted and reported formal CMM® appraisals and more than 400,000 organizations are registered under ISO 9001:1994. Unfortunately, there are no data to show the number of organizations in both groups and the number of the ISO registered organizations with active process improvement programs. Nevertheless, since the publication of the revised standards in late 2000, significant interest has been seen in certification and registration under ISO 9001:2000 and in transition from the CMM® to the CMMI®. The ISO Web site shows that more than 43% of all the certificates they awarded in 2001 were certificates of conformity to ISO 9001:2000.

Any company interested in using both standards must ask if they are compatible. The answer is a resounding *yes*. However, it is less clear how an organization that has already invested in one or both of the legacy standards can transition to the revised standards. In this chapter we show how ISO 9001:2000 and the CMMI® are synergistic. Chapters 6 and 7 will show how this synergy can be used to develop a consistent process improvement strategy that will lead to ISO certification and achievement of targeted CMMI® maturity or capability levels.

A high-level comparison of those two standards is shown in Table 5.1 [1]. This comparison points to both similarities and

Table 5.1 High-Level Comparison of ISO 9001:2000 and CMMI® Features

ISO 9001:2000	*CMMI®*
Standard	Model
Broad direction	Detailed
One set of requirements to be satisfied	Progressive steps (levels)
No guidelines for implementation	Institutionalization and implementation guidance
Requires interpretation for an organization with many programs	Accommodates organizations with many programs

differences. Fortunately, the synergy between the frameworks can be exploited and the weaknesses of one can be supplemented by the strengths of the other.

ISO 9001 is an international standard, widely accepted around the world. Certification represents a ''badge'' of quality and is often a mandatory business requirement. On the other hand, the CMMI® is a model. Its predecessor model, the CMM® v1.1 for software, was and is widely used and has become a de facto software industry standard. It is expected that the CMMI® as its successor will be similarly widely accepted. As a model, the CMMI® intent is different from that of the ISO standard. While ISO 9001 is structured in clauses and uses *shall* statements, the CMMI® is not prescriptive and has no *shall* statements. Appraisals against ISO 9001 are primarily used to judge compliance with its clauses. The CMMI® is based on real-world experiences and the consensus of experienced professionals that will help an organization develop its products with fewer errors, within budget, and on time. CMMI®-based appraisals are primarily used to guide process improvement. ISO 9004:2000 provides guidance for continual process improvement based on ISO 9001:2000, but it is not used for certification or contractual purposes. Thus, the intent of ISO 9004:2000 is closer to that of the CMMI® than to its counterpart ISO 9001:2000.

ISO 9001:2000 can be applied to any organization regardless of its size or the field in which it operates. On the other hand, the CMMI® specifically focuses on organizations that develop products and systems containing software.

Looking at the size of these two documents, we realize that ISO is very sparse, totaling just a little more than 20 pages, whereas the CMMI® is published in two representations, each more than 700 pages long. ISO does not provide guidelines for interpretation and does not elaborate its statements. The CMMI® provides details needed for its understanding, provides typical work products expected from each practice, and many elaboration

statements that provide hints for its implementation. Nevertheless, many users will find both ISO and the CMMI® inadequate for guiding implementation, regardless of their relative size.

Another major difference between ISO and the CMMI® (also shared by their predecessor models) is in the approach used to achieve their goals. Whereas the CMMI® provides a road map for achieving process capability or maturity levels, ISO requires all of its requirements to be fulfilled before certification can be issued.

With its eight sections and 20-plus pages, ISO provides virtually no guidelines for its implementation. Although several notes are provided that elucidate the requirements, in general, the ISO standard simply sets forth requirements to be fulfilled. The requirements flow from the eight ISO 9000 management principles and thus provide a direct link to the best practices for achieving customer satisfaction and product quality. The CMMI® is structured to guide gradual process improvement, moving an organization from an initial, possibly chaotic state, to statistically controlled processes that will enable the development of high-quality products that are delivered on time and within budget. In addition, the CMMI® is based on the premise that if processes are institutionalized, they will endure even when the circumstances around it are not optimal.

The CMMI® builds process capability and maturity around projects that develop products. Initially, these projects may improve their own processes, while at the higher capability or maturity levels the whole organization benefits from process improvements. This concept is not visible in ISO 9001, which addresses the whole enterprise. Products may be developed by various projects within and outside this enterprise, but interactions among projects are not explicitly addressed.

The CMM® and the CMMI® stress the need for stable management processes before technical processes can be systematically addressed. ISO makes no such distinction—it requires both management and production processes to be implemented at the same time. ISO addresses purchasing of products and services from the outside the enterprise but does not address interactions within that enterprise.

So after contrasting the ISO 9001:2000 and CMMI® approaches and philosophies, one may ask—where is the synergy?

Both ISO and the CMMI® are based on principles of systems engineering and a process approach. Systems engineering is ''an interdisciplinary approach governing the total technical and managerial effort required to transform a set of customer needs, expectations, and constraints into a product solution and support that solution throughout the product's life'' [2]. A process has inputs and outputs, activities that consume resources, and has

requirements for measurement and analysis of its performance to guide its management and improvement. In other words, a process is a building block for the system. Whereas ISO requires this process approach at a very high level, the CMMI® decomposes those processes and shows how individual subprocesses can be managed to fulfill top-level requirements.

Figure 5.1 relates ISO sections to CMMI® PAs and generic practices. Viewed in this way, we can consider the CMMI® to be a framework within the ISO framework. In other words, ISO provides the *what to do* direction,

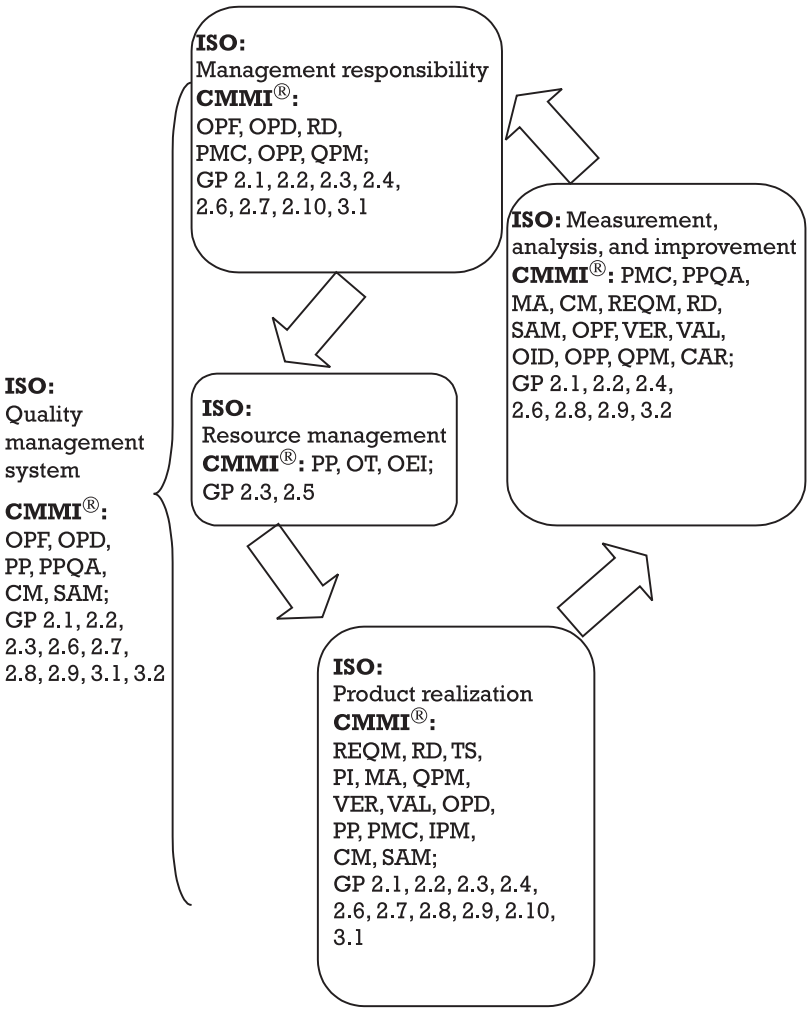

Figure 5.1 ISO–CMMI® relationships.

while the CMMI® elaborates these *what's* in more detail without mandating the *how's*.

To better understand the commonalties and synergy between these two standards, let us first discuss the terminology they use. Terms that are essentially equivalent in both standards (such as system or process) are not discussed. Table 5.2 lists selected ISO and the CMMI® terminology. Detailed definitions are given in [2, 3]. Further discussion of some terms is given below and later in this chapter when commonalties and differences between the two standards are addressed.

Quality management system (QMS), Quality Manual In the ISO standard, the QMS is described as a set of interrelated and interacting processes that include product and customer satisfaction requirements. In other words, the QMS has to satisfy an organization's quality policy and quality objectives. In this case, the organization is the whole enterprise or a major part of the enterprise. In the CMMI®, the organization is ''an administrative structure in which people collectively manage one or more projects as a whole, and whose projects share a senior manager and operate under the same policies'' [2]. Furthermore, the CMMI® defines an enterprise as ''the larger entity not always reached by the word 'organization''' [2]. If we now want to apply the ISO 9001:2000 standard to such an organization, as a subset of an enterprise, we have two options: (1) Apply ISO to the whole enterprise and treat this particular organization as a part of the enterprise, or (2) apply ISO to the organization itself. In most practical instances, case (1) is an extension of case (2). An organization that develops a product containing software may be part of a larger enterprise developing other products that may or may not include software. Such an organization will:

- Depend on the whole enterprise;
- Share management responsibility with other parts of the enterprise;
- Use the resource management capability of the whole enterprise;
- Follow a common quality policy.

At the same time, the organization may have, for example, its own quality objectives, product realization processes, and measurement and analysis processes. In this book, we describe case (2), in which each organization is assumed to have its own QMS, as shown in Figure 5.2. This will enable us to better explain the synergy between ISO and the CMMI® without the loss of generality.

Table 5.2 High-Level Comparison of ISO 9001:2000 and CMMI® Terminology

ISO 9000:2000	*CMMI®*	*Comment*
Top management	Higher level management; senior management	Similar; pertains to a management role in the organization.
Quality management system, quality manual	Organization's set of standard processes	The QMS is the set of processes an organization follows to reach its objectives. The QMS is documented in a quality manual. An organization's set of standard processes contains definitions that guide all activities in an organization.
Quality plan	Project plan, software development plan, system engineering management plan, data management plan	ISO terminology is much broader and less specific than CMMI® terminology. The project plan can be construed to contain the project's defined process, based on tailoring of the organization's standard process.
Customer, interested party	Customer, stakeholder	The CMMI® term *stakeholder* is much broader and less specific than ISO terminology.
Documented procedure	Plan for performing the process	Planning the process produces the process description, which includes or references relevant standards and procedures.
Record	Work product, record, evidence	Similar meanings; captures results of activities and supports compliance verification.
Quality management	Quality management	ISO uses the term in a very broad sense. CMMI® usage focuses on quantitative management.

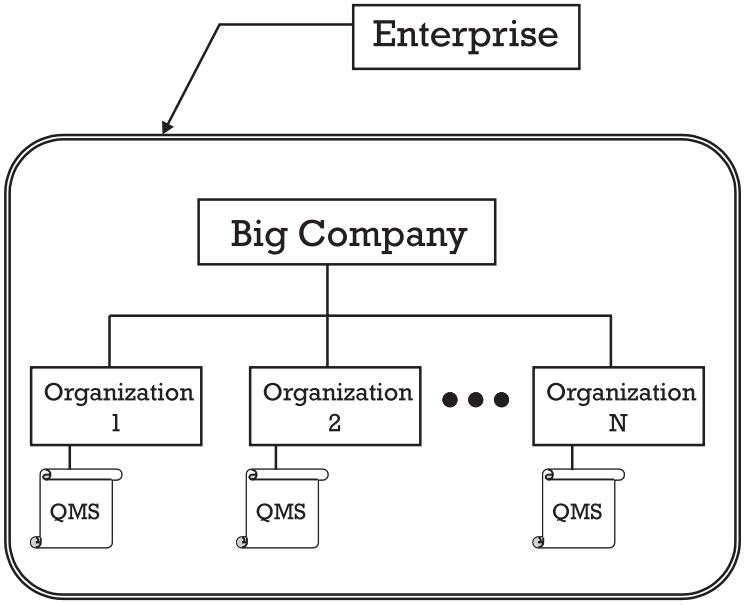

Figure 5.2 Each organization has a QMS.

The quality manual, described in Chapter 4, documents (1) the scope of the QMS, (2) procedures for the QMS, and (3) descriptions of processes and their interactions. In CMMI® terms, the ISO quality manual is thus roughly equivalent to the organization's set of standard processes—a collection of documents that describe organizational policies, processes and process elements, description of approved life-cycle models, tailoring guidelines, standards, and procedures.

Quality Plan The ISO standard requires a quality plan that also includes plans for product realization. The product realization plan addresses these topics:

- Quality objectives;
- Product requirements;
- Processes needed to develop the product;
- Documentation and resources needed;
- Verification;
- Validation;

- Monitoring;
- Inspection and test activities performed;
- Collection of associated records.

All of this is aimed at ensuring that the product satisfies customer requirements. Additional information is provided in ISO 10005, *Quality management—Guidelines for quality plans* [4]. ISO 9001, however, is mute on the concept of tailoring the QMS (the organization's standard process) to develop this plan.

The CMMI® adds this powerful idea: An organization has a standard process (QMS) that is systematically tailored to produce a project's defined process (quality plan). From the CMMI® point of view, the ISO quality plan reflects the project's defined process and includes the project plan, systems engineering management plan, software development plan, and system master schedule. For organizations at higher capability or maturity levels, this means that an ''integrated plan'' has to be developed (as defined in the IPM PA). An integrated plan:

- Incorporates project needs, objectives, and requirements;
- Addresses customers and users;
- Integrates other plans that affect the project, such as QA and CM plans;
- Defines the risk management strategy;
- Incorporates the project's defined process.

Quality management ISO defines quality management as ''coordinated activities to direct and control an organization with regard to quality'' [3]. These are the activities for setting up quality policies and quality objectives, establishing a quality plan, quality assurance and quality control, and implementing quality improvements. The CMMI® uses *quality management* terminology much more narrowly, primarily as part of quantitative management activities.

The ISO sense of quality management—based on the principles espoused in ISO 9000, especially process approach, systems approach, and continual improvement—are found throughout the CMMI®.

5.1 Commonalities

Quite frequently, when an organization attempts to implement more than one standard, it relies on correspondence tables or mappings. Some mappings are published and some are homegrown. Some tables even appear as appendices to the formal standards. For example, Annex B of ISO 9001:2000 shows the correspondence between ISO 9001:1994 and ISO 9001:2000 clauses. Some organizations have developed databases that contain comparisons of multiple models and standards. Figure 5.3 shows some mappings that can be established between pairs of standards and models.

Although the cross-references help to quickly visualize commonalties and differences between a pair of standards, they fall short of illuminating the underlying principles of those standards. Moreover, all such mappings are subject to the interpretations of their creators and cannot be viewed in absolute terms. To successfully implement multiple standards, a process engineer has to be familiar with each standard and understand their underlying principles. We too provide several mappings in this book. They are

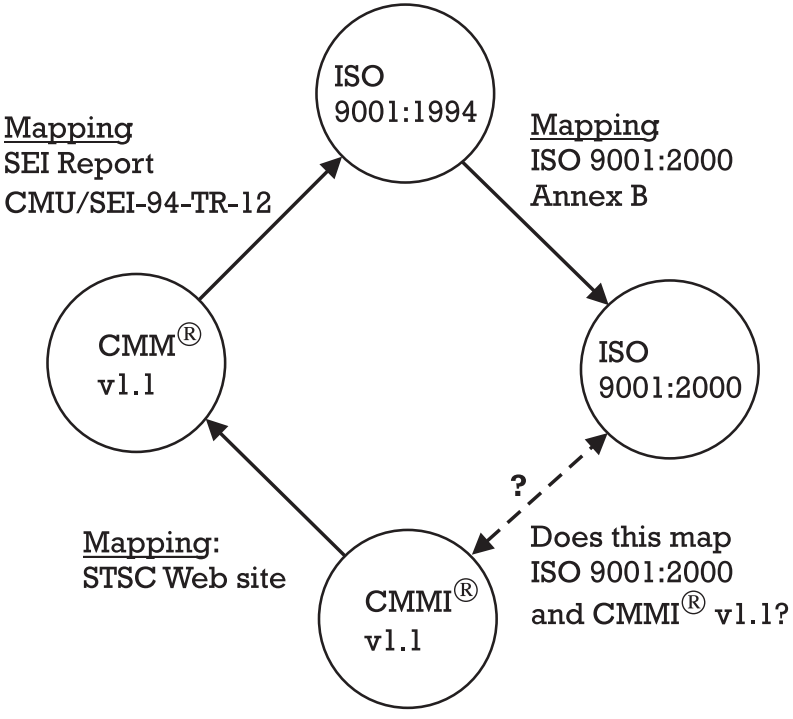

Figure 5.3 Standards mapping.

included only for convenience in comparing frameworks and not as a tool for implementation. In this book, we strive to capture the essence of ISO 9001:2000 and the CMMI® and explain and interpret their similarities and differences.

Because ISO 9001:2000 is based on the eight ISO 9000:2000 quality management principles described in Chapter 4, let us explore the similarities between those principles and the CMMI®. One would expect many of the quality management principles to correspond to CMMI® generic practices since the generic practices provide a foundation for process institutionalization. The comparison is given next. (The CMMI® differs from the ISO approach to principles 1 and 8, but all principles are listed here for completeness.)

1. *Customer focus.* In the CMMI®, customer focus is addressed through generic practice GP 2.7, *Identify and Involve Relevant Stakeholders,* and specific practice SP 2.6, *Plan Stakeholder Involvement,* in the Project Planning PA. As we will discuss later, customer focus is also addressed in the Requirements Development and Technical Solution PAs. This principle is much more strongly represented in ISO than in the CMMI®.

2. *Leadership.* Leadership is covered in several generic practices: GP 2.1, *Establish an Organizational Policy,* GP 2.4, *Assign Responsibility,* and GP 2.10, *Review Status with Higher Level Management.* In addition, the OPF PA supports aspects of leadership.

3. *Involvement of people.* The involvement of people is addressed in the CMMI® through implementation of generic practices GP 2.3, *Provide Resources,* GP 2.5, *Train People,* and GP 2.7, *Identify and Involve Relevant Stakeholders.*

4. *Process approach.* The process approach is amply supported by generic practices GP 2.2, *Plan the Process,* and GP 3.1, *Establish a Defined Process.* It is also explicitly supported by the OPD and IPM PAs and implicitly supported by all other PAs.

5. *System approach.* The system approach is addressed explicitly with GP 3.1, as well as by all the PAs.

6. *Continual improvement.* Continual improvement is the focus of the CMMI®. Simply stated, the whole CMMI®, with its capability or maturity levels, provides a foundation for continual improvement.

7. *Factual approach to decision making.* The CMMI® supports this principle through generic practice GP 2.8, *Monitor and Control the Process,* and through several PAs. Specifically, strong support is provided through the PMC, MA, IPM, and DAR PAs.

8. *Mutually beneficial supplier relationships.* The CMMI® addresses suppliers, especially in the SAM PA, from the control point of view rather than from the collaboration point of view.

5.2 Differences

As indicated in the previous section, many similarities exist between ISO 9001 and the CMMI®, but there are also several major differences. We often refer to the CMMI® as a standard, but it is only a de facto standard. It is a widely accepted model for applying systems and software engineering principles to product development that can be also used to measure process improvement progress. ISO 9001:2000 is intended for broad implementation in variety of industries and uses, whereas the CMMI® is specifically intended to apply to systems engineering, software engineering, and, more recently, to software acquisition.

A major difference between these two standards is in their language. Whereas ISO is clearly prescriptive, the CMMI® does not list its requirements using *shall* statements. For example, ISO specifies its requirement for the QMS as ''The organization shall a) identify the processes needed for the QMS . . . ,'' whereas the corresponding CMMI® OPD specific practice SP 1.1 states: ''Establish and maintain the organization's set of standard processes'' and goes on to list nine subpractices describing the details needed to successfully implement this practice.

Another major difference is found in the compactness of the ISO language, which uses phrases such as ''establish and maintain'' or ''determine and provide.'' For example, in the ISO standard, ''The organization shall determine and provide . . .'' addresses two distinct actions: first determining resource requirements, and then providing those resources. In the CMMI®, this ISO requirement maps to project planning (''determine'') and then to GP 2.3 in all PAs to ensure that the resources are available (''provide'').

Because of their differing targets and intent, the amount of detail they exhibit is also vastly different. As a model, the CMMI® covers details necessary for developing complex systems. On the other hand, ISO simply outlines a set of requirements necessary for developing high-quality products and satisfying customer requirements. The details of satisfying these requirements

are left to the user, but to achieve ISO registration, *all* of its requirements have to be satisfied. ISO 9004:2000 provides very high-level guidelines for implementing process improvement, but no details are given on how to approach this task, where to start, and how to sustain improvements when the process improvement goals are finally reached. In contrast, the CMMI® has five levels of process maturity and six levels of process capability that guide an organization in progressively attaining its goals. The CMMI® generic and specific practices provide an orderly progression, enabling specific activities to become established in changing organizations. ISO 9001:2000 does not provide guidelines for implementing its requirements in small organizations or in very large multiproject organizations, or for that matter for products that contain software. The CMMI®, on the other hand, distinguishes between localized process improvement and organization-wide process improvement.

5.3 Strengths

Each standard has strengths that may help to offset the other standard's weaknesses. Some important ISO 9001:2000 strengths are as follows:

- Broad applicability;
- Affects most functional areas of an organization;
- International recognition and appeal;
- Freedom of implementation.

An obvious strength of the ISO 9001:2000 standard is its broad applicability. It can be applied to any industry or environment and still provide sensible requirements for implementing a QMS. ISO 9001:2000 affects most organizational entities, such as management, human resources, production, engineering, and quality. Interaction among these entities is needed to ensure that customer requirements are satisfactorily implemented. ISO standards have an international appeal as a mark of excellence awarded to companies that are ISO registered.

Because the standard is so sparsely worded, organizations have considerable freedom in interpreting the requirements. Documentation types and levels of detail can largely be addressed as the organization sees fit.

Selected CMMI® strengths include (1) inclusion of institutionalization practices, (2) a ''road map'' for improvement through maturity and capability levels, and (3) recognition of organizational versus project-defined processes. If one were to select a single major contribution that the CMM® and CMMI®

have brought to the field of process improvement, it would be the notion of *institutionalization.* Institutionalization is defined in the CMM® and CMMI® as:

> The building and reinforcement and corporate culture that support methods, practices, and procedures, so that they are the ongoing way of doing business, even after those who originally defined them are gone.

As previously noted, institutionalization in the CMMI® is further strengthened through the institutionalization goal in every PA. It indicates a set of prerequisites needed for implementing specific practices and ensuring that those practices are implemented.

Process improvement plans often specify a targeted maturity or capability level. The CMMI®, with its maturity levels and the notion that maturity levels cannot be skipped, outlines a strategy for attaining that goal. It becomes clear that an organization must first stabilize its management activities before introducing advanced technology into processes. The CMMI® continuous representation allows greater freedom of process improvement implementation than the staged representation. However, although one can select a PA to improve, it may be more advantageous to first establish the enabling PAs and then capitalize on them to implement the selected PA. The concept of ''enabling PAs'' further enhances the notion of systematic process improvement: Start with those PAs, institutionalize them, and then build the enduring process improvement infrastructure. In general, the CMMI® provides sufficient guidelines for systematically implementing process improvement. We will address this in the next chapter.

As an organization climbs the process improvement ladder, it will usually include an increasing number of projects under the process improvement umbrella. Projects benefit from the experiences and lessons learned by others by collecting those lessons learned in an organizational process asset library and database. They all benefit by tailoring the family of standard processes for their own purposes. Participating projects are obligated to provide their own experience to this library and database. This transition from ''individual learning'' to ''local learning'' to ''organizational learning'' [5] is one of the great concepts in process improvement, but unfortunately it is not articulated in the ISO standards.

5.4 Weaknesses

Although both standards have many strengths, they also exhibit a few weaknesses. ISO 9001:2000 is very general, provides no interpretation for how

to apply it to entities smaller than the enterprise, and provides no guidelines for implementation in various industries.

The CMMI® may be too detailed for some organizations, may be considered prescriptive, requires major investment to be fully implemented, and may be difficult to understand. Where the CMMI® is too detailed, requiring large expenditures for its full implementation, ISO is too general, requiring guidelines for its specific implementation. Lack of specific guidelines when implementing the ISO standard causes some organizations to spend a lot of time developing and implementing their QMS. The use of the QMS is often not sustained after registration is achieved or between reregistrations. This weakness contrasts with the CMMI® institutionalization focus, which enables organizations to sustain process improvement achievements. Similarly, whereas the ISO standard lacks details, the CMMI® may be too detailed.

Because of the ISO standard's wide applicability, there are few guidelines for its implementation in some specific industries or fields. In addition, there are no guidelines for implementing it in a division or at a site of an enterprise. For ISO 9001:1994, another standard, ISO 9000-3, was published as an informative guide to interpret ISO 9001 for software. Subsequently, an assessment tool (TickIT) was developed to facilitate benchmarking an organization's software processes with respect to ISO 9001:1994.

ISO 9004:2000 is dedicated to process improvement. It follows the structure of ISO 9001 and provides some explanation of what is expected, but it falls short of delivering a road map for implementing process improvement.[1] When reading ISO 9004, one does not know which areas to address first and which to address next. This is where the CMMI® is helpful.

5.5 Synergy

Based on the preceding discussion, one can see where ISO and the CMMI® complement each other and how the strengths of one can remedy weaknesses of the other. ISO 9001:2000 and the CMMI® are both based on the process approach and systems thinking. This facilitates their comparison and is a major contribution to their synergy. We now take a closer look at their synergy and show how they work together to provide guidance for process improvement.

It is important to emphasize that this chapter simply points out the synergy between ISO and the CMMI®. Later chapters address the practical

1. As of this writing, ISO 9000-3:2000 is being balloted and has not been released.

implementation of this synergy. In this section, we discuss, at a high level, how the CMMI® satisfies specific ISO requirements. For more details on the generic and specific CMMI® practices, refer to Chapter 4.

5.5.1 Institutionalization

Because one of the most important features of the CMMI® is the concept of institutionalization, we start our discussion of the synergy between the two standards by comparing the CMMI® generic practices with the clauses of ISO 9001:2000.

Let us first consider ISO 9001:2000 Section 4, *Quality Management System.* Section 4 requires an organization to establish, document, maintain, and improve a set of interrelated processes that will enable it to develop a quality product and satisfy customer requirements. The CMMI® will help such an organization by providing the necessary guidelines for establishing a QMS.

What does this mean in terms of CMMI®? As discussed in Chapter 4, GPs, by their nature, apply to all PAs and specifically enable institutionalization. Therefore, it is appropriate to compare the CMMI® generic practices to ISO Sections 4.0, *Quality Management System,* and 4.1, *General Requirements,* as shown in Table 5.3. CMMI® GPs support this clause in establishing, documenting, implementing, maintaining, and continually improving a QMS. GP 2.1, *Establish an Organizational Policy,* requires an organization's management to define expectations for the relevant processes and make those expectations visible. Specifically, GP 2.1 of the OPD PA requires organizations to define expectations for establishing and maintaining the *organization's set of standard processes* (OSSPs) and making them available across the organization. As

Table 5.3 Comparison of ISO Part 4 and CMMI® Generic Practices

ISO 9001:2000		*CMMI®* Generic Practices
4.1	General requirements	GP 2.1 Establish an Organizational Policy GP 2.2 Plan the Process GP 2.3 Provide Resources GP 2.6 Manage Configurations GP 2.7 Identify and Involve Relevant Stakeholders GP 2.8 Monitor and Control the Process GP 2.9 Objectively Evaluate Adherence GP 3.1 Establish a Defined Process GP 3.2 Collect Improvement Information
4.2	Documentation requirements	GP 2.1 Establish an Organizational Policy GP 2.2 Plan the Process GP 2.6 Manage Configurations

discussed earlier, an OSSP may be considered equivalent to a QMS. By implementing GP 2.1 across all PAs, an organization will be on its way to satisfying the requirements for a QMS.

CMMI® GP 2.6 supports the ISO requirements for the control of documents (ISO clause 4.2.3) and control of records (ISO clause 4.2.4). Note that the CMMI® Level 3 generic practices, GP 3.1, *Establish a Defined Process,* and GP 3.2, *Collect Improvement Information,* are not initially required by the CMMI®. Process improvement can be started without them and they can be introduced after an organization has already attained some process improvement capability. However, awareness of these practices certainly helps while establishing the OSSP. In addition, these GPs are required for satisfying the ISO requirements. In the next chapter, we will see how one can capitalize on their early implementation.

The only GPs not mapped to ISO Section 4 are GP 2.4, *Assign Responsibility,* GP 2.5, *Train People,* and GP 2.10, *Review Status with Higher Level Management.* These three practices are not explicitly addressed in Section 4 but are expected by other ISO sections.

Let us now compare ISO Sections 5 through 8 to the CMMI® generic practices. Table 5.4 summarizes this comparison and shows a very strong relationship between the generic practices and the ISO sections. This is particularly significant because it indicates that the generic practices can be used to establish, improve, and institutionalize the QMS.

ISO 9001:2000 primarily addresses issues that concern the whole organization in Sections 5 and 6 and it addresses product issues in Sections 7 and 8. The CMMI® distinguishes between the organizational and project process aspects and carefully builds organizational processes on the strengths of the project processes. ISO does not address the relationship between the OSSP and project process at all. Therefore when interpreting the CMMI® we have to be careful when applying GPs and SPs from organizational and project PAs.

It is interesting to note that all CMMI® generic practices are mapped to one or more ISO clauses. The message of this comparison is that institutionalizing the processes required by the CMMI® leads to a stable and strong process infrastructure that will also satisfy the ISO requirements.

5.5.2 Process areas and specific practices

We now compare ISO requirements to CMMI® PAs and specific practices. For that purpose, we use ISO sections and discuss how the CMMI® can be used to implement this section.

Table 5.4 Comparison of ISO Sections 5–8 and CMMI® Generic Practices

ISO 9001:2000		*CMMI® Generic Practices*
5.0	Management responsibility	GP 2.1 Establish an Organizational Policy GP 2.2 Plan the Process GP 2.3 Provide Resources GP 2.4 Assign Responsibility GP 2.6 Manage Configurations GP 2.7 Identify and Involve Relevant Stakeholders GP 2.10 Review Status with Higher Level Management GP 3.1 Establish a Defined Process
6.0	Resource management	GP 2.3 Provide Resources GP 2.5 Train People
7.0	Product realization	GP 2.1 Establish an Organizational Policy GP 2.2 Plan the Process GP 2.3 Provide Resources GP 2.4 Assign Responsibility GP 2.6 Manage Configuration GP 2.7 Identify and Involve Relevant Stakeholders GP 2.8 Monitor and Control the Process GP 2.9 Objectively Evaluate Adherence GP 2.10 Review Status with Higher Level Management GP 3.1 Establish a Defined Process
8.0	Measurement, analysis, and improvement	GP 2.1 Establish an Organizational Policy GP 2.2 Plan the Process GP 2.4 Assign Responsibility GP 2.6 Manage Configuration GP 2.8 Monitor and Control the Process GP 2.9 Objectively Evaluate Adherence GP 3.2 Collect Improvement Information

5.5.2.1 QMS

As described in Chapter 4, ISO Section 4, *Quality Management System,* contains the basic requirements for establishing, documenting, implementing, maintaining, and improving the QMS. Most other ISO sections refer to this section. Therefore, it is important to understand this section in depth when comparing it to the CMMI®.

What does this mean in terms of CMMI®? Most ISO Section 4 requirements are satisfied by the OPD PA. The OPD PA goes further than ISO: It requires organizations to define a set of life-cycle models to be used by projects when they tailor the OSSP. It also requires an organizational measurement repository and a process asset library, which is different from the ISO requirement for controlling records (ISO 4.2.4). Although OPD is a

maturity level 3 PA (in the staged representation), implementation of its specific practices will enable an organization at any level to implement maturity level 2 PAs more effectively.

The previous chapter discussed CMMI® generic practices and their contribution to implementing processes that will satisfy ISO requirements. Implementing GP 2.2, *Plan the Process,* for each PA seems to lead to an organizational set of processes. Although such processes may satisfy ISO requirements, they would not meet all of the CMMI® requirements for defining an organization's standard processes. Process elements comprised in the OSSP must include definitions of process element relationships, such as ordering, dependencies, and interfaces.

ISO requires processes to be managed in accordance with the QMS requirements. This is equivalent to CMMI® GP 2.1, which requires an organization to establish, publish, and maintain organizational policies and set the associated expectations for those policies.

In ISO 9001, several requirements that deal with outsourcing are introduced in Section 4 and expanded in Section 7. Outsourcing includes, for example, purchasing of services, labor, or computer maintenance, and control of the suppliers. By implementing SAM generic practices GP 2.2, 2.7, 2.8, and 2.9, and specific practices SP 1.3, *Establish Supplier Agreements,* and SP 2.2, *Execute the Supplier Agreement,* these ISO requirements will be satisfied.

Implementation of GP 2.6, *Manage Configurations,* for each relevant PA (supported by the CM PA) satisfies the document control requirements of Section 4.2.3. Here, *relevant* means those PAs that are relevant to ISO 9001 implementation.

ISO 9001, Section 4.2.4, requires the control of records. This control is implemented by establishing a *documented procedure* to address identification, storage, protection, retrieval, retention time, and disposition of records. This is one of only six required procedures in the whole ISO standard. Implementing project planning SP 2.3, *Plan for Data Management,* will ensure that all required documents, including records, are identified and controlled. This practice is much broader than that required by ISO.

5.5.2.2 Management responsibility

Implementation of the QMS is a management responsibility. It is not, however, sufficient for management to merely express its commitment to quality. Management must provide ongoing evidence that it is committed to the QMS and its continual improvement. It is interesting to note that all clauses in this section commence with the phrase ''Top management shall . . .'' [6], thus emphasizing management responsibility. The customer focus theme

runs through this section, requiring an organization to not only satisfy requirements but also to enhance customer satisfaction. Furthermore, it requires the following to happen:

- A quality policy must be established.
- Quality objectives must be established in relevant functions and at various levels.
- A QMS must be planned and maintained.
- Responsibilities and authorities must be identified.
- The QMS must be reviewed and improved to ensure its effectiveness.

What does this mean in terms of CMMI®? The CMMI® establishes a framework equivalent to the ISO requirements for management responsibility, commitment, and review through GP 2.1, *Establish Organizational Policy*; GP 2.3, *Provide Resources*; GP 2.4, *Assign Responsibility*; and GP 2.10, *Review Status with Higher Level Management.* However, the CMMI® does not explicitly require senior management to establish a quality policy and objectives and tie them together into an encompassing whole—this is left to the ''organization.'' In the CMMI®, senior management is responsible for defining organizational expectations, guiding principles, and direction and for reviewing the processes. Specifically, if an organization implements OPD GP 2.1, *Establish Policy,* it will satisfy the ISO requirements for management commitment.

Quality objectives are addressed in the OPP PA in SP 1.3, *Establish Quality and Process-Performance Objectives,* and GP 4.1, *Establish Quantitative Objectives for the Process.* OPP is a level 4 PA in the staged representation and is one of the advanced process management PAs. GP 4.1 is a capability level 4 generic practice. This indicates that from the CMMI® point of view, these important concepts can be deferred until an organization attempts to achieve level 4 maturity or implement level 4 capability in selected PAs. This may not satisfy the ISO requirements. In other words, every organization must address this ISO requirement regardless of CMMI® maturity level.

There is no explicit CMMI® requirement to name a management representative responsible for ensuring that the QMS is established, implemented, maintained, and improved (ISO clause 5.5.2). The closest match to this clause is GP 2.4, *Assign Responsibility,* in the OPF PA, which addresses process improvement products and services. The typical implementation of this practice establishes a management council and an engineering process group to provide guidance for improvements, which may include quality goals and objectives. A typical management council reviews and approves the OSSP, which is by our definition equivalent to the QMS.

Customer focus is achieved in the CMMI® by implementing GP 2.7, *Identify and Involve Relevant Stakeholders,* in every PA. Customer focus is also provided by the RD PA:

- SP 1.1-1, *Collect Stakeholder Needs*[2];
- SP 1.1-2, *Elicit Needs*;
- SP 1.2-1, *Develop the Customer Requirements*;
- SP 2.1-1, *Establish Product and Product-Component Requirements*;
- SP 3.3, *Analyze Requirements*;
- SP 3.4, *Analyze Requirements to Achieve Balance*;
- SP 3.5, *Validate Requirements with Comprehensive Methods*.

In the CMMI®, stakeholders include both internal and external customers and end users.

As far as process improvements are concerned, the CMMI® OPF PA (particularly SP 1.2, *Appraise the Organization's Processes,* and SP 1.3, *Identify the Organization's Process Improvement*) corresponds to ISO clause 5.6.1.

As indicated earlier, an organization should establish measurable quality objectives regardless of the CMMI® requirements. Further, the management council must be visible and its chair must have responsibility for the OSSP. Ensuring that the OSSP is implemented, maintained, improved, and communicated will satisfy not only the letter of the ISO requirements but also the spirit.

Although GP 2.10 requires senior management to periodically review processes, the CMMI® does not specifically list review inputs and outputs as ISO does in Section 5.6. PMC specific practices SP 1.6, *Conduct Progress Reviews,* and SP 1.7, *Conduct Milestone Reviews,* as well as SG 2, *Manage Corrective Actions to Closure,* can be used as guidelines. Engineering process groups generally provide senior management with expected review inputs and outputs. For example, typical review topics associated with the state of process improvement include these:

- Results of appraisals;
- Actions required for process improvement;

2. Recall that a number after a dash in the SP title in the continuous representation denotes the capability level to which that SP pertains.

- Customer feedback on process performance;
- Status of outstanding problem reports;
- Actions required for the resolution of problem reports.

Similarly, the outputs of these reviews are in these forms:

- Action items for resolving the reviewed problems;
- Plans and schedules for resolving problems;
- Resources needed for their resolution.

Reviews can be made effective by specifically outlining senior management inputs and outputs and by maintaining review action items.

5.5.2.3 Resource management

Organizations require resources for developing, implementing, monitoring, and improving the QMS and for addressing customer requirements and customer satisfaction. Resource management functions are needed by every other process, so they are generally distributed throughout the organization and receive senior management attention. ISO distinguishes human resources and infrastructure resources, such as buildings, equipment, supporting services, and the work environment.

What does this mean in terms of CMMI®? In the CMMI®, GP 2.3, *Provide Resources,* when applied to all relevant PAs, satisfies the ISO requirement for providing needed resources. This GP addresses human and other resources, such as development tools. The OT PA, as a whole, and GP 2.5, *Train People,* when applied to all relevant PAs, address ISO clause 6.2.2. Evaluation of training effectiveness, that is, determination of the achievement of ''competence,''[3] is covered by SP 2.3, *Assess Training Requirements,* in the OT PA. Planning for necessary training is addressed in PP SP 2.5, *Plan for Needed Knowledge and Skills.*

The infrastructure and work environment requirements are mostly satisfied by the OEI PA (an IPPD PA), particularly SP 1.2, *Establish an Integrated Work Environment,* and by the PP SP 2.4, *Plan Project Resources.* Although

3. Competence is defined as the ability to demonstrate use of education, skills, and behaviors to achieve the results required for the job [6].

OEI SP 1.2 describes the need for establishing an IPPD environment, it is sufficiently broad to be used as a guideline for responding to the infrastructure and work environment requirements identified in this ISO section. The CMMI® states:

> An integrated work environment includes the physical infrastructure (e.g., facilities, tools, equipment, and support needed to effectively use them) that people need to perform their jobs effectively. Properly functioning environments help people communicate clearly and efficiently about the product, processes, people needs, and organization. An integrated work environment helps integrate the business and technical functions and the interfaces among teams, projects, and organization. [2]

5.5.2.4 Product realization

This is largest section in the ISO standard. It is subdivided into several processes: planning, customer-related processes, design and development, purchasing, production and service provision, and control of monitoring and measuring devices. Figure 5.4 shows at a very high level how product realization interacts with all other ISO processes. We now address each ISO product realization subprocess and compare it to the CMMI®.

What does this mean in terms of CMMI®?

Planning

As noted earlier, from the CMMI® point of view this ISO section addresses each project's defined processes. Therefore, the PP specific practices satisfy most of the ISO requirements. Implementing GP 2.2, *Plan the Process,* in each relevant PA will provide sufficient planning to satisfy the ISO requirements. However, the CMMI® goes beyond the ISO requirements by recognizing that for a plan to be effective, ''those responsible for implementing and supporting the plan'' are required to make a commitment to that plan (PP SG 3).

An organization will also benefit by implementing the IPM PA, particularly SP 1.1, *Establish the Project's Defined Process*; SP 1.2, *Use Organizational Process Assets to Plan Project Activities*; and SP 1.3, *Integrate Plans.* Although IPM is a maturity level 3 (staged) PA and requires the organization to have an OSSP, these practices will enable consistent implementation of processes across the organization. Similarly, implementing GP 3.1, *Establish a Defined Process,* in all relevant PAs will help organizations satisfy this ISO requirement. It is interesting to note that the QPM PA may provide additional input to this ISO requirement, but may be too difficult to implement in lower maturity organizations.

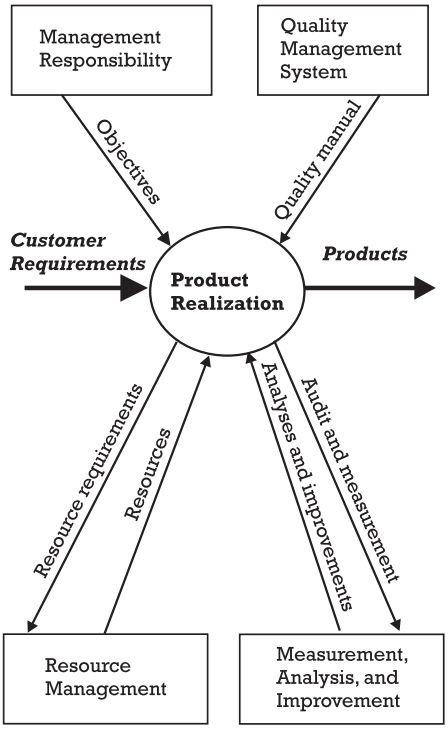

Figure 5.4 Product realization interactions.

Customer-related processes

The customer-related processes addressed in Section 7 of ISO 9001:2000 correspond to the CMMI® requirements definition, requirements review, and customer communication processes. The RD PA corresponds quite well to this ISO requirement. The first two RD specific goals, SG 1, *Develop Customer Requirements,* and SG 2, *Develop Product Requirements,* satisfy the requirements definition clauses. The third specific goal, SG 3, *Analyze and Validate Requirements,* supplements the ISO requirements of this section. It requires projects to analyze requirements based on operational concepts and functionality and then validate and balance those requirements. In addition, it requires an organization to address regulatory, safety, and organizational requirements. Specifically, it is sensitive to the difference between the requirements that are spelled out by an external customer versus those that are implied for organizations that deal with the general public marketplace, such as developers of shrink-wrapped software.

The REQM PA provides additional guidelines for managing requirements. Specifically, it addresses understanding requirements (SP 1.1), obtaining

commitments to those requirements (SP 1.2), managing changes to the requirements (SP 1.3), and identifying inconsistencies between project work products and requirements (SP 1.5).

Requirements reviews are addressed in several instances in the CMMI®. Requirements for review of processes for handling requirements definition and management are covered by generic practices GP 2.7, *Identify and Involve Relevant Stakeholders*; GP 2.9, *Objectively Evaluate Adherence*; and GP 2.10, *Review Status with Higher Level Management.* In addition, specific practices of the PMC, PPQA, and VER PAs address both formal and informal reviews of the activities and products of the requirements definition and management process.

Customer communication is implemented by RD generic practice GP 2.7, *Identify and Involve Relevant Stakeholders,* and IPM specific goal SG 2, *Coordinate and Collaborate with Relevant Stakeholders.* The MA PA also provides several specific practices that enable effective communication with customers.

Design and development

The design and development section in ISO 9001 covers several related topics: planning, inputs and outputs, reviews, verification, validation, and control of changes.

Generic practices GP 2.2, 2.8, and 2.9 in the RD, REQM, TS, VER, and VAL PAs provide necessary planning, monitoring and control, and reviews required by ISO. The PP and PMC PAs amply cover design and development planning, and replanning, as required by ISO. In addition, specific practices SP 1.1, 1.2, 1.3, and 1.4 of the IPM PA are applicable to this ISO requirement, providing an additional benefit for organizations that desire conformity in their processes. ISO requirements for design and development are addressed in the TS and PI PAs. Most of the specific practices in these PAs apply.

The IPM specific goal SG 2, *Coordinate and Collaborate with Specific Stakeholders,* and GP 2.7 in the TS, PI, VER, and VAL PAs cover management of the interfaces between different groups. In addition, two goals associated with the IPPD domain, SG 3, *Use Project Shared Vision for IPPD,* and SG 4, *Organize Integrated Teams,* effectively address this issue.

The ISO requirements for determining, capturing, and reviewing product requirements were discussed earlier in the discussion of customer-related processes. Design and development reviews are covered in the PMC PA under specific practices SP 1.6 and SP 1.7.

ISO requirements for verification and validation are covered by the CMMI® in the VER and VAL PAs, respectively. By implementing generic practice GP 2.6, *Manage Configurations,* in the TS, PI, VER and VAL PAs

and the CM PA, ISO requirements for controlling design and development changes are completely satisfied.

Purchasing

The SAM PA satisfies most ISO purchasing requirements regardless of the product category and includes outsourcing, acquisition of COTS products (including development tools), and subcontracting. This information is supplemented by specific practices SP 1.1, SP 1.2, SP 1.3, and SP 2.4 in the TS PA. These specific practices address the selection of alternative solutions that could include purchased components. Control and verification of the purchased product is also covered in the SAM PA. The CMMI® does not explicitly address verification at the supplier premises (except indirectly and in very general terms in SP 1.3, subpractice 3), but unlike ISO it discusses transitioning of the acquired products from the supplier to the project.

Production and service provision

Implementation of the CMMI® TI, PI, VAL, and CM PAs fulfills the spirit of the ISO requirements, although the CMMI® is weaker than the ISO standard in these areas. Replication, delivery, installation, and postdelivery activities are largely ignored in the CMMI®. Maintenance per se is not covered. In most cases, maintenance is addressed by following the typical development process and using specific interpretations such as trouble report versus requirement.

Identification and traceability are addressed by SP 1.4, *Maintain Bidirectional Traceability of Requirements,* in the REQM PA.

The CMMI® does not explicitly address ISO requirements for customer property. Although the CM PA supports the required activities, it is not sufficient to fully satisfy this requirement. Customer property may assume different aspects, such as hardware, development tools, intellectual property, or live data to be used for testing. In all of these cases, CM processes are invoked but implementation may be different. Similarly, the preservation of product, such as storing and maintaining product versions and protecting computer media required by ISO Section 7.5.5, have to be addressed. Therefore, we suggest that organizations specifically address those issues not explicitly covered by the CMMI®.

Control of monitoring and measuring devices

There is no CMMI® equivalent for the ISO requirements for calibration of measurement equipment and for assessing the impact of the malfunctioning equipment on the product. Although it is not clear that this ISO requirement

has very much meaning for software development, the draft ISO 9000-3 standard [7] interprets it as the validation of development tools used for analysis development and testing, validation of data used for testing, and analysis of the impact of development tools on the product quality.

Organizations developing products that require calibration of measurement equipment will have to develop processes to satisfy these requirements.

5.5.2.5 Measurement, analysis, and improvement

The ISO measurement, analysis, and improvement section has a somewhat different purpose than the other sections. Measurement processes are required in every other ISO element to monitor performance. Based on the analysis of the results obtained, improvements will be identified. Although most measurement requirements are found in this section, other sections also address measurements, monitoring, and analysis.

What does this mean in terms of CMMI®? This ISO element corresponds, in general terms, to the MA PA. The CMMI® requires an organization to

- Develop measurement and analysis objectives;
- Align those objectives with its goals and objectives;
- Specify the measures, including their collection and storage, analysis techniques, and reporting mechanisms;
- Plan their implementation and use.

The distributed nature of the measurements and analysis that appears in the ISO standard is also found in the CMMI®. In addition to the MA PA, the PMC PA and GP 2.8, *Monitor and Control the Process,* satisfy this ISO requirement when applied to all PAs.

ISO requires organizations to plan and implement the collection and analysis of product and process measures needed to demonstrate conformity to applicable requirements and to continually improve the effectiveness of the QMS. Similarly, the CMMI® MA PA requires such planning and further requires definition of the measurements, analysis techniques, and data collection methods. Measurement of continual improvement is addressed in the OPF PA, while QPM SG 2, *Statistically Manage Subprocess Performance,* provides guidelines for selecting measurements, analysis techniques, implementation of statistical methods, and performance monitoring.

Customer satisfaction

Customer satisfaction, one of the most prominent new ISO requirements, is not strongly represented in the CMMI®. In the CMMI®, customers and end users are declared stakeholders. The CMMI® addresses stakeholders throughout the model and, in several instances, refers specifically to ''customers,'' but it seems that measurement of customer satisfaction is not addressed. Customer satisfaction can be measured in several ways, such as customer satisfaction surveys (usually by a third party), measurement of *mean-time-to-repair* (MTTR), the number of help desk calls, or the number of requests for support. Therefore, organizations using the CMMI® will have to specify and implement customer satisfaction measurements and analyses to satisfy the ISO requirements.

Internal audit

The ISO requirement for internal audits is addressed in two ways in the CMMI®. One aspect of internal audits is the appraisal of the organization's processes addressed in the OPF PA. Those appraisals are intended to bring insight and understanding of the strengths and weaknesses of the OSSP. A second type of audit is addressed in the PPQA PA. Those audits focus on compliance to process and product standards. In addition, GP 2.9, *Objectively Evaluate Adherence,* is applicable to all PAs and addresses this ISO requirement.

The selection of auditors is not explicitly addressed in the CMMI® except in the definition of *objective evaluation.* The composition and qualification of process appraisal teams are addressed at length in the *Standard CMMI® Appraisal Method for Process Improvement*℠ (SCAMPI℠). SCAMPI℠ satisfies the ISO requirements for objectivity and impartiality.

Monitoring and measurement of processes

Measurements are used to demonstrate that by following the QMS processes, the desired results will be achieved. Each PA identifies a number of measurements that can be used for analyzing and controlling processes. In general, those measurements cover product quality, product size, and development effort and cost. This ISO requirement is satisfied by GP 2.8, *Monitor and Control the Process,* and by specific practices in the MA, PMC, PPQA, and QPM PAs. The PPQA PA and PMC SG 2, *Manage Corrective Actions to Closure,* address corrective actions in terms of ensuring compliance.

Monitoring and measurement of product

Specific practices in the VER, VAL, and REQM PAs satisfy this ISO requirement. Acceptance criteria for purchased products are addressed in the SAM

PA. The CM PA addresses the release and integrity aspects of the developed products by requiring configuration control board approvals.

The CMMI® is silent on ensuring that all planned activities are satisfactorily completed prior to product release, but by performing configuration audits, the spirit of this ISO requirement is satisfied with the implementation of CM SP 3.2.

Control of nonconforming products

Nonconforming products should be isolated, segregated, and disposed of to avoid contamination of released products. The VER and VAL PAs ensure that products meet their specified requirements and are suitable for their intended use. The CM PA ensures that release of products is appropriately authorized and that the problem of nonconforming products is adequately addressed.

Analysis of data

Data analysis addresses information obtained, for example, from customer satisfaction surveys, process assessment and performance measurement, product quality measurement, and supplier performance. The CMMI® addresses this ISO requirement in the MA, VER, VAL, and OPF PAs. In addition, the RD PA addresses the analysis of the product requirements, and the SAM PA addresses analysis of the data obtained from monitoring suppliers. For more mature organizations, the OPP and QPM PAs address the use of the statistical process control and quantitative management techniques for data analysis and process control.

Continual improvement

Continual improvement is addressed in the OPF and MA PAs. For the organizations at higher capability and maturity levels, the OID PA provides an additional requirement for the collection and analysis of process and technology improvement proposals. OID is an advanced PA found at maturity level 5.

Corrective action

Corrective actions are addressed by the CMMI® in the OPF, PPQA, PMC, and CAR PAs. The OPF PA mostly addresses process improvement issues, while the other PAs address process and product corrective actions. CAR is an advanced PA found at maturity level 5.

Preventive action

Preventive action requirements are addressed in the OPF and CAR PAs, and, to some extent, in the PPQA PA. The CAR PA enables organizations to communicate identified problems across projects, thus helping them avoid reoccurrence of those problems. Causal analysis can be applied to defects as well as to other issues, such as cycle time. In the latter case, causal analysis may launch additional engineering analyses, simulations, or identify new business directives.

5.5.3 Relationship between ISO and the CMMI®

It is customary to develop mappings between models to help associate the more familiar model with a less familiar one. Some standards present their own mappings: ISO 9001:2000 includes an appendix showing the mapping between its clauses and ISO 9001:1994 clauses. Some standards, such as ISO 9000-3 [7], reference another standard to provide a more detailed description of a clause or requirement. Several organizations have published maps between various models; see, for example, [8, 9].

If mappings are developed at a high level, they may erroneously show more similarities or differences than they would have shown had they been developed at more detailed level. We developed our maps at the ISO requirement (*shall*) level and at the CMMI® practice level, thus providing sufficient granularity for understanding of both models. These ISO 9001:2000–CMMI® maps are presented in Chapter 9.

How should the mappings be used? Initially, the mappings highlight the similarities and differences between the two models using the more familiar model as a starting point. As understanding of a model increases, the mappings become less and less important—they serve as reminders of the issues that need to be addressed. In general, every map is a subjective interpretation of one model against another. Users of the mappings have to be aware that no map is a substitute for understanding the model's subtleties.

Many users will be motivated by the need to use more than one model, possibly driven by regulatory or contractual considerations. There is, therefore, a need to uncover those areas where additional work may be required to satisfy both models. Another use of the mappings is to assist in developing a process infrastructure based on multiple models and while considering model similarities and differences. This use is our primary objective.

Developing a map helps in the understanding of each model. One is forced to question what the model's authors intended. When developing a map, we are led to address those intentions in a much deeper sense than if we were to simply try to understand its literal meaning. In addition, when

the maps are complete a different picture starts to emerge, leading to questions such as these:

- Are there aspects that were not covered by one model and are better addressed in another?
- Can we use one model to explain another?
- Are the models synergistic or contradictory?
- Can we use the synergy to help develop a more complete and extendable infrastructure?

We first mapped ISO 9001:2000 to the CMMI® and then used that map to develop the inverse map from the CMMI® to ISO. The inverse map showed that some practices we expected to be covered in ISO were not addressed. That prompted us to iterate the mappings several times to ensure that all possible associations were addressed. Several reviewers, facilitated by the SEI, provided valuable comments on our original maps. Most of their comments are reflected in the tables in Chapter 9. Through that process, we learned a lot about each model and their authors' intent.

So what are those maps telling us? The ISO-to-CMMI® map shows how each requirement in the ISO 9001:2000 standard relates to the CMMI® practices. We used that map in this chapter when discussing synergy and differences between the models. It helped us to understand where we need to interpret ISO statements in terms of the CMMI®. It also shows that there are ISO requirements that have weak or no correspondence in the CMMI®. Using the CMMI® when implementing ISO means additional effort is needed to specifically address those deficiencies.

Similarly, when using the CMMI®-to-ISO map we realized that several PAs are not explicitly addressed in ISO, such as the RSKM and DAR PAs. It became apparent that some ISO requirements map to a PA in such a manner that all specific practices are addressed. For example, ISO requirement 7.5.3 maps to the whole CM PA. However, some ISO requirements map to only one or two specific practices in a PA. For example, ISO requirements map quite well to the engineering PAs, whereas project management PAs are much weaker in the ISO standard. This does not mean that those PAs are not required. Rather, it means that there may be an efficient way to develop a process improvement infrastructure that will supplement ISO requirements with much more detailed CMMI® statements. It also means that one has to understand the CMMI® structure and intent to effectively use those maps.

One of the most interesting results of the mapping was that the PPQA specific practices map to only two ISO clauses, 8.2.2 and 8.2.4, which deal with internal audit and the monitoring and measurement processes. Our initial reaction was one of disbelief. After careful inspection of the ISO standard intent, we realized that the standard addresses quality management as noted earlier in this chapter. Quality assurance and quality control are defined as those parts of quality management focused on ''providing confidence that quality requirements will be fulfilled'' and ''on fulfilling quality requirements,'' respectively [3]. Neither ''quality assurance'' nor ''quality control'' is used in the standard. Of course, this does not mean that quality assurance and control are not represented or are reduced to the internal audit functions. It simply means that the emphasis of the standard is on quality management—moving away from the misnomer of ''quality assurance standard.'' The implementation of these functions is left to the organization. From the CMMI® point of view, this simply means that PPQA, which supports all PAs through the implementation of GP 2.9, *Objectively Evaluate Adherence,* is present throughout the model.

By studying the maps, we were able to develop a strategy for process improvement that is based on the synergy between ISO 9001:2000 and the CMMI®. The approach, described in the next chapters, capitalizes on the framework's similarities while minimizing the impact of their differences and ensuring that the CMMI® spirit is preserved. We will refer to those maps when we explain how those models may be used to develop such an infrastructure.

5.6 Summary of ISO requirements not covered by the CMMI®

This chapter discussed the ISO–CMMI® synergy and explained how the weaknesses of one model are supplemented by the strengths of another. We also indicated which ISO requirements are not covered in the CMMI®, as summarized here:

- Appointing a management representative;
- Internally communicating the effectiveness of the QMS;
- Requiring validation prior to delivery or implementation of the product;
- Verification of the suppliers on their premises;
- Handling of customer property;

- Control of monitoring and measuring devices;
- Defining a method for obtaining and using customer satisfaction information;
- Establishing internal audit criteria, scope, frequency, and methods;
- Ensuring independence of auditors;
- Determining the appropriateness of preventive actions to be commensurable with the effects of potential problems.

Development and implementation of additional processes and procedures will be necessary to address the ISO requirements that are not covered by the CMMI®. Some may have a significant impact on the emerging organizational process architecture. These activities must be considered during process improvement and will be addressed further in Chapter 7.

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