Maturity Model
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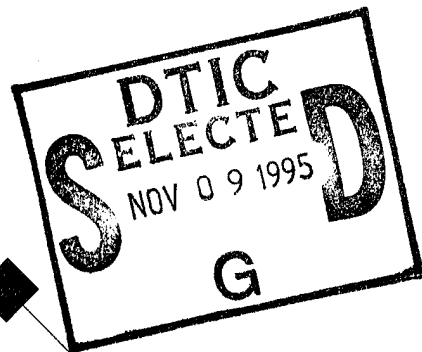
Carnegie-Mellon University
Software Engineering Institute

Overview of the People

Capability Maturity ModelSM

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September 1995

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Overview of the People Capability Maturity Model^{SM}

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Capability Maturity Modeling

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This report was prepared for the

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The ideas and findings in this report should not be construed as an official DoD position. It is published in the interest of scientific and technical information exchange.

Review and Approval

This report has been reviewed and is approved for publication.

FOR THE COMMANDER

Thomas R. Miller, Lt. Col, USAF
SEI Joint Program Office

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Acknowledgments

The People Capability Maturity Model[SM] (P-CMM[SM]) draws on the topics of capability maturity models, benchmark practices, and organizational improvement to increase an organization's capability to engineer software; and presents a documented roadmap for organizational improvement.

For his contributions and guidance as the leader of the Capability Maturity Models[SM] (CMM[SM]) project, his broad contributions to our ongoing discussions regarding the evolving drafts of the P-CMM, and his continuing support for the P-CMM efforts, we thank Mike Konrad. Watts Humphrey contributed to many discussions that led to the development and refinement of the model. Jim Over has shared his expertise and knowledge of the Personal Software Process (PSP) [Humphrey95a, 95b] to the development of the P-CMM. We thank them for their contributions. The extraordinary efforts of Mark Paulk in the development of the Capability Maturity Model for Software established a world-class standard and enabled the P-CMM to build on these efforts.

We acknowledge Ron Radice, Floyd Hollister, and Bill Peterson for their foresight in providing initial sponsorship for this work, as well as Miriam Browning, Cynthia Kendall (Office of the Assistant Secretary of Defense C^{3}I), LTG Otto Guenther (U.S. Army, DISC4) and David Borland (U.S. Army, DISC4) for providing the sponsorship from the U.S. Department of Defense (DoD) necessary to complete this work. We also thank Arlene Dukanauskas (U.S. Army, DISC4) and Joyce France (Office of the Assistant Secretary of Defense C^{3}I) for their continued and unfailing support and advice.

We would especially like to thank the members of the P-CMM Advisory Board who have helped to guide our efforts. In addition to providing technical insights, they helped focus our effort and worked with us to

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Acknowledgments

About This Document

What Is the Purpose of This Document?

This document provides an overview and an introduction to the People Capability Maturity Model (P-CMM) [Curtis95]. Specifically, this document defines the concepts necessary to understand the P-CMM and the motivation and purpose behind the P-CMM. This overview describes the P-CMM structural components, consisting of key process areas within the five maturity levels of the P-CMM, and the principles that underlie each of the maturity levels. Finally, the document addresses potential uses of the P-CMM in assessing organizational practice or guiding improvement of an organization's workforce capability.

The document is intended to provide an overview of the comcepts of the P-CMM, while the People Capability Maturity Model [Curtis95] describes the key practices for each level of the P-CMM.

How Is This Document Organized?

This document consists of an executive overview and three major sections:

Chapter 1 — Introduction Defines the concepts necessary to understand the P-CMM and the motivation and purpose behind it.

Chapter 2 — Maturity Levels Describes the five levels of the P-CMM and the principles that underlie them. Describes how the P-CMM is structured into

key process areas within maturity levels, organized by common features, and described in terms of key practices.

Chapter 3 – Applying the P-CMM   Addresses potential uses of the P-CMM and the need to apply professional judgment in using the P-CMM within any given organization.

Appendix A provides a high-level overview of the *People Capability Maturity Model* [Curtis95] by identifying the goals of each key process area (KPA).

Background

The concepts that grew to become the P-CMM were initially conceived by Bill Curtis at the SEI's first CMM workshop in 1988. The concept was published in *American Programmer* in August, 1990 [Curtis90]. Following the publication of the concept, Citicorp ran a successful pilot program during 1990 and 1991.

A project to develop the model was announced at the 1992 SEI Symposium. This work extends the management and organizational perspectives of the Capability Maturity Model for Software [Paulk93a; Paulk93b; Paulk95] to include the management of the people resources necessary for the development and maintenance of software systems. The SEI has been developing and refining the P-CMM since 1992.

Following initiation of the project, a P-CMM Advisory Board formed in July 1993. This advisory board consists of senior individuals with backgrounds in software engineering, information systems development

and management, and human resources. Version 0.1 of the P-CMM was released for review by the advisory board in October, 1993. Subsequent to release of Version 0.1, the advisory board investigated best practices.

Strategic DoD sponsorship was obtained during 1994. The sponsors of this work are the

❏ Army Office of the Director of Information Systems for Command, Control, Communication, and Computers, Directorate of Army Information

❏ Office of the Assistant Secretary of Defense for Command, Control, Communication, and Intelligence, Deputy Assistant Secretary of Defense for Information Management

P-CMM Draft Version 0.2 was developed based on the concepts described above and current best practices. It was widely distributed for review by the members of the P-CMM Advisory Board, P-CMM Correspondence Group[1], and other interested reviewers, and was the subject of discussion at a National Workshop, held December 14-15, 1994, in Virginia.

Following the National Workshop, a focused two-day working meeting was held to address the structure and content of capability maturity models and the interrelationships between these models. In this meeting, our discussions focused on people- and skills-related topics and issues, and how these people and skills topics map across capability maturity models.

P-CMM Draft Version 0.3 was developed based on extensive feedback (over 1400 comments) on P-CMM Version 0.2, as well as our continued

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[1]You can join the group by contacting Customer Relations at the Software Engineering Institute, Carnegie Mellon University, Pittsburgh, PA 15213-3890 (412/268-5800; fax: 412/268-5758; Internet: customer-relations@sei.cmu.edu).

efforts to identify the best benchmark practices in each of the key process areas. As with Version 0.2, P-CMM Version 0.3 was widely distributed for review by the members of the P-CMM Advisory Board, P-CMM Correspondence Group, and other interested reviewers. Over 1,000 copies of Draft Version 0.3 were distributed in hard copy, and several hundred copies were obtained electronically.

P-CMM (Version 1.0) [Curtis95] was released at the 1995 SEI Software Engineering Symposium, September 11-14, 1995, held in Pittsburgh, Pennsylvania.

How to Receive More Information

For further information regarding the P-CMM and its future associated products, including training on the P-CMM and how to perform P-CMM-based assessments, contact

> SEI Customer Relations
> Software Engineering Institute
> Carnegie Mellon University
> Pittsburgh, PA 15213-3890
> (412) 268-5800
> Internet: customer-relations@sei.cmu.edu

SEI technical reports are directly available from Research Access Inc. (RAI), the National Technical Information Service (NTIS), and the Defense Technical Information Center (DTIC). These documents can be obtained by contacting

> RAI: Research Access Inc.
>   800 Vinial Street

Pittsburgh, PA 15212
Telephone: (800) 685-6510
International: +1-412-321-2992
FAX: +1-412-321-2994
WWW: http://www.rai.com

NTIS: National Technical Information Service
         U.S. Department of Commerce
         Springfield, VA 22161-2103
         Telephone: (703) 487-4600

DTIC: Defense Technical Information Center
         ATTN: DTIC-OCP
         8725 John J. Kingman Rd.
         Suite 0944
         Ft. Belvoir, VA 22060-6218

Additional information about the SEI, its efforts and publications are available using the World Wide Web at

   http://www.sei.cmu.edu

Information about available P-CMM documents is available at

   ftp://ftp.sei.cmu.edu/pub/p-cmm/READ_ME.txt

SEI technical reports are also available via Internet. To obtain the P-CMM via anonymous FTP from a Unix system on Internet

```
ftp ftp.sei.cmu.edu
login: anonymous
password: <your user id or any string>
cd pub/p-cmm
get READ_ME.txt
get <files>
quit
```

The file READ_ME.txt contains information on what files are available. Other SEI publications are available in a similar manner in the directory /pub/documents. The Capability Maturity Model for Software is available in a similar manner in the directory /pub/cmm.

Executive Overview

Need for the People Capability Maturity Model^{SM}

In order to improve their performance, organizations must focus on three interrelated components—people, process, and technology—shown in Figure EO.1. With the help of the Capability Maturity Model^{SM} for Software (CMM^{SM}) [Paulk95], many software organizations have made cost-effective, lasting improvements in their software processes and practices [Herbsleb94]. Yet many of these organizations have discovered that their continued improvement requires significant changes in the way they manage, develop, and use their people for developing and maintaining software and information systems—changes that are not fully accounted for in the CMM. To date, improvement programs for software organizations have often emphasized process or technology, not people.

People

High Quality Products and Services

Process

Technology
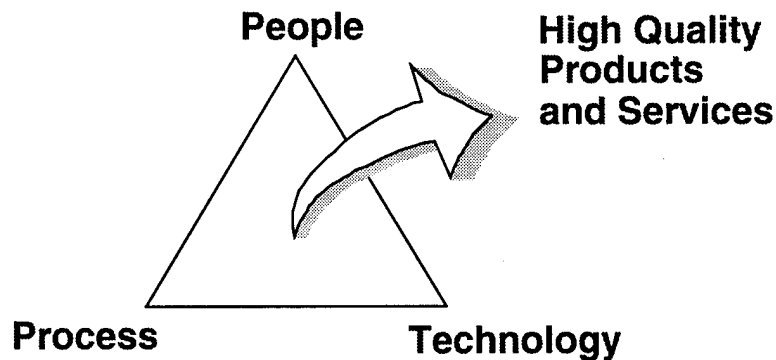
Figure EO.1 Three Components of Improvement Focus

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^{SM} Capability Maturity Model and CMM are service marks of Carnegie Mellon University.

To provide guidance to organizations that want to improve the way they address these people-related issues, the SEI has developed the People Capability Maturity Model[SM] (P-CMM[SM]). The P-CMM is a maturity framework, patterned after the structure of the CMM, that focuses on continuously improving the management and development of the human assets of a software or information systems organization. The P-CMM provides guidance on how to continuously improve the ability of software organizations to attract, develop, motivate, organize, and retain the talent needed to steadily improve their software development capability. The strategic objectives of the P-CMM are to

❏ improve the capability of software organizations by increasing the capability of their workforce

❏ ensure that software development capability is an attribute of the organization rather than of a few individuals

❏ align the motivation of individuals with that of the organization

❏ retain human assets (i.e., people with critical knowledge and skills) within the organization

The P-CMM describes an evolutionary improvement path from ad hoc, inconsistently performed practices, to a mature, disciplined, and continuously improving development of the knowledge, skills, and motivation of the workforce. The P-CMM helps software organizations

❏ characterize the maturity of their workforce practices

❏ guide a program of continuous workforce development

❏ set priorities for immediate actions

❏ integrate workforce development with process improvement

❏ establish a culture of software engineering excellence

The P-CMM is designed to guide software organizations in selecting immediate improvement actions based on the current maturity of their workforce practices. The benefit of the P-CMM is in narrowing the scope of improvement activities to those practices that provide the next foundational layer for an organization's continued workforce

development. These practices have been chosen from industrial experience as those that have significant impact on individual, team, unit, and organizational performance. The P-CMM includes practices in such areas as

- [ ] work environment
- [ ] communication
- [ ] staffing
- [ ] managing performance
- [ ] training
- [ ] compensation
- [ ] competency development
- [ ] career development
- [ ] team building
- [ ] culture development

Structure of the P-CMM

As organizations establish and improve their people management practices, they progress through five levels of maturity. Figure EO.2 depicts these five levels, each of which provides a layer in the foundation for the continuous improvement of an organization's workforce practices. Each maturity level is composed of several *key process areas* (KPA) that identify clusters of related workforce practices. When performed collectively, the practices of a key process area achieve a set of goals considered important for enhancing workforce capability.

Achieving each maturity level in the P-CMM institutionalizes new capabilities as a result of an organizational improvement program, resulting in an overall increase in the workforce capability of the organization. Growth through the maturity levels creates fundamental changes in how people are managed and the culture in which they work.

Continuously improve
methods for developing
personal and
organizational
competence

Level 5—Optimizing

Continuous Workforce Innovation
Coaching
Personal Competency Development

Quantitatively manage
organizational growth
in workforce
capabilities and
establish
competency-
based teams

Level 4—Managed

Organizational Performance Alignment
Organizational Competency Management
Team-Based Practices
Team Building
Mentoring

Identify primary
competencies
and align
workforce
activities
with them

Level 3—Defined

Participatory Culture
Competency-Based Practices
Career Development
Competency Development
Workforce Planning
Knowledge and Skills Analysis

Instill basic
discipline
into
workforce
activities

Level 2—Repeatable

Compensation
Training
Performance Management
Staffing
Communication
Work Environment

Level 1—Initial

Figure EO.2   The Five Maturity Levels of the P-CMM

In maturing from the Initial to the Repeatable level, the organization installs the discipline of performing basic practices for managing its workforce. In maturing to the Defined level, these practices are tailored to enhance the particular knowledge, skills, and work methods that best support the organization's business. The core competencies of the organization are identified, and workforce activities are aligned to support the development of these competencies. In maturing to the Managed level, the organization uses data to evaluate how effective its workforce processes are and to reduce variation in their execution. The organization quantitatively manages organizational growth in workforce capabilities and, when appropriate, establishes competency-based teams. In maturing to the Optimizing level, the organization looks continually for innovative ways to improve its overall talent. The organization is actively involved in applying and continuously improving methods for developing individual and organizational competence.

A number of improvement themes course through the P-CMM. These themes help organize an understanding of the structure of the model and the relationships among the key process areas within the P-CMM. As shown in Figure EO.3, the key process areas are mapped to four process categories. The four themes of these process categories are

❑ developing capabilities

❑ building teams and culture

❑ motivating and managing performance

❑ shaping the workforce

The P-CMM has been designed to be coupled with a CMM-based software process improvement program. However, it can be used on its own to guide improvements in the workforce practices of an organization. The P-CMM can be used to guide an assessment of the workforce practices of an organization, and the SEI is piloting an assessment method. However, the use of the P-CMM should been done in conjunction with those in an organization who have expertise in workforce practices.

Maturity Levels	Process Categories			
	Developing capabilities	Building teams and culture	Motivating and managing performance	Shaping the workforce
5 Optimizing	Coaching Personal Competency Development	Continuous Workforce Innovation		
4 Managed	Mentoring	Team Building	Organizational Performance Alignment Team-Based Practices	Organizational Competency Management
3 Defined	Competency Development Knowledge and Skills Analysis	Participatory Culture	Competency-Based Practices Career Development	Workforce Planning
2 Repeatable	Training Communication	Communication	Compensation Performance Management Work Environment	Staffing
1 Initial				

Figure EO.3   The Key Process Areas Assigned to Process Categories

1 Introduction

1.1 Motivation for Improving Software Development Talent

"The most important ingredient on this successful project was having smart people...Very little else matters in my opinion...The most important thing you do for a project is selecting the staff...Really the success of the software development organization is very, very much associated with its ability to recruit good people."

"The only rule I have in management is to ensure that I have good people—real good people—and that I grow good people, and that I provide an environment where good people can produce."

> Two software vice presidents quoted in [Curtis88]

"The central question in how to improve the software art centers, as it always has, on people."

> [Brooks87]

"Personnel attributes and human resource activities provide by far the largest source of opportunity for improving software development productivity."

> [Boehm81]

Knowledge is the raw material of software development, and it is software engineers who transform knowledge into software products. Although software tools can help record and manage knowledge, they do not create and apply it. The level of talent on a software project is often the strongest predictor of its results [Boehm81], and personnel shortfalls are one of the most severe project risks [Boehm88]. Therefore, improving technology

and process alone is not enough in the most knowledge-intense industry in history. Improving a software organization requires continual improvement of its people and of the conditions that empower their performance.

Software development is large-scale, integrated, intellectual work [Humphrey89]. The skill of developing software is the skill of managing intellectual complexity. Performance ranges among professional software engineers routinely exceed 20 to 1 [Curtis81, Sackman68, Valett89]. Software engineers differ markedly in the level of complexity they can handle [Basili83]. The folklore of software engineering is replete with remarkable feats by heroes, wizards, and gurus. Although the presence of an extraordinary individual on a project can have dramatic impact, there are not enough of these individuals to staff more than a handful of the projects in most organizations [Curtis88]. Software organizations can lament these circumstances, or they can take actions to improve them.

As the size of software systems continues to grow an order of magnitude each decade, the industry must change from a mystique of artistically creative individuals to a team-based profession that emphasizes continuous learning. Accordingly, software organizations must become centers of excellence that take talented individuals from universities and other sources and develop them into motivated and productive software engineering teams. Increasing the knowledge, skills, and performance of software developers is necessary to

❏ compete with lower priced talent in other countries

❏ satisfy the exponential explosion in the amount and complexity of software required by most current and future products

❏ increase the quality and reliability of software systems to levels achieved by hardware, especially in life- and business-critical applications

To motivate continuous improvement of the workforce, the organization must perceive its people as assets rather than as expense items. When members of the workforce are essentially interchangeable, organizations

focus more on managing workforce costs than on increasing workforce performance. It is tragic when this old labor relations model is carried over into high technology, because it was based on jobs that were never as knowledge intense as those in software development. With the level of performance differences cited for software engineers, individual and team skills become strategic competitive assets.

The benefit of better workforce practices has been demonstrated empirically in numerous studies [Labor93, Mavrinac95]. Companies with the best workforce practices have been shown to outperform other firms in growth of profits, sales, earnings, and dividends [Hansen89, Kravetz88]. These practices are usually considered to be integral to a total quality management (TQM) program, and are included as criteria in the Malcolm Baldridge National Quality Award [Commerce95]. Nevertheless, most software organizations have moved slowly on improving their workforce practices.

With the help of the Capability Maturity Model[SM] for Software (CMM[SM]) [Paulk95], many organizations have made improvements in their software processes and practices. These improvements have resulted in improved productivity, quality, and time to market [Herbsleb94]. Even so, many of these organizations have discovered that their continued improvement requires significant changes in the way they manage people, changes that are not fully accounted for in the CMM for Software. To date, most improvement programs for software organizations have emphasized process or technology, not people.

Despite the importance of talent, human resources and other workforce practices in many organizations are often ad hoc and inconsistent, and software managers are insufficiently trained in performing them. Consequently, managers often expect their human resources departments to be responsible for the administration of most people-related practices. Compounding the problem, these practices are often applied with little analysis of their impact. In many cases, even when software organizations

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are aware of the problem and want to include people-related activities in their improvement programs, they don't know where or how to begin.

1.2 A Maturity Framework for Developing Human Talent

1.2.1 P-CMM Objectives

The People Capability Maturity Model[SM] (P-CMM[SM]) focuses on continuously developing the human assets of a software or information systems organization. The P-CMM provides guidance on how to develop an organization whose practices continuously improve the capability of its workforce. The motivation for the P-CMM is to radically improve the ability of software organizations to attract, develop, motivate, organize, and retain the talent needed to steadily improve their software development capability.

The strategic objectives of the P-CMM are to

❑ improve the capability of software organizations by increasing the capability of their workforce

❑ ensure that software development capability is an attribute of the organization rather than of a few individuals

❑ align the motivation of individuals with that of the organization

❑ retain human assets (i.e., people with critical knowledge and skills) within the organization

1.2.2 The Maturity Framework

The P-CMM is a maturity framework, patterned after the structure of the Capability Maturity Model for Software (CMM), that describes the key

elements of managing and developing an organization's workforce. It describes an evolutionary improvement path from ad hoc, inconsistently performed practices, to a mature, disciplined development of the knowledge, skills, and motivation of the workforce, just as the CMM describes an evolutionary improvement path for the software processes within an organization. The P-CMM helps software organizations

❑ characterize the maturity of their workforce practices

❑ guide a program of continuous workforce development

❑ set priorities for immediate actions

❑ integrate workforce development with process improvement

❑ establish a culture of software engineering excellence

The P-CMM is designed to guide software organizations in selecting high-priority improvement actions based on the current maturity of their workforce practices. The benefit of the P-CMM is in narrowing the scope of improvement activities to those practices that provide the next foundational layer for developing an organization's workforce. By concentrating on a focused set of practices and working aggressively to install them, organizations can steadily improve their workforce and make lasting gains in their performance and competitiveness.

The P-CMM guides an organization through a series of increasingly sophisticated practices and activities for developing its workforce. These practices have been chosen from industrial experience as those that have significant impact on individual, team, unit, and organizational performance. The P-CMM includes practices in such areas as

❑ work environment

❑ communication

❑ staffing

❑ managing performance

❑ training

❑ compensation

❑ competency development

❑ career development
❑ team building
❑ culture development

When installed, key practices in these areas improve the ability of organizations to attract, develop, motivate, and retain a talented workforce. These practices also help organizations align the performance of individuals and teams with that of units and the organization.

1.2.2.1 Background of the Maturity Framework

The maturity framework underlying the CMM for Software applies total quality management practices to software organizations to help them improve their capability to develop high-quality software on schedule and within budget. This framework guides software organizations through five stages in improving their capability. The conceptual structure of the CMM is based on quality management principles evolved by W. Edwards Deming [Deming86], Philip Crosby [Crosby79], Joseph Juran [Juran89], and others over the last 60 years.

The original concept for a maturity framework was developed by Watts Humphrey and his colleagues at IBM in the early 1980s. In his 27 years at IBM, Humphrey noticed that the quality of a software product was directly related to the quality of the process used to develop it. Observing the success of total quality management in other parts of industry, Humphrey wanted to install a Shewart-Deming cycle (plan-do-check-act) into a software organization as a way to continually improve its processes.

Humphrey realized that the Shewart-Deming cycle must be installed in stages as impediments to continuous improvement are systematically removed. The staged structure that underlies the maturity framework was first elaborated by Crosby in *Quality is Free* [Crosby79]. Crosby's quality management maturity grid describes five evolutionary stages in adopting quality practices in an organization. This framework was adapted to the

software process by Ron Radice and his colleagues working under the direction of Humphrey at IBM [Radice85].

Humphrey brought these concepts to the Software Engineering Institute (SEI) in 1986. In 1986 the SEI received a request from the U.S. Air Force to develop a method for assessing the capability of its software contractors. With assistance from Mitre, the SEI elaborated the process maturity framework [Humphrey88] and developed a questionnaire [Humphrey87] to aid in appraising maturity. The SEI intended the maturity questionnaire to provide a simple tool for identifying areas where an organization's software process needed improvement. In particular, it was designed to collect some initial data to guide the in-depth interviews during a software process assessment. Unfortunately, the maturity questionnaire was too often regarded as "the model" rather than as a vehicle for exploring process maturity issues.

The original formulation for the structure of the CMM in its current form was presented by Humphrey in *Managing the Software Process* [Humphrey89]. Through software process assessments, workshops, and extensive review, the SEI evolved the software process maturity framework into the Capability Maturity Model for Software (CMM) [Paulk95]. Version 1 was released for national review in August 1991, and the revised Version 1.1 [Paulk93a, 93b] was released in January 1993.

The CMM is widely used for guiding software process improvement programs both in the U.S. and abroad. Although originally adopted by aerospace firms, the CMM is now used in commercial software and information systems organizations. The CMM has been used successfully to improve software performance in companies such as Citicorp, Corning, GTE, Grumman, Hewlett-Packard, Hughes Aircraft, IBM, Motorola, Procase Corp., Raytheon, Rockwell, Schlumberger, and the U.S. Air Force [Billings94, Dion93, Goldenson95, Grady92, Herbsleb94, Humphrey91, Johnson94a, Johnson94b, Lipke92, Nidiffer95, Paulk95, Selfridge94, Sudlow94, Wohlwend93]. Recent empirical results point to an average return on investment in software process improvement of $5.70 saved for every $1 spent [Herbsleb94].

1.2.2.2 Principles Underlying the Maturity Framework

A fundamental premise underlying the maturity framework is that a practice cannot be improved if it cannot be repeated. In an organization's least mature state, systematic and repeated performance of practices is only sporadic. The Repeatable level of the CMM (Level 2) is primarily focused on helping software organizations remove the impediments that keep them from repeating successful software development or maintenance practices. The most common impediments are schedule or resource commitments that the software staff could not meet regardless of how sophisticated their skills or processes are. Another particularly wicked impediment is uncontrolled requirements changes that devastate the original planning.

In a rush to satisfy unreasonable objectives, the project staff begin cutting corners on sound engineering practices and making mistakes that are not caught until it is much more time consuming and expensive to remove them. As a result, projects lose control of their schedule, costs, and product quality. When sound practices are sacrificed to schedule or other constraints, engineers have little chance to improve their performance or follow through effectively on innovative ideas. The primary objective at the Repeatable level is to instill a process discipline in the environment that ensures that the basic practices needed to stabilize the environment are performed on a regular and repeatable basis.

Having established an ability to make and protect achievable commitments, the organization can focus on transferring its best development or maintenance practices across the organization. Although successful practices are executed repeatably at the Repeatable maturity level, they may be performed quite differently by different people or in different groups. Some ways of performing these practices will prove more effective than others.

Capitalizing on processes that work best is the heart of the Defined level (Level 3). The organization identifies the design, testing, inspection,

management, configuration control, and other processes that seem to have worked best on different projects, and integrates them into an organization-wide process for development. This process is trained throughout the organization so that people have a common reference for performing their work. In using defined organization-wide processes, managers and technical staff benefit from lessons learned on earlier projects and do not have to reinvent successful methods.

Once the organization can execute its development processes consistently, it can use its process data to systematically eliminate the causes of wide variations in its performance. The objective of the Managed level (Level 4) is to set quantitative performance and quality targets and reduce the variation in process to stabilize the organization's capability in achieving these targets. During this attempt to reduce performance variation, statistical process control principles can be applied. However, their application, and even the relevant statistical methods, may differ from those used in manufacturing. Managers now use these detailed process data as their primary management tool.

At the Optimizing level (Level 5), the organization continues on its improvement path with a focus on continuous process improvement. The organization begins to identify technology and process innovations that can continually improve its performance and competitive posture. Causes of defects are systematically eliminated. The organization focuses on continual improvement of any factor that affects the achievement of its business goals.

The CMM guides organizations in steadily improving their capability for developing software. The capability of an organization to develop software is the range of results it ordinarily experiences when executing projects. Capability is improved by establishing a learning environment where the organization has quantitative feedback on its performance. In the abstract, the maturity framework builds an environment in which

❑ practices can be repeated

❑ best practices can be rapidly transferred across groups

❏ variations in performing best practices are reduced

❏ practices are continuously improved to enhance capability

This maturity framework should be applied only to practices that contribute directly to the business performance of an organization. These are the practices that increase the organization's capability to provide high-quality products and services efficiently. Since the knowledge, skills, and motivation of an organization's software development talent are crucial to its performance, the practices for managing their development are excellent candidates for improvement using the maturity framework. Thus, the P-CMM seeks to increase the capability of the workforce in the same way that the CMM increased the capability of the organization's software process.

1.2.3 A Family of Maturity Models

In laying a strategy for improving the practice of software engineering, the SEI focused on improvements in three areas. As depicted in Figure 1.1, these three areas—people, process, and technology—are the primary sources of leverage for improving the software engineering practice of an organization and its resulting products. The SEI has been conducting programs in each of these areas since the mid-1980s.
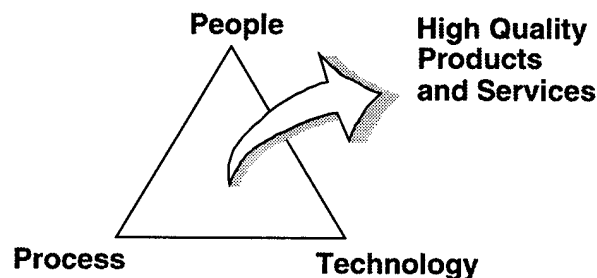
Figure 1.1 Three Components of Improvement Focus

The efforts of the SEI in software process have centered around using the CMM for Software as a guide for improving an organization's software process. The SEI has supplemented the use of the CMM in improvement programs by providing methods for

❑ appraising the actual practice of software engineering in organizations

❑ defining and representing software processes

❑ using quantitative methods for process management and improvement

❑ improving each developer's personal software process

The success of the CMM for Software generated an interest in applying maturity principles to other activities within an organization. The SEI is now exploring the application of maturity principles to each corner of the triangle in Figure 1.1. An obvious application of the maturity framework is to raise its application from the software component up to the level of systems engineering. The SEI has coordinated the development of a Systems Engineering Capability Maturity Model (SE-CMM) [Bate94]. This model translates the CMM to terms and processes that are relevant to the entire systems engineering process on a project.

As many defense contractors began to mature their development processes, the DoD realized that their acquisition practices were becoming a major impediment to further gains in productivity and quality. Accordingly, DoD has begun the development of an System Acquisition Capability Maturity Model (SA-CMM) to guide improvements in DoD acquisition practices. The combination of the CMM, SE-CMM, and SA-CMM should dramatically increase the effectiveness of the contractor-acquisition office partnership for delivering defense systems. These models will be just as beneficial in commercial industry as they are in the aerospace industry.

The SEI has also tentatively explored the application of maturity principles to software technology. The objective of such a model would be to evaluate software technologies on a continuum that stretches from ad hoc inconsistent methods to consistently performed, quantitatively-based

methods. Thus, software would be designed using methods that yield a quantitative characterization of the results of design decisions. The initial formulations of this model are promising, but it is still under exploration.

The P-CMM was developed to apply maturity principles to the development of the workforce. In applying these principles, we are implying that the development of the workforce is a process with practices that can be improved. Further we are implying that principles that have been traditionally used for the improvement of a product can also be applied to the improvement of people. Thus, the P-CMM rests on the premise that people have skills that can be measured and that organizations can continuously improve their processes for developing and organizing these skills.

The P-CMM is the foundation for systematically building a set of tools, including an assessment method, which are useful in understanding an organization's baseline capabilities to develop its workforce and in charting improvements in an organization's workforce practices. Although the P-CMM has been developed with the needs of the software engineering and information systems community in mind, the key practices for developing the workforce can be applied to almost any knowledge-intense job. In fact, most of these practices will apply to jobs throughout an organization. We use software examples frequently throughout the P-CMM, but this does not imply that these practices can be applied only to people directly involved with software. It may be possible for an organization to use the P-CMM and associated assessment instruments to address its capability for developing people in areas outside of software, and to integrate the resulting action plans into an overall plan for revitalizing the organization.

2 Maturity Levels of the People CMM

2.1 Definition of the P-CMM Maturity Levels

As a capability maturity model, the P-CMM guides organizations in establishing and improving their workforce practices through five evolutionary stages. Achieving each maturity level in the P-CMM institutionalizes new capabilities for developing the knowledge and skills of the workforce, resulting in an overall increase in the talent of the organization. Growth through the maturity levels creates fundamental changes in how people are developed and organized and in their working culture.

Figure 2.1 depicts the five maturity levels of the P-CMM. Each maturity level provides a layer in the foundation for continuous improvement of an organization's workforce practices. In maturing from the Initial to the Repeatable level, the organization installs the discipline of performing the basic practices. In maturing to the Defined level, these practices are tailored to enhance the particular knowledge, skills, and work methods that best support the organization's business. In maturing to the Managed level, the organization develops competency-based, high-performance teams and empirically evaluates how effectively its workforce practices are meeting objectives. In maturing to the Optimizing level, the organization looks continually for innovative ways to improve its workforce capability and to support individuals in their pursuit of professional excellence.

2.1.1 Level 1 - The Initial Level

At the Initial level, the performance of workforce activities is inconsistent. The organization typically provides forms for activities such as performance appraisals or position requisitions, but offers little guidance

or training in conducting the activities supported by these forms. Typically managers have not been trained in performing most of their workforce responsibilities, so their ability to manage those who report to them is based on previous experience and their personal "people skills." These organizations are not necessarily abusive or inconsiderate. Their problem is that they do not have the ability to systematically develop the competitive capability of their workforce.
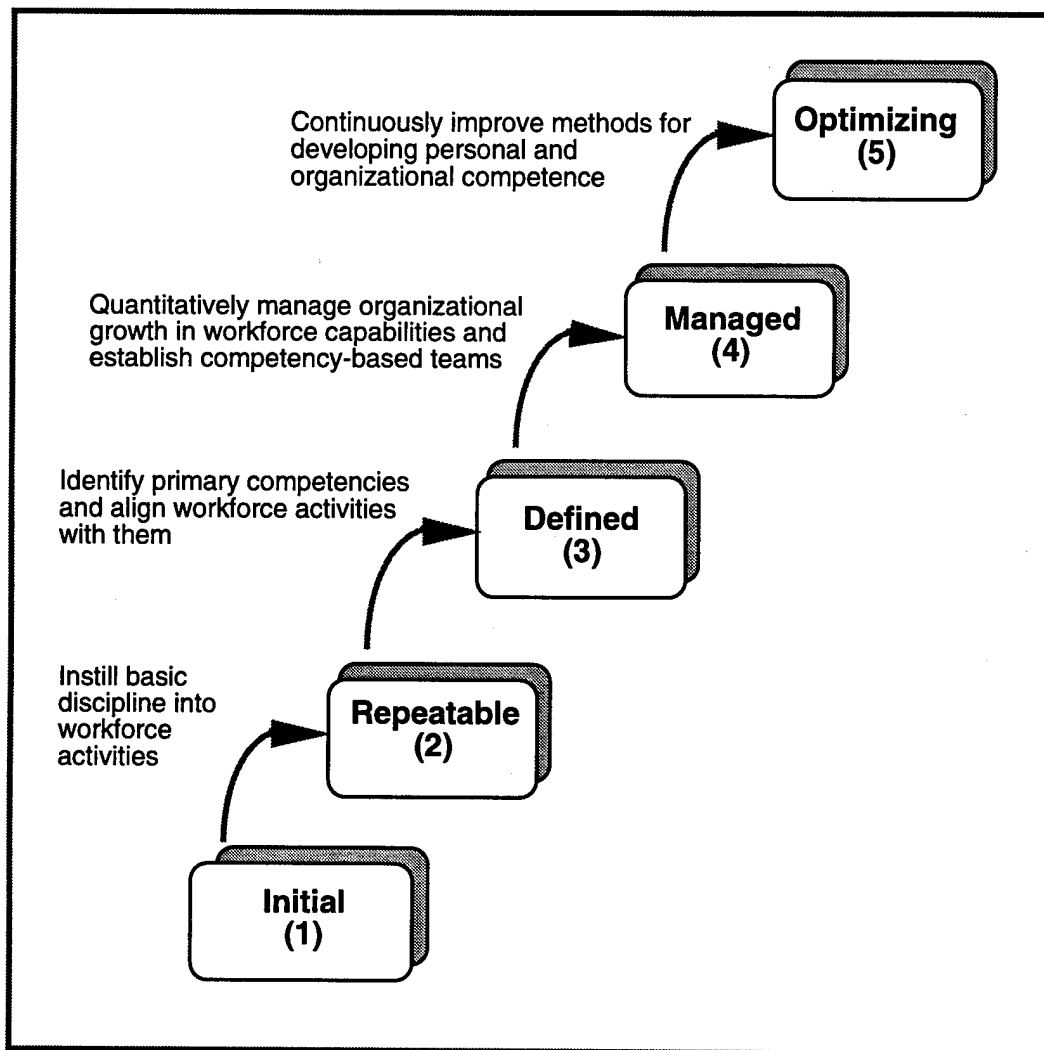
Figure 2.1 The Five Maturity Levels of the P-CMM

In the worst circumstances, managers in Level 1 organizations do not accept developing the members of their unit as a primary personal responsibility. They perform workforce activities such as interviewing job candidates or conducting performance appraisals with little preparation, often resulting in poor staffing decisions or disgruntled employees. The human resources department too often imports practices and applies them with little analysis of their effectiveness. Individuals in most Level 1 organizations do not take workforce practices seriously, since they do not believe the practices have much relation to their real work and level of contribution to the organization.

The workforce capability of a Level 1 organization is unknown, since there is little effort to measure or improve it. Individuals are motivated to pursue their own agendas, since there are few incentives in place to align their motivations with the business objectives of the organization. Turnover is high when people feel there are better working conditions or growth potential in another organization. Consequently, the level of knowledge and skills available in the organization does not grow over time because of the need to replace experienced and knowledgeable individuals who have left the organization.

2.1.2   Level 2 - The Repeatable Level

The primary objectives at the Repeatable level are to eliminate problems that keep people from being able to perform their work responsibilities effectively and to establish a foundation of workforce practices that can be continuously improved in developing the workforce. The most frequent problems that keep people from being able to perform effectively in low-maturity organizations include

❑ environmental distractions

❑ unclear performance objectives

❑ lack of relevant knowledge or skill

❑ poor communication

In maturing to the Repeatable level, an organization establishes policies that commit it to developing its people. A primary objective in achieving a repeatable capability is to establish a sense of responsibility and discipline in performing basic workforce practices. These practices ensure that the people in each unit will have the knowledge and skills required to perform their current assignment. When these practices are institutionalized, the organization has laid a foundation on which it can build improved methods and practices.

At the Repeatable level, those who have been assigned responsibility for performing workforce activities accept personal responsibility for ensuring that all workforce practices are implemented effectively. In doing so, they accept the growth and development of their staff as a primary responsibility of their position. When people take their workforce responsibilities seriously, they begin to develop repeatable methods for performing specific activities such as interviewing or establishing performance criteria. Individuals will notice greater consistency in the performance of workforce functions within their group, although different managers or groups may have individual variations in the specific methods they use.

The effort to implement improved workforce practices begins when executive management commits the organization to constantly improve the knowledge, skills, motivation, and performance of its workforce. The organization states that the continuous development of its workforce is a core value. The organization documents policies and develops basic workforce practices that the units will implement. Units develop plans for satisfying their workforce needs and responsibilities. These initial needs are in the areas of the work environment, communication, staffing, performance management, training, and compensation. Until these basic workforce practices become institutionalized, the organization will have difficulty adopting more sophisticated workforce practices.

2.1.3 Level 3 - The Defined Level

Organizations at the Repeatable level find that although they are performing basic workforce practices, there is inconsistency in how these practices are performed across units. The organization is not capitalizing on opportunities to standardize its best workforce practices, because it has not identified the common knowledge and skills needed across its units and the best practices to be used for developing them. The organization is motivated to achieve the Defined level in order to gain a strategic competitive advantage from its core competencies.

At the Defined level, the organization begins to adapt its workforce practices to the specific nature of its business. By analyzing the skills required by its workforce and the business functions they perform, the organization identifies the core competencies required to perform its business. The organization then adapts its workforce practices to develop the specific knowledge and skills that compose these core competencies. The organization identifies best practices in its own workforce activities or those of other organizations and tailors them as the basis for adapting its workforce practices.

The organization analyzes its business processes to determine the core competencies involved in its work and the knowledge and skills that constitute these competencies. The organization then develops strategic and near-term plans for developing these competencies across the organization. A program is defined for systematically developing core competencies, and individuals' career development strategies are planned to support competency development for each individual. The organization administers its workforce practices to develop and reward growth in its core competencies and to apply them to improve performance.

A common organizational culture can develop at the Defined level, because the organization becomes focused on developing and rewarding a set of core competencies. This culture places importance on growing the

organization's capability in its core competencies, and the entire workforce begins sharing responsibility for this growth. Such a culture is reinforced when workforce practices are adapted to encourage and reward growth in the organization's core competencies. This culture can be enhanced by establishing a participatory environment where individuals and groups are involved in decisions regarding their work.

The workforce capability of organizations at the Defined level is based on having a workforce that possesses the basic knowledge and skills to perform the core business functions of the organization. Knowledge and skills in the organization's core competencies are more evenly spread across the organization. The organization has improved its ability to predict the performance of its work activities based on knowing the level of knowledge and skills available in its workforce. Also, it has established a foundation on which continuous development of knowledge and skills can be built.

2.1.4   Level 4 - The Managed Level

Organizations at the Defined level have established the foundation for continuously improving their workforce. At the Managed level, the organization takes the first steps in capitalizing on managing its core competencies as a strategic advantage. It sets quantitative objectives for growth in core competencies and for the alignment of performance across the individual, team, unit, and organizational levels. These measures establish the quantitative foundation for evaluating trends in the capability of the organization's workforce. Further, it seeks to maximize the effectiveness of applying these competencies by developing teams that integrate complementary knowledge and skills.

At the Managed level, high-performance teams composed of people with complementary knowledge and skills are developed where conditions support their functioning. Team-building activities are performed to improve the effectiveness of these teams. When applied to teams,

workforce practices are tailored to support team development and performance.

Mentors are made available to both individuals and teams. Mentors use their experience to provide personal support, guidance, and some skill development. Mentors also provide another way to retain and disseminate lessons learned across the organization.

Organizational growth in each of the organization's core competencies is quantitatively managed. Data on the level of core competencies in the organization are analyzed to determine trends and capability. These competency trends are then used to evaluate the effectiveness of competency-related workforce practices. In addition, performance data are collected and analyzed for trends in the alignment of performance at the individual, team, unit, and organizational levels. Trends in the alignment of performance are used to evaluate the effectiveness of performance-related workforce practices. These trends are tracked against the objectives set in the strategic and near-term workforce plans.

The workforce capability of Level 4 organizations is predictable because the current capability of the workforce is known quantitatively. The organization has also developed a mechanism for deploying its competencies effectively through high-performance, competency-based teams. Future trends in workforce capability and performance can be predicted because the capability of the workforce practices to improve the knowledge and skills of the workforce is known quantitatively. This level of workforce capability provides the organization with an important predictor of trends in its business capability.

2.1.5   Level 5 - The Optimizing Level

At the Optimizing level, there is a continuous focus on improving individual competencies and finding innovative ways to improve workforce motivation and capability. The organization supports

individuals' effort toward continuous development of personal
competencies. Coaches are provided to support further development of
personal or team competencies.

Data on the effectiveness of workforce practices are used to identify needs
for innovative workforce practices or technologies. Innovative practices
and technologies are evaluated and the most promising are used in
exploratory trials. Successful innovations are then transferred into use
throughout the organization.

The workforce capability of Optimizing organizations is continuously
improving because they are perpetually improving their workforce
practices. Improvement occurs both by incremental advancements in
their existing workforce practices and by adoption of innovative practices
and methods that may have a dramatic impact. The culture created in an
Optimizing organization is one in which all members of the workforce are
striving to improve their own, their team's, and their unit's knowledge,
skills, and motivation in order to improve the organization's overall
performance. The workforce practices are honed to create a culture of
performance excellence.

2.2   The Key Process Areas of the P-CMM

Figure 2.2 displays the key process areas for each of the five maturity levels
in the P-CMM. Each *key process area* (KPA) identifies a cluster of related
activities that, when performed collectively, achieve a set of goals
considered important for enhancing workforce capability. Key process
areas have been defined to reside at a single maturity level.

Key process areas identify the capabilities that must be institutionalized to
achieve a maturity level. They describe the practices that an organization
should implement to improve its workforce capability.
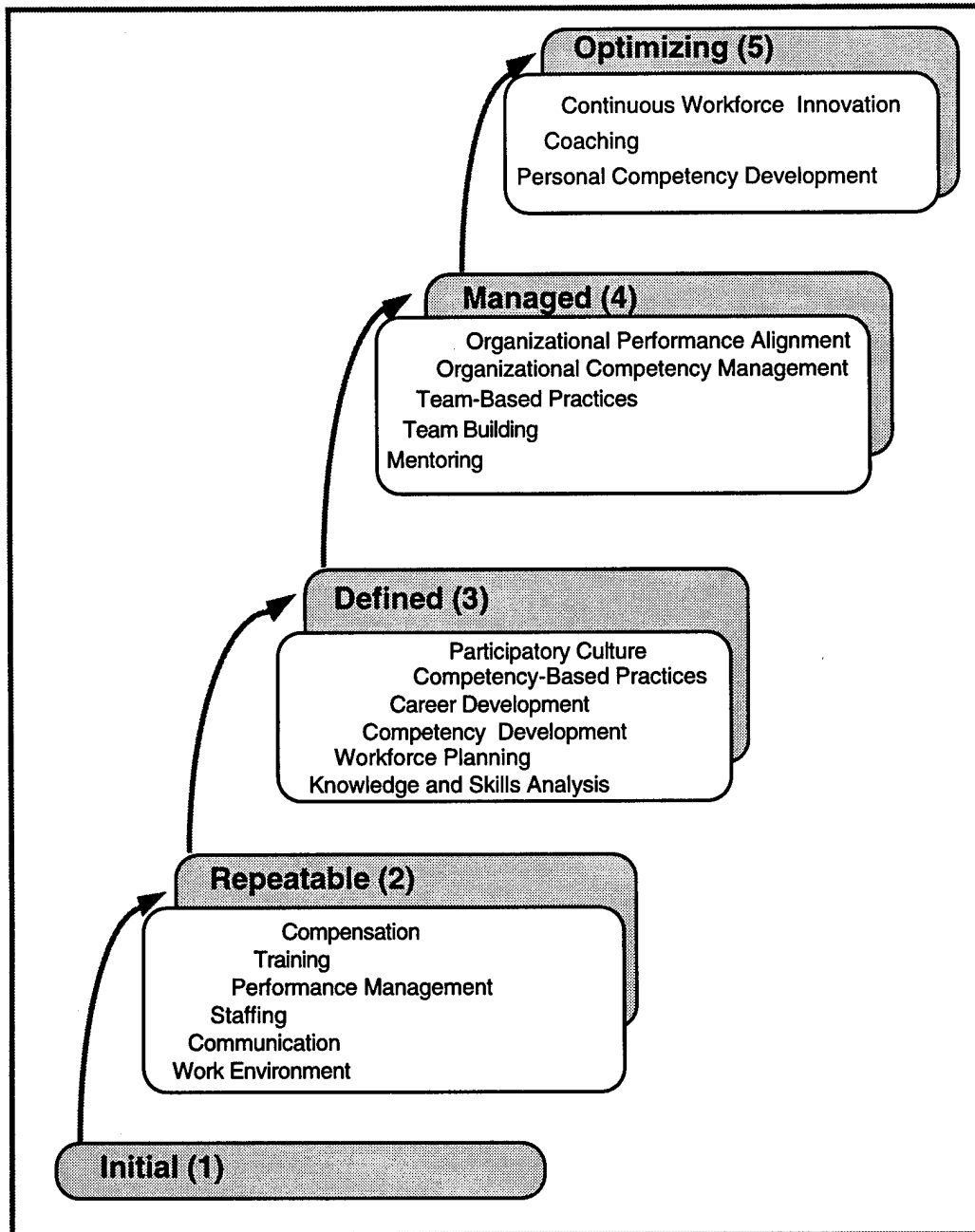
Figure 2.2 The Key Process Areas of the P-CMM by Maturity Level

2.2.1 Key Process Areas at the Repeatable Level

The key process areas at the Repeatable level focus on establishing basic workforce practices and eliminating problems that hinder work performance. Descriptions of each of the six key process areas at Level 2 are presented below:

❑ **Work Environment** is designed to establish and maintain working conditions that allow individuals to concentrate on their tasks without unnecessary or inappropriate distractions. Work Environment involves ensuring that an appropriate work environment exists, that the work environment complies with all applicable laws and regulations, that improvements are made that will enhance performance, that impediments to performance are removed, and that distractions are minimized.

❑ **Communication** is designed to establish a social environment that supports effective interaction and to ensure that the workforce has the skills to share information and coordinate their activities efficiently. Communication involves establishing effective top-down and bottom-up communication mechanisms within the organization, and ensuring that all individuals have the necessary communications skills to perform their tasks, coordinate effectively, conduct meetings efficiently, and resolve problems.

❑ **Staffing** is designed to establish and use a formal process by which talent is recruited, selected, and transitioned into assignments in the organization. Recruiting involves identifying the knowledge and skill requirements for open positions, motivating all individuals to seek out qualified candidates, announcing the availability of positions to likely sources of candidates, and reviewing the effectiveness of recruiting efforts. Selection involves developing a list of qualified candidates, defining a selection strategy, identifying qualified candidates, thoroughly evaluating qualified candidates, and selecting the most qualified candidate. Transitioning involves attracting

selected candidates, orienting them to the organization, and ensuring their successful transition into their new positions.

❑ **Performance Management** is designed to establish objective criteria against which unit and individual performance can be measured, to provide performance feedback, and to enhance performance continuously. Performance Management involves establishing objective criteria for unit and individual performance, discussing performance regularly and identifying ways to enhance it, providing periodic feedback on performance, identifying development needs, and systematically addressing performance problems or rewarding extraordinary performance.

❑ **Training** is designed to ensure that all individuals have the skills required to perform their assignments. Training involves identifying the skills required to perform critical tasks, identifying training needs within each unit, and ensuring that needed training is received.

❑ **Compensation** is designed to provide all individuals with remuneration and benefits based on their contribution and value to the organization. Compensation includes developing a documented compensation strategy, developing a plan for administering compensation, and making periodic adjustments to compensation based on performance.

2.2.2 Key Process Areas at the Defined Level

The key process areas at the Defined level address organizational issues, as the organization tailors its defined workforce practices to the core competencies required by its business environment. Descriptions of each of the six key process areas for Level 3 are given below:

❑ **Knowledge and Skills Analysis** is designed to identify the knowledge and skills required to perform core business processes so that they may be developed and used as a basis for workforce practices. Knowledge and Skills Analysis involves identifying the business processes in which the organization must maintain competence, developing profiles of the knowledge and skills needed to perform these business functions, maintaining a knowledge and skills inventory, and identifying future knowledge and skill needs.

❑ **Workforce Planning** is designed to coordinate workforce activities with current and future business needs at both the organizational and unit levels. Workforce Planning involves developing a strategic workforce plan that sets organization-wide objectives for competency development and workforce activities, and developing near-term plans to guide the workforce activities of each unit.

❑ **Competency Development** is designed to constantly enhance the capability of the workforce to perform their assigned tasks and responsibilities. The core competencies identified in Knowledge and Skills Analysis and Workforce Planning provide the foundation for the organization's development and training program. Competency Development involves establishing training and other development programs in each of the organization's core competencies. Development activities are designed to raise the level of knowledge and skill in the organization's current and anticipated core competencies.

❑ **Career Development** is designed to ensure that all individuals are motivated and are provided opportunities to develop new skills that enhance their ability to achieve career objectives. Career Development includes discussing career options with each individual, developing a personal development plan, tracking progress against it, identifying training opportunities, and making assignments that enhance career objectives.

❑ **Competency-Based Practices** is designed to ensure that all workforce practices are based in part on developing the knowledge and skills of the workforce. Competency-Based Practices involves recruiting against knowledge and skill needs, basing selection methods on assessing the knowledge and skills of candidates, assessing job performance against the tasks and roles assigned to the position, and basing compensation at least in part on growth in knowledge and skills.

❑ **Participatory Culture** is designed to ensure a flow of information within the organization, to incorporate the knowledge of individuals into decision-making processes, and to gain their support for commitments. Establishing a participatory culture lays the foundation for building high-performance teams. Participatory Culture involves establishing effective communications among all levels of the organization, seeking input from individuals, involving individuals in making decisions and commitments, and communicating decisions to them.

2.2.3 Key Process Areas at the Managed Level

The key process areas at the Managed level focus on building competency-based teams and establishing a quantitative understanding of trends in the development of knowledge and skills and in the alignment of performance across different levels of the organization. Analyses of the five key process areas at this level are highly interdependent, as described below:

❑ **Mentoring** is designed to use the experience of the organization's workforce to provide personal support and guidance to other individuals or groups. This guidance can involve developing knowledge and skills, improving performance, handling difficult situations, and making career decisions. Mentoring involves setting objectives for a mentoring program, designing mentoring activities to

achieve these objectives, selecting and training appropriate mentors, assigning mentors to individuals or groups, establishing mentoring relationships, and evaluating the effectiveness of the mentoring program.

❑ **Team Building** is designed to capitalize on opportunities to create teams that maximize the integration of diverse knowledge and skills to perform business functions. Team Building involves matching potential team members to the knowledge and skill requirements of the team, training all new members in team skills, defining objectives for team performance, tailoring standard processes for use by the team, and periodically reviewing team performance.

❑ **Team-Based Practices** is designed to tailor the organization's workforce practices to support the development, motivation, and functioning of teams. Team-Based Practices involves ensuring that the work environment supports team functions, setting performance criteria and reviewing team performance, involving team members in performing workforce activities, and reflecting team criteria in individual compensation decisions.

❑ **Organizational Competency Management** is designed to increase the capability of the organization in its core competencies and to determine the effectiveness of its competency development activities in achieving specific competency growth goals. Organizational Competency Management involves setting measurable goals for growth in the organization's core competencies, defining and collecting data relevant to them, analyzing the impact of competency development activities on achieving these goals, and using the results to guide the application and improvement of competency development activities.

❑ **Organizational Performance Alignment** is designed to enhance alignment of performance results at the individual, team, unit, and

organizational levels with the appropriate goals and to quantitatively assess the effectiveness of workforce practices on achieving alignment. Organizational Performance Alignment involves setting measurable goals for aligning performance at the individual, team, unit, and organizational levels, defining the data and analyses, collecting the data, analyzing trends against objectives, acting on exceptional findings, analyzing the impact of people-related practices on performance alignment, and reporting results.

2.2.4 Key Process Areas at the Optimizing Level

The key process areas at the Optimizing level cover the issues that both the organization and individuals must address in implementing continuous improvements in their capability. Descriptions of each of the three key process areas for Level 5 are given below:

❑ **Personal Competency Development** is designed to provide a foundation for professional self development. Personal Competency Development consists of a voluntary program for continuously improving individual work processes. This program involves developing goals and plans for personal work activities, establishing and using defined personal processes, measuring and analyzing the effectiveness of these personal processes, and implementing improvements to them.

❑ **Coaching** is designed to provide expert assistance to enhance the performance of individuals or teams. Coaches engage in close relationships with individuals or teams to guide development of skills that improve performance. Coaching involves selecting appropriate coaches, analyzing data on personal or team performance, providing guidance on methods for improving performance, and evaluating progress toward goals for improving performance.

❑ **Continuous Workforce Innovation** is designed to identify and evaluate improved workforce practices and technologies, and implement the most promising ones throughout the organization. Continuous Workforce Innovation involves establishing a mechanism for proposing improvements in workforce activities, identifying needs for new practices and technologies, surveying and evaluating innovative practices and technologies, conducting exploratory trials of new practices and technologies, and implementing the most beneficial ones across the organization.

2.3 Themes in the P-CMM

By definition, key process areas are expressed at a single maturity level. There are, however, relationships between the key process areas that stretch across maturity levels. These relationships establish four themes that run through the P-CMM:

❑ developing capabilities

❑ building teams and culture

❑ motivating and managing performance

❑ shaping the workforce

The key process areas are mapped to the four themes in Figure 2.3. Each of these themes are represented as process categories in the figure, and the four themes are described in further detail below. These process categories help organize an understanding of the structure of the P-CMM and relationships of the key process areas within the P-CMM.

The existence of these themes implies that improvements in some areas need not be restricted to a single key process area, but can include an integrated set of practices from several process areas. Further, the implementation of key process areas at one level can be seen as establishing the basis for practices and capabilities at the next level.

Maturity Levels	Process Categories			
	Developing capabilities	Building teams and culture	Motivating and managing performance	Shaping the workforce
5 Optimizing	Coaching Personal Competency Development	Continuous Workforce Innovation		
4 Managed	Mentoring	Team Building	Organizational Performance Alignment Team-Based Practices	Organizational Competency Management
3 Defined	Competency Development Knowledge and Skills Analysis	Participatory Culture	Competency-Based Practices Career Development	Workforce Planning
2 Repeatable	Training Communication	Communication	Compensation Performance Management Work Environment	Staffing
1 Initial				

Figure 2.3   The Key Process Areas Assigned to Process Categories

Developing capabilities — The effort to develop the capabilities of the people in the organization begins at the Repeatable level with identifying the immediate training needs of people in each unit (Training). Oral and written communication capabilities are improved through training (Communication). At the Defined level the organization takes a more systematic look at the knowledge and skills required to perform the organization's business processes (Knowledge and Skills Analysis) and

identifies core competencies. The organization also establishes an organization-wide development program for these competencies (Competency Development). At the Managed level mentors are provided to guide individuals or teams in their development (Mentoring). Finally, at the Optimizing level, people can initiate an individual program to develop their competencies (Personal Competency Development), and coaches will be provided for those who want assistance (Coaching). The maturity trend in developing the workforce starts with identifying current training needs within a unit, graduates to the identification of core competencies that are developed by the organization, and then returns to individuals being able to establish their own program of professional development.

Building teams and culture — The effort to improve the ways in which people are organized and interact in the organization begins at the Repeatable level with a focus on improving both the formal and interpersonal communications within the organization (Communication). At the Defined level the organization develops a participatory culture by increasing the involvement of the workforce in decisions that affect their work (Participatory Culture). At the Managed level the organization begins building high-performance, competency-based teams and provides them with an appropriate level of autonomy (Team Building). At the Optimizing level the organization continuously searches for innovative ways to improve the culture or the functioning of teams (Continuous Workforce Innovation). The maturity trend in building teams and culture begins with establishing basic communication skills, grows to developing a participatory culture, and continues on into formal team building and continuous improvement of team capabilities.

Motivating and managing performance — The focus on motivation and performance begins at the Repeatable level with establishing an environment that has adequate resources and does not impede or distract from job performance (Work Environment). Discussions about how to improve performance are held periodically, unacceptable performance is managed, and recognition is provided for outstanding performance (Performance Management). The basic compensation and benefits system is defined at this level, and its administration is partly tied to performance

(Compensation). At the Defined level the workforce practices established at the Repeatable level are adapted to motivate the development of core competencies (Competency-Based Practices). The organization also establishes a set of graduated career opportunities designed to motivate and reward people for developing additional skill (Career Development). At the Managed level the workforce practices are again adapted, this time for use with competency-based teams (Team-Based Practices). The organization also sets and tracks targets for the alignment of performance at the individual, team, unit, and organizational levels (Organizational Performance Alignment). At the Optimizing level the organization searches for innovative workforce practices and technologies that can further motivate or enhance competency development or work performance (Continuous Workforce Innovation). The maturity trend in motivating and managing performance begins with establishing basic performance management and compensation practices, then improves these practices through adapting them to competency development and team building, and then looks for constant sources of innovation.

Shaping the workforce — The effort to shape the workforce to meet business needs begins at the Repeatable level by establishing basic practices for recruiting, selecting among job candidates, and orienting people into new assignments (Staffing). At the Defined level the organization begins developing strategic and near-term plans for ensuring that it has the core competencies that it needs to meet current and future business demands (Workforce Planning). At the Managed level the organization sets and tracks targets for the development of knowledge and skill in each of its core competencies (Organizational Competency Management). At the Optimizing level the organization searches for innovative practices or technologies to help shape its workforce (Continuous Workforce Innovation). The maturity trend in shaping the workforce begins with establishing basic staffing practices, grows to developing plans for workforce development, sets and tracks objectives for competencies in the workforce, and then looks for constant sources of innovation.

3 Applying the People CMM

The P-CMM adapts the architecture and the maturity framework underlying the CMM for use with people-related improvement issues. The CMM focuses on helping organizations improve their software development processes. By adapting the maturity framework and the CMM architecture, activities guided by the P-CMM can be more easily integrated into existing software process improvement programs. This section discusses using the P-CMM to guide the people-related aspects of an improvement program.

The value of the P-CMM is in the way that organizations use it. The P-CMM can be applied by an organization in two primary ways:

❑ as a standard for assessing workforce practices
❑ as a guide in planning and implementing improvement activities

Each key process area in the P-CMM is organized into five sections called common features. The common features (Commitment to Perform, Ability to Perform, Activities Performed, Measurement and Analysis, and Verifying Implementation) specify the key practices that, when collectively addressed, accomplish the goals of the key process area. Some of these common features implement the practices, while other common features establish the support needed to institutionalize their performance. These key practices are contained in the *People Capability Maturity Model (P-CMM)* [Curtis95].

3.1 P-CMM-Based Assessments

The P-CMM provides a standard against which the workforce practices of an organization can be assessed. A P-CMM-based assessment may be conducted by itself, or jointly with some other assessment of the organization, such as an employee opinion assessment or software process assessment. The assessment team for a P-CMM-based assessment would include at a minimum someone skilled in conducting such assessments,

someone who will be involved in making P-CMM-related improvements, and someone from the human resources function. A single person may fill more than one of these roles.

During the fall of 1995 a P-CMM-based assessment method will be developed, and trial use of this method is scheduled for late 1995 and into 1996. This assessment method is planned to be compliant with the CMM Appraisal Framework [Masters95], but it will be tailored so it consumes less time and resources than a traditional software process assessment or CMM-based assessment. P-CMM-related training courses will also be available in 1996.

When a P-CMM-based assessment is conducted jointly with a software process assessment, data for the P-CMM-based assessment should be gathered separately, since the unit of study is not a project, as it is during a software process assessment. Because of its content, the P-CMM focuses on organizational units such as groups, sections, and departments, and how workforce practices are conducted within these units. Even so, a P-CMM-based assessment will use many of the same conventions as a software process assessment. For example, both are performed by a trained assessment team, collect some initial data using questionnaires, observe confidentiality of the information obtained, and interview people at different levels of the organization. The results of a P-CMM-based assessment might be presented at the same time as those of a process assessment, but they should be presented as a separate analysis of the organization.

A P-CMM-based assessment will look at workforce practices as actually performed across the organization. The P-CMM assessment team determines whether a practice is implemented broadly across the organization and is institutionalized. The assessment team determines whether the goals and intent of each key process area have been implemented. However, they need not assess key process areas for maturity levels that are clearly beyond the current maturity of the organization.

The results of a P-CMM-based assessment are presented as a profile of the organization's strengths and weaknesses against the key process areas of the P-CMM. The maturity level of an organization is the lowest level for which all of the key process areas have been successfully implemented. The results of the assessment indicate the practices or process areas that the organization should consider when initiating an improvement program.

In the future, the P-CMM should help an organization compare the maturity of its workforce practices with the state of the practice across industry. Using the P-CMM as a benchmark will require that P-CMM-based assessments be submitted to a common repository, such as the Process Appraisal Information System (PAIS) at the SEI. These data will indicate trends in the industry in addition to providing a benchmark.

3.2 Using the P-CMM as a Guide for Improvement

3.2.1 Guidance Provided by the P-CMM

The P-CMM provides guidance for implementing practices in an organizational improvement program. There are two levels of guidance provided by the P-CMM: guidance on a strategy for developing the organization over time and guidance on practices that the organization can employ to solve explicit problems or shortcomings in its workforce practices.

In providing guidance, the P-CMM does not specify the explicit workforce practices to be implemented. Rather, it sets a framework for selecting and tailoring practices to the organization's history, culture, and environment. There are many professional sources that describe specific methods for

workforce practices such as performance management, team building, and training.

The P-CMM does not provide guidance on how to implement the improvement program itself. The P-CMM is a roadmap for organizational growth and needs to be coupled with a model of how to implement an improvement program. A model for conducting improvement programs will be presented in Section 3.4.

3.2.2 Skipping Maturity Levels

The maturity levels in the P-CMM describe the characteristic practices of an organization at that maturity level. Each level forms a foundation on which an organization can build workforce practices effectively and efficiently at succeeding maturity levels. However, an organization can occasionally benefit from implementing processes described at a higher maturity level even though it has not satisfied all the key process areas at a lower maturity level.

The P-CMM should not be interpreted as prohibiting practices or activities from higher maturity levels that the organization finds beneficial. For example, team-related processes are not discussed in the P-CMM until the Managed level, yet organizations at the Initial level may have implemented self-managed teams for some activities, or may even have a long history of using mentors. Similarly, a less mature organization may be able to train its workforce in areas that would correspond to core competencies (Defined level), provide team-based incentives (Managed level), or use mentors (Managed level).

Improvement of personal competencies is the focus of an Optimizing key process area; however, understanding and improving individual work processes, through such means as the application of the Personal Software Process [Humphrey95a, 95b], can provide substantial individual benefits at lower maturity levels. These practices should be institutionalized

throughout the organization when the organization achieves the
Optimizing level.

If the organization sees the opportunity to benefit from a higher maturity
practice and can support its performance, then the organization should
implement it. However, the ability to implement practices from higher
maturity levels does not imply that maturity levels can be skipped
without risk. There is risk in implementing practices without the proper
foundation being developed beneath them. For example, the team-
building literature contains many examples of failed teams [Mohrman95].
These failures occurred because the foundation in communication skills
and participatory culture had not been properly developed. Similarly,
many innovative motivational practices fail to work effectively in an
environment where there are no objective performance criteria or where
basic performance management practices are performed inconsistently.

Skipping levels is counterproductive because each level forms a necessary
foundation upon which the next level can be built. The P-CMM was
designed to develop the supporting foundation needed to ensure that
higher level practices could achieve their full impact on raising workforce
capability. Processes without the proper foundation fail at the very point
they are needed most – under stress – and they provide no basis for future
improvement.

3.3   Locating a P-CMM-Based Improvement Program in the Organization

Organizations are initially inclined to house the coordination of a P-CMM-
based improvement program in the human resources function. However,
there is a strong belief that this is not the most effective home for such a
program. The P-CMM Advisory Board, many of whom are human
resources executives, was strong in its belief that P-CMM-based
improvements not be perceived as a function of the human resources

group. Rather, they strongly advised that people-related improvements be integrated with existing software process improvement programs.

The P-CMM Advisory Board recommended that a human resources professional be added to the software engineering process group (SEPG) to work on P-CMM-based improvements. Thus, the message carried to software executives is, "We have a program to address the improvement of your overall software operation. This program includes components that address process, technology, and people." The P-CMM part of the improvement program is where the people-related practices are addressed.

Many human resources professionals have reported a frustration in not being considered part of the mainstream of the organization. Accordingly, they are concerned that an improvement program coming from the human resources function will not be considered a critical part of the improvement effort. Accordingly, including P-CMM improvements as part of the overall improvement program that is housed in a development organization provides a vehicle for human resources professionals to partner in a mainstream effort to improve the business. Further, coordinating P-CMM-based improvements from the SEPG includes members of the workforce directly in making improvements that affect them. This involvement instills a greater sense of ownership of the improved practices.

3.4 Implementing a P-CMM-Based Improvement Program

The SEI has developed a model for improvement programs that is grounded in several years experience with and lessons learned from software process improvement programs. This model, presented in Figure 3.1, is a life cycle for organizing the phases of an improvement program. It is called the IDEAL[SM] model after the first letters in each of its

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SM IDEAL is a service mark of Carnegie Mellon University.

five phases: initiating, diagnosing, establishing, acting, and leveraging. In the following paragraphs, an approach to conducting a P-CMM-based improvement program will be presented through the phases of the IDEAL model.
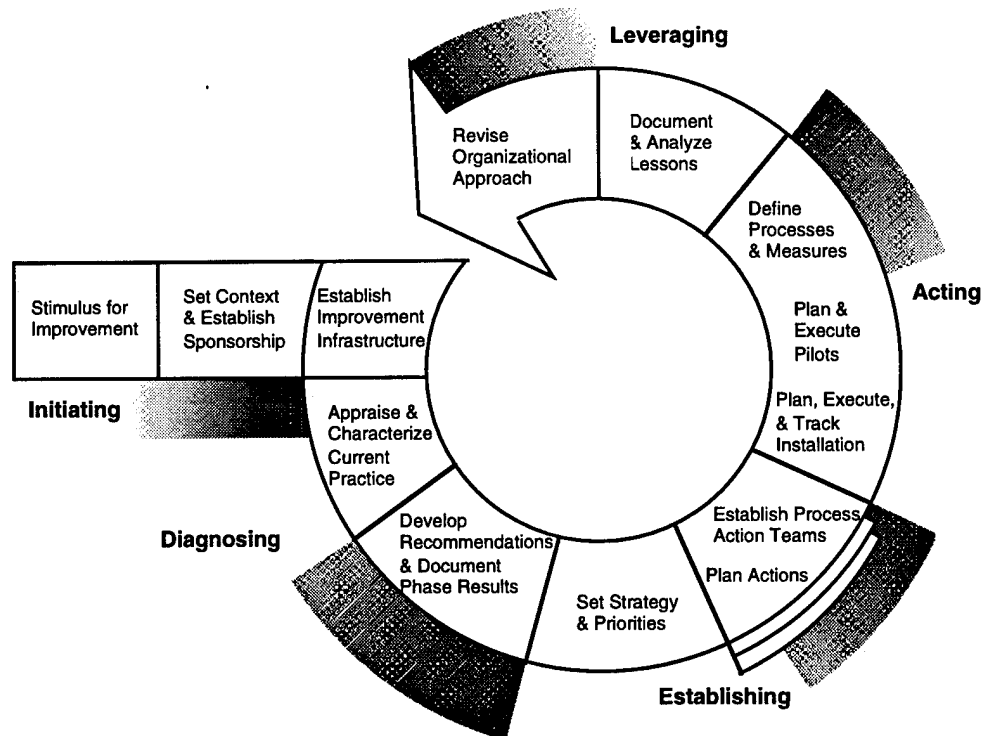
Figure 3.1 The IDEAL^{SM} Model

One of the clearest lessons that we have learned is that successful improvement programs must be run like any other project. That is, they must have plans, their progress must be tracked, and someone must be held accountable for their performance. The IDEAL model presents a proven life cycle that can be used to manage and guide an improvement program in the same way that a standard development life cycle is used with a software development project.

The first stage of IDEAL is the *Initiating* phase, wherein executive support is engaged and the infrastructure for improvement is organized. The most common reason for the failure of improvement programs is lack of executive support. The program should not be initiated until executive support is ensured. The effort begins with one or more briefings to executives. These briefings should include information about

❏ the benefits of P-CMM-based improvements such as reduced turnover and greater readiness to perform in fast-paced environments

❏ a description of the effort and schedule involved in the improvement program

❏ executive responsibilities under the P-CMM and in supporting the improvement program

Once executive support is ensured, the infrastructure for improvement should be organized. There are several groups that should be created to run the improvement program. The program should be run from an improvement group such as an SEPG or some other entity that reports to line management in the organization. If no such group exists, then one should be created explicitly for making people-related improvements. Such a group should include people with expertise in human resources and in software development. Such a cross-functional team has the best chance of making sensible improvements in the organization.

The improvement group should report to a Management Steering Committee that oversees and approves the improvement effort. This group should have representation both from line operations and from the human resources function. It should have immediate knowledge of how various people-related practices are being performed within the organization and a vision for improving the current practices. The steering group must also have authority to commit some of their own people to improvement activities.

Once executive support and an infrastructure for improvement have been established, the organization then prepares to enter the *Diagnostic* phase. During this phase, the organization conducts a P-CMM-based assessment

and develops the findings and recommendations. P-CMM-based assessments have been discussed in Section 3.1.

With the assessment results in hand, the organization is ready to enter the *Establishing* phase. In this phase, the improvement team selects several of the most pressing problems for action and gets the Management Steering Committee to approve this strategic selection. Since the organization can absorb only a limited amount of change at one time, only the most serious problems should be chosen for action.

An action team should then be organized to address each problem. The members of the action team should be chosen to ensure that it contains expertise both in the problem and in the method of solution. For instance, an action team addressing performance management in a software organization should have people who understand the criteria against which software performance should be measured, how best to work with software engineers in analyzing job performance, the methods of evaluating job performance, what kind of recognition and rewards motivate software engineers, and other related topics that are covered in the Performance Management key process area. Such a team will consist of people who know software and people who understand performance management methods.

One of the first duties of the team is to develop an action plan that addresses planned improvements in their problem area. Developing and tracking such an action plan is one of the distinguishing factors of successful improvement teams. To ensure that the action team stays on a successful trajectory, the team should be facilitated by someone from the core improvement group.

Once the action team has developed a basic plan for its activities, it launches into the *Acting* phase. The action team should identify best workforce practices that are already being used in the organization and build around them. Additional practices can be identified to implement a key process area completely. Any proposed workforce practices should be

reviewed by the action team with those who are expected to implement them.

The practices that have been defined should usually be tested to ensure that they work as expected before being installed across the organization. After a successful trial has been conducted, then the practices can be implemented across the organization and institutionalized. Institutionalization implies that there is enough infrastructure developed in the organization to ensure that the practices are continually practiced even with the inevitable movement of people to new responsibilities and the assignment of new people.

When the action teams have completed implementing practices in their assigned areas, then the organization can complete the IDEAL cycle with the *Leveraging* phase. In this phase, the action teams assess their lessons learned in developing and implementing their improvements, and the improvement group determines how the process of future improvement efforts can be enhanced. They then begin planning the next implementation of an IDEAL cycle to make the next round of improvements. Since executive support should remain strong if a successful implementation has been completed, the improvement team can begin planning the next P-CMM-based assessment.

IDEAL is a repeating cycle that establishes a continuous improvement capability within the organization. The IDEAL cycle is a version of the Shewart-Deming plan-do-check-act improvement cycle. As such it has much in common with other total quality management improvement activities. The use of IDEAL with workforce improvements implies that many of the same principles that have been used for improving other aspects of organizational life can be used in improving the development of the workforce.

3.5 Integrating Maturity-Based Improvement Programs

The P-CMM applies the essential elements of a capability maturity model to the workforce practices of the organization. Therefore, organizations that have some experience in applying the CMM to improve their software development processes will find the P-CMM to be compatible with an improvement philosophy they have already adopted. Both the CMM and P-CMM can be used in an IDEAL improvement cycle.

Using the CMM and P-CMM together in an improvement program begs the question of whether the organization should synchronize its maturity levels on the two models. Maturity growth on one model does not require or restrict maturity growth on the other. However, maturity growth on either model probably assists in maturity growth on the other.

Both models begin at the Repeatable level by emphasizing the responsibility of project or unit managers for installing basic discipline in their environments. Creating this basic discipline using either model aids in creating the management attitudes that support growth in the other model. Basic management discipline will aid both the process of developing software or the process of developing the workforce.

At the Defined level, the analysis of knowledge and skills and the determination of core competencies requires an understanding of the work being performed. Thus, it is probably best that the organization have defined its software process before it begins defining the knowledge and skills required by the competencies involved in its specific software activities. This may be the area of dependency between the two models. Certainly the concepts of an organization-wide way of performing technical activities and of an organization's core competencies fit well together, each supporting development in the other. The P-CMM activities for defining and developing core competencies elaborate and extend the required training program activities described in the CMM.

At the Managed level, the data being generated by the software process provide an excellent source of information on whether the development of knowledge and skills is being effective, and where shortfalls might exist. That is, a mature software process will provide data that can be used in analyzing the trends that form the core of managing the organization's competency development and performance alignment. At the same time, the development of high-performance, competency-based teams instills the kind of empowerment that has been observed in high-maturity organizations [Billings94, Paulk95].

At the Optimizing level, both models emphasize establishing continuous improvement as an ordinary process. Both models also seek to engage individuals in making the continuous improvement of their own work a personal objective. Thus, at the Optimizing level the models begin to merge in their search for ways to improve performance continuously. At this level, the capability of the process will probably be difficult to distinguish from the capability of the workforce.

Since both the CMM and P-CMM share similar underlying philosophies about how to change and mature an organization, it should not be surprising that they support each other at each level of maturity. The challenge for an organization initiating an improvement program that has both CMM and P-CMM components is to integrate an improvement strategy that allows improvements guided by one model to help create an environment that supports improvements guided by the other model. At the same time, the organization must always balance the amount of change being undertaken so that the workforce is not inundated with change activities that interfere with conducting the organization's business. An organization that can balance these tensions and improvement strategies will find that it has a powerful competitive advantage in a well-defined process being executed by a well-prepared and motivated workforce.

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Appendix: Goals for Each Key Process Area

The goals for each P-CMM key process area are listed by maturity level below. Figure A.1 depicts the key process areas within each maturity level.
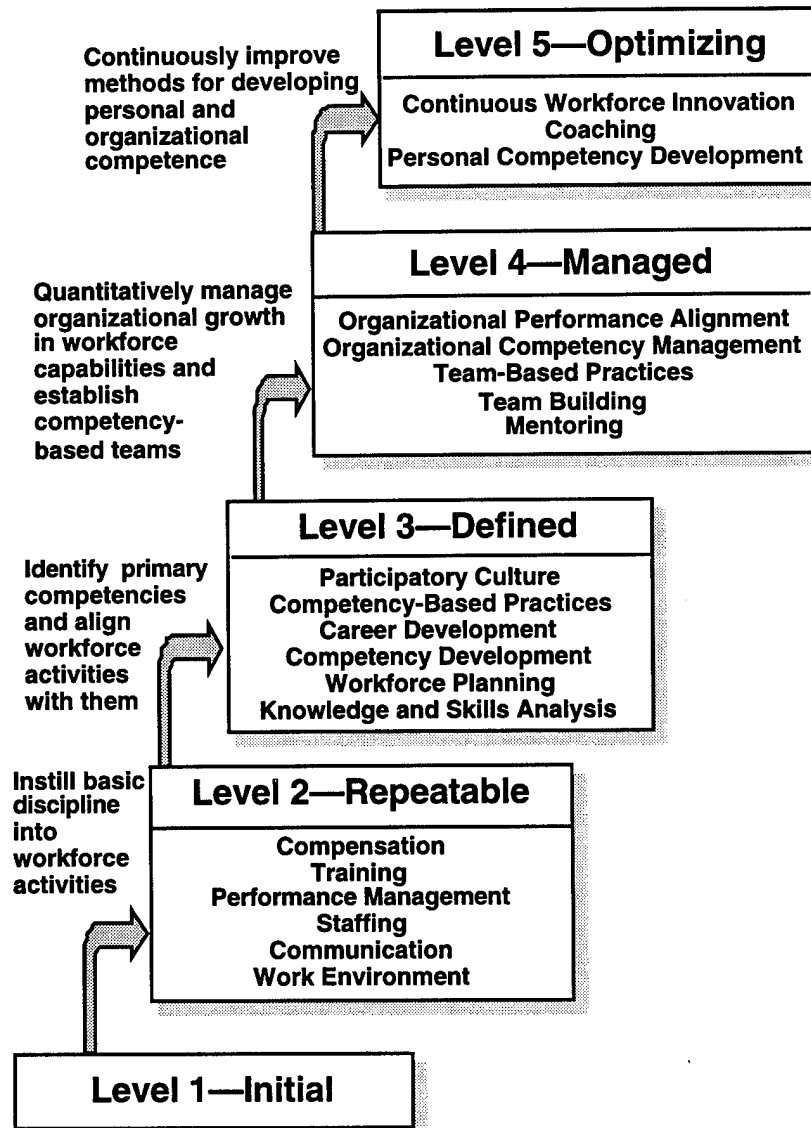
Continuously improve methods for developing personal and organizational competence

Level 5—Optimizing

Continuous Workforce Innovation
Coaching
Personal Competency Development

Quantitatively manage organizational growth in workforce capabilities and establish competency-based teams

Level 4—Managed

Organizational Performance Alignment
Organizational Competency Management
Team-Based Practices
Team Building
Mentoring

Identify primary competencies and align workforce activities with them

Level 3—Defined

Participatory Culture
Competency-Based Practices
Career Development
Competency Development
Workforce Planning
Knowledge and Skills Analysis

Instill basic discipline into workforce activities

Level 2—Repeatable

Compensation
Training
Performance Management
Staffing
Communication
Work Environment

Level 1—Initial

Figure A.1   P-CMM Key Process Areas

A.1 The Key Process Areas for Level 2: Repeatable

The goals of Work Environment are

1. An environment that supports the performance of business processes is established and maintained.

2. The resources needed by the workforce to perform their assignments are made available.

3. Distractions in the work environment are minimized.

The goals of Communication are

1. A social environment that supports task performance and coordination among individuals and groups is established and maintained.

2. Information is shared across levels of the organization.

3. Individuals develop skills to share information and coordinate their activities.

4. Individuals are able to raise grievances and have them addressed by management.

The goals of Staffing are

1. The organization actively recruits for qualified talent.

2. The most qualified candidate is selected for each position.

3. Selected candidates are transitioned into their new positions.

4. Members of a unit are involved in its staffing activities.

The goals of Performance Management are

1. Job performance is measured against objective criteria and documented.

2. Job performance is regularly discussed to identify actions that can improve it.

3. Development opportunities are discussed with each individual.

4. Performance problems are managed.

5. Outstanding performance is recognized.

The goals of Training are

1. Training in the critical skills required in each unit is provided.

2. Individuals receive timely training that is needed to perform their assignments.

3. Training opportunities are made available to all individuals.

The goals of Compensation are

1. Compensation strategies and activities are planned, executed, and communicated.

2. Compensation is equitable relative to skill qualifications and performance.

3. Adjustments in compensation are made periodically based on defined criteria.

A.2 The Key Process Areas for Level 3: Defined

The goals of Knowledge and Skills Analysis are

1. The core competencies required to perform the organization's business processes are known.

2. Knowledge and skills profiles exist for each business process.

3. Knowledge and skills profiles are updated for anticipated future needs.

The goals of Workforce Planning are

1. The organization develops a strategic plan for long-term development of the competencies and workforce needed for its business operations.

2. Near-term workforce and competency development activities are planned to satisfy both current and strategic workforce needs.

3. The organization develops talent for each of its key positions.

4. The organization tracks performance in achieving its strategic and near-term workforce development objectives.

The goals of Competency Development are

1. The organization knows its current capability in each of the core competencies required to perform its business processes.

2. The organization develops capabilities in its core competencies.

3. Individuals develop their knowledge and skills in the organization's core competencies.

The goals of Career Development are

1. Career development activities are conducted with each individual.

2. The organization offers career opportunities that provide growth in its core competencies.

3. Individuals are motivated to pursue career goals that optimize the value of their knowledge and skills to the organization.

The goals of Competency-Based Practices are

1. Workforce practices are tailored to motivate individuals and groups to improve their knowledge and skills in the core competencies of the organization.

2. Workforce activities are adjusted to support development in the core competencies of the organization.

3. Compensation and reward strategies are tailored to motivate growth in the core competencies of the organization.

The goals of Participatory Culture are

1. Communication activities are enhanced to improve the flow of information within the organization.

2. Decisions are made at the lowest appropriate level of the organization.

3. Individuals and groups participate in decision-making processes that involve their work or commitments.

A.3 The Key Process Areas for Level 4: Managed

The goals of Mentoring are

1. Mentoring activities are matched to defined objectives.

2. Mentors are selected and prepared for their responsibilities.

3. Mentors are made available for guidance and support to other individuals or groups.

The goals of Team Building are

1. Teams are formed to improve the performance of interdependent tasks.

2. Team assignments are made to integrate complementary knowledge and skills.

3. Team members develop their team skills.

4. Team members participate in decisions regarding their work.

5. The organization provides standard processes for tailoring and use by teams in performing their work.

The goals of Team-Based Practices are

1. The organization adjusts its workforce practices and activities to motivate and support the development of team-based competencies within the organization.

2. Workforce activities are tailored to support the needs of different types of teams within the organization.

3. Team performance criteria are defined and measured.

4. Compensation and reward systems are tailored to motivate improved team performance.

The goals of Organizational Competency Management are

1. Measurable goals for capability in each of the organization's core competencies are defined.

2. Progress toward achieving capability goals in the organization's core competencies is quantified and managed.

3. The knowledge and skills-building capability of the organization's competency development activities is known quantitatively for each of its core competencies.

The goals of Organizational Performance Alignment are

1. Measurable goals for aligning individual, team, unit, and organizational performance are defined.

2. Progress toward achieving performance alignment goals is quantified and managed.

3. The capability of workforce activities to align individual, team, unit, and organizational performance is known quantitatively.

A.4 The Key Process Areas for Level 5: Optimizing

The goals of Personal Competency Development are

1. Individuals know their capability in each of the competencies involved in their work.

2. Individuals continuously improve their knowledge and skills in the competencies involved in their work.

3. Participation in improving personal competencies is organization-wide.

The goals of Coaching are

1. Coaches are selected for their expertise and prepared for their responsibilities.

2. Coaches work with individuals to improve their personal competency and performance.

3. Coaches work with teams to improve their team-based competencies and performance.

The goals of Continuous Workforce Innovation are

1. Innovative workforce practices and technologies are evaluated to determine their effect on improving core competencies and performance.

2. The organization's workforce practices and activities are improved continuously.

3. Participation in improving the organization's workforce practices and activities is organization-wide.

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The People Capability Maturity Model(SM) (P-CMM[SM]) adapts the maturity framework of the Capability Maturity Model(SM) for Software (CMM[SM]) [Paulk 95], to managing and developing an organization's workforce. The motivation for the P-CMM is to radically improve the ability of software organizations to attract, develop, motivate, organize, and retain the talent needed to continuously improve software development capability. The P-CMM is designed to allow software organizations to integrate workforce improvement with software process improvement programs guided by the CMM. The P-CMM can also be used by any kind of organization as a guide for improving their people-related and

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ABSTRACT — continued from page one, block 19

workforce practices.

Based on the best current practices in the fields such as human resources and organizational development, the P-CMM provides organizations with guidance on how to gain control of their processes for managing and developing their workforce. The P-CMM helps organizations to characterize the maturity of their workforce practices, guide a program of continuous workforce development, set priorities for immediate actions, integrate workforce development with process improvement, and establish a culture of software engineering excellence. It describes an evolutionary improvement path from ad hoc, inconsistently performed practices, to a mature, disciplined development of the knowledge, skills, and motivation of the workforce, just as the CMM describes an evolutionary improvement path for the software processes within an organization.

The P-CMM consists of five maturity levels that lay successive foundations for continuously improving talent, developing effective teams, and successfully managing the people assets of the organization. Each maturity level is a well-defined evolutionary plateau that institutionalizes a level of capability for developing the talent within the organization.

This document provides an overview of the P-CMM. The P-CMM and its key practices are fully described in the People Capability Maturity Model(SM) (CMU/SEI-95-MM-02, September 1995).