



SEI 软件工程丛书·影印版

卡内基·梅隆大学软件工程研究所推荐·软件学院教材



# CMMI 集成过程改进

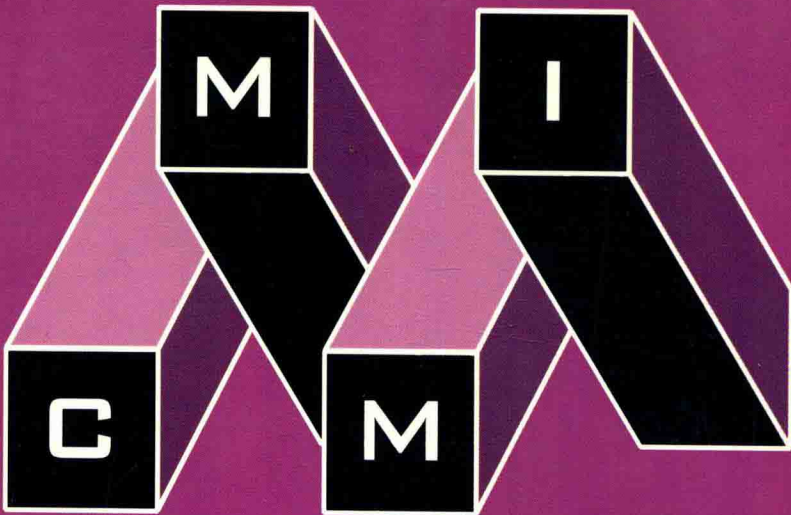
**CMMI Distilled:** A Practical Introduction to  
Integrated Process Improvement

丹尼斯·M·阿汉 [Dennis M. Ahern]

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著



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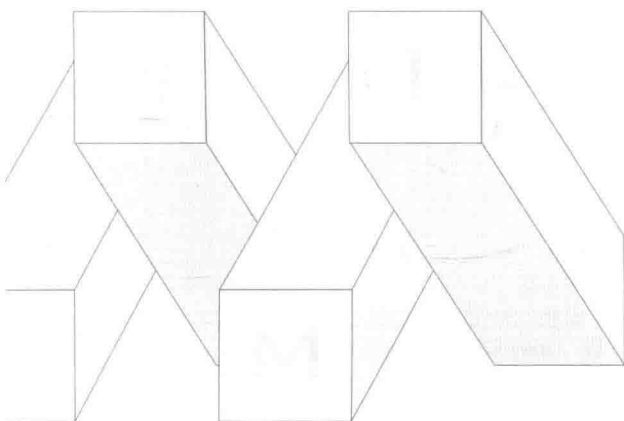
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北京

## 内 容 简 介

本书讲解了如何在 21 世纪的工程项目中, 突破了 20 世纪的过程改进系统的限制, 并教会你如何为自己的组织挑选合适的 CMMI 模型和工具。本书是集成过程改进系统的所有实现者的必修课。

本书是卡内基·梅隆大学软件工程研究所推荐的软件学院及高校软件专业相关课程的教材, 也可以供软件公司各级管理和开发人员参考。

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**Dennis M. Ahern, Aaron Clouse, Richard Turner**

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## 出版说明

1984年,美国国防部出资在卡内基·梅隆大学设立软件工程研究所(Software Engineering Institute,简称SEI)。SEI于1986年开始研究软件过程能力成熟度模型(Capability Maturity Model,CMM),1991年正式推出了CMM 1.0版,1993年推出CMM 1.1版。此后,SEI还完成了能力成熟度模型集成(Capability Maturity Model Integration,简称CMMI)。目前,CMM 2.0版已经推出。

CMM自问世以来备受关注,在一些发达国家和地区得到了广泛应用,成为衡量软件公司软件开发管理水平的重要参考因素,并成为软件过程改进的事实标准。CMM目前代表着软件发展的一种思路,一种提高软件过程能力的途径。它为软件行业的发展提供了一个良好的框架,是软件过程能力提高的有用工具。

SEI十几年的研究过程和成果,都浓缩在由SEI参与研究工作的资深专家亲自撰写的SEI软件工程丛书(SEI Series In Software Engineering)中。

为增强我国软件企业的竞争力,提高国产软件的水平,经清华大学出版社和三联四方工作室共同策划,全面引进了这套丛书,分批影印和翻译出版,这套丛书采取开放式出版,不断改进,不断出版,旨在满足国内软件界人士学习原版软件工程高级教程的愿望。

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# 总 序

周伯生

美国卡内基·梅隆大学软件工程研究所 (CMU/SEI) 是美国联邦政府资助构建的研究单位, 由美国国防部主管。他们确认, 为了保证软件开发工作的成功, 由软件开发人员、软件采办人员和软件用户组成的集成化团队必须具有必要的软件工程知识和技能, 以保证能按时向用户交付正确的软件。所谓“正确的”就是指在功能、性能和成本几个方面都能满足用户要求且无缺陷; 所谓“无缺陷”就是指在编码后对软件系统进行了彻底的穷举测试修复了所有的缺陷, 或保证所编写的代码本身不存在缺陷。

CMU/SEI 为了达到这个目的, 提出了创造、应用和推广的战略。这里的“创造”是指与软件工程研究社团一起, 共同创造新的实践或改进原有的实践, 而不墨守成规。这里的“应用”是指与一线开发人员共同工作, 以应用、改进和确认这些新的或改进的实践, 强调理论联系实际。这里的“推广”是指与整个社团一起, 共同鼓励和支持这些经过验证和确认的、新的或改进的实践在世界范围内的应用, 通过实践进行进一步的检验和提高。如此循环, 往复无穷。

他们把所获得的成就归纳为两个主要领域。一个是倡导软件工程管理的实践, 使软件组织在采办、构建和改进软件系统时, 具有预测的能力与控制质量、进度、成本、开发周期和生产效率的能力。另一个是改进软件工程技术的实践, 使软件工程师具有分析、预测和控制软件系统属性的能力, 其中包括在采办、构建和改进软件系统时, 能进行恰当的权衡, 作出正确的判断和决策。CMU/SEI 通过出版软件工程丛书, 总结他们的研究成果和实践经验, 是推广这两个领域经验的重大举措。

SEI 软件工程丛书由 CMU/SEI 和 Addison-Wesley 公司共同组织出版, 共分 4 个部分: 计算机和网络安全 (已出版了 2 本著作), 工程实践 (已出版了 8 本著作), 过程改进和过程管理 (已出版了 11 本著作), 团队软件过程和个体软件过程 (已出版了 3 本著作)。前两者属于软件

工程技术实践,后两者属于软件工程管理实践。目前这4个部分共出版了24本著作,以向软件工程实践人员和学生方便地提供最新的软件工程信息。这些著作凝聚了全世界软件工程界上百位开拓者和成千上万实践者的创造性劳动,蕴含了大量的宝贵经验和沉痛教训,很值得我们学习。

清华大学出版社邀请我和郑人杰教授共同组织 SEI 软件工程译丛编委会。清华社计划首先影印 6 本著作,翻译出版 15 本著作。据我所知,在 Addison-Wesley 公司出版的 SEI 软件工程丛书中,人民邮电出版社已经翻译出版了《个体软件过程》和《团队软件过程》,还拟影印出版《个体软件过程》和《软件工程规范》;电子工业出版社已经翻译出版了《净室软件工程的技术与过程》、《能力成熟度模型 CMM 1.1 指南》、《能力成熟度模型集成 CMMI》和《软件项目管理》;北京航空航天大学出版社已经翻译出版了《统计过程控制》。这些出版社共计影印 2 本著作,翻译出版 7 本著作。这样,可以预期我国在今年年底共可影印 8 本著作,翻译出版 22 本著作。各个出版社的有远见的辛勤劳动,为我们创造了“引进、消化、吸收、创新”的机遇。我们应该结合各自的实践,认真学习国外的先进经验,以大大提高我国软件工程的理论和实践水平。

在这套丛书中,特别值得一提的是,在过程工程领域被誉为软件过程之父的 Humphrey 先生所撰写的《软件过程管理》、《技术人员管理》、《软件工程规范》、《个体软件过程》、《团队软件过程》和《软件制胜之道》等 6 本著作,将于今年年内全部翻译出版,其中《软件过程管理》、《技术人员管理》、《软件工程规范》、《个体软件过程》和《软件制胜之道》等 5 本著作亦已经或将于今年年内影印出版。

《软件过程管理》是软件过程领域的开创性著作,是为软件公司经理和软件项目经理撰写的。用这本书提出的原理来指导软件开发,可以有效地按照预定进度得到高质量的软件,同时还可了解如何持续进行过程改进。美国 CMU/SEI 按照这本书提出的原理开发了能力成熟度模型,在国际上得到绝大多数国家的认可和广泛采用,是改进软件过程能力的有力武器。在信息技术迅速发展和企业激烈竞争的今天,能否持续改进过程往往决定企业的命运。

作为一个软件经理,在改进组织的能力之前,首先必须明确绝大多

数软件问题是由管理不善所引起的。因此，要改进组织的性能，首先需要改进自己的管理模式。同时还要认识到软件开发是一项智力劳动，需要拥有掌握高技能和忘我工作的技术人员。因此，有效的软件管理需要充分注意技术人员的管理。

《技术人员管理》这本著作就是为达到这个目的而撰写的。高质量的技术工作要求没有差错，这就要求人们高度专心和高度献身。因此要求人们对他所从事的工作不仅具有高度的责任感，而且具有浓厚的兴趣和高度的热忱。在当前知识经济群龙相争的今天，一个能激励人们进行创造性工作的领导群体，是众多竞争因素中最重要的因素。本书提供了大量的实用指南，可用来有效地改进工程人员、经理和组织的性能。

Humphrey 先生还认为这本书特别适合于在我国工作的软件经理。我国是一个人口大国，拥有大量能干的知识分子，而且信息领域的劳动力价格比国际市场的价格要低，因此吸引了许多国家到我国来投资。但若不提高人员的素质，不在产品质量和进度方面也狠下功夫，就不能在这方面持续保持优势。

《软件工程规范》是为编程人员撰写的。它精辟地阐述了个体软件过程（PSP）的基本原理，详尽地描述了人们如何来控制自己的工作，如何与管理方协商各项安排。在软件工程界，这本著作被誉为是软件工程由定性进入定量的标志。目前在世界范围内，有成千上万的软件工程技术人员正在接受有关 PSP 的培训，以便正确地遵循 PSP 的实践、开发和管理工作计划，在他们承诺的进度范围内，交付高质量的产品。

《软件制胜之道》这本著作描述了团队软件过程的基本原理，详尽地阐述了在软件组织中如何应用 PSP 和 TSP 的原理以及它所能带来的效益。此外，虽然 CMM 同样适用于小型组织，但在其他著作中都没有描述如何应用 CMM 于个体或小型团队，这本书填补了这个空白。应该指出，如果一个组织正在按照 CMM 改进过程，则 PSP 和 TSP 是和 CMM 完全相容的。如果一个组织还没有按照 CMM 改进过程，则有关 PSP 和 TSP 的训练，可以为未来的 CMM 实践奠定坚实的基础。

在软件工程技术实践方面目前共出版了 10 本著作，其中《用商业组件构建系统》、《软件构架实践》和《软件构架评估——方法和案例研究》等 3 本著作详尽地阐述了软件构架的构建、实践和评估。鉴于是否有一个稳定的软件构架，对软件的质量和成本影响很大，因此如何获得



一个好的构架就成为当今软件界研究的重点。我相信这几本著作的出版，将对我国软件构架领域的研究与实践有重要的参考价值。此外，众所周知，计算机与网络的安全问题对信息系统的可靠使用关系极大，《CERT 安全指南——系统与网络安全实践》的出版将会对我国在这一领域的研究和实践起积极的促进作用。《风险管理——软件系统开发方法》、《软件采办管理——开放系统和 COTS 产品》、《项目管理原理》、《软件产品线——实践和模式》和《系统工程：基于信息的设计方法》等 5 本著作，分别从风险管理、软件采办、项目管理、软件产品线以及信息系统设计方法等几个方面阐述了大型、复杂软件系统的开发问题，是有关发展软件产业的重要领域，很值得我国软件产业界借鉴。

目前我们所处的时代是信息化时代，是人类进入能够综合利用物质、能量和信息三种资源的时代。千百年来以传统的物质产品的生产、流通、消费为基本特征的物质型经济，将逐步进入以信息产品的生产、流通、利用和消费为基本特征的知识型经济。在这个历史任务中，建造和广泛应用各类计算机应用系统是其公共特征。计算机软件是计算机应用系统的灵魂，没有先进的软件产业，不可能有先进的信息产业，从而也不可能建成现代化的知识型经济。

我们应该看到，在软件领域中我国在总体上离世界先进水平还有相当大的差距。但是，我们不能跟随他国的脚印，走他人的老路。我们应该抓住机遇，直接针对未来的目标，在软件工程技术和软件工程管理两个方面，注意研究 SEI 软件工程丛中倡导的原理和方法，联系实际，认真实践，并充分利用我国丰富优秀的人力资源和尊重教育的优良传统，大力培养各个层次的高质量的软件工程人员，使其具有开发各类大型、复杂软件系统的能力。我衷心地预祝清华大学出版社影印和翻译出版这套丛书，在把我国建设成为一个真正现代化的软件产业大国的历史任务中起到推波助澜的作用，并请读者在阅读这些译著时，对这套丛书的选题、译文和编排等方面都提出批评和建议。

周伯生  
于北京

2002 年 8 月 18 日

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# **CMMI<sup>SM</sup> Distilled**

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# CMMI<sup>SM</sup> Distilled

## *A Practical Introduction to Integrated Process Improvement*

**Dennis M. Ahern  
Aaron Clouse  
Richard Turner**



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# Preface

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This book is about a new way of approaching process improvement for engineering development. Process improvement is a generally well-understood and accepted means of achieving quality and productivity gains for software development, and the recognition of its importance for other engineering disciplines is growing. The success and wide adoption of the Capability Maturity Model (CMM) for Software have inspired increased development of similar models in disciplines other than software. The resulting proliferation of models in engineering organizations has led to conflicts in process improvement goals and techniques, considerable increases in required training, and confusion on the part of practitioners as to which of the various models applies to their specific needs.

The Capability Maturity Model Integration (CMMI) project, an ongoing effort by industry, the U.S. government, and the Software Engineering Institute (SEI) of Carnegie Mellon University, is attempting to address this situation. Started in 1998, CMMI is an effort to codify the tenets of model-based process improvement and provide a single, integrated framework for improving engineering processes in organizations that span several disciplines. By integrating the tools and techniques used to improve individual engineering disciplines, both the quality and the efficiency of organizational process improvement are enhanced.<sup>1</sup>

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1. CMMI initially focused on development activities (that is, building things), with a special emphasis on systems and software engineering. Clearly, many aspects of process improvement apply more broadly, to other engineering as well as nonengineering disciplines. As you learn about CMMI, you may gain insight into how its process improvement framework might be extended and applied to other areas. We assume that the majority of readers are interested in the initial CMMI focus on the development of software-intensive systems, and hence we write from that perspective. We also invite readers to think about other potential applications within the engineering development world and beyond.

In the last quarter of 2000, after extensive stakeholder review and piloting, the first official CMMI products were released. These models provide users with a choice of single or integrated disciplines and a choice of a staged or continuous representation. They include a wealth of engineering and process improvement information, such as clear goals and extensive guidance on the best practices to achieve them. Most importantly, a well-defined framework outlines how additional disciplines may be brought into the product suite so as to minimize the development of incompatible models in the future.

### **Purpose of the Book**

This book has a threefold purpose. First, we intend to help organizations understand how an integrated approach to process improvement can help mature their technical and management processes. Second, to support this integrated approach, we present a new set of tools developed by the CMMI project specifically designed for multidiscipline process improvement. Finally, we provide practical guidance in the selection and use of those tools. This guidance is based on lessons learned from organizations that have adopted integrated process improvement, as well as the knowledge and experience gained from the hundreds of professionals who were involved in the development of the CMMI product suite.

### **Audience for the Book**

The intended audience for this book comprises executives, middle managers, team leaders, acquisition specialists, process improvement champions, and the often overlooked and overworked process improvement practitioners. Executives, who may have deferred process improvement in the past because the scope of their business exceeded the boundaries of a single model, will find an approach and tools to mitigate their concerns. Middle managers and team leaders will find information on the effects of process improvement on their responsibilities and the cross-discipline nature of their environments. Process improvement champions will find a means to enlarge their base of support and focus their efforts in a way that heightens the chances of adoption and success. Finally, individuals who are charged with implementing the process improvement will find help in applying models in the real world. It is our hope that when unsuspecting project and program managers are

instructed to “implement that CMMI stuff,” this book will provide sufficient information to save both their careers and their sanity.

While applicable to any organization involved with rigorous, time-critical development of complex systems, this book will hold special interest for system developers and systems integrators who supply the U.S. government. The federal government participated in the CMMI development work, thereby supporting the efforts of its suppliers (both external and internal) to improve process performance. In October 1999, the U.S. Department of Defense established the requirement that its large program development contractors demonstrate full compliance with a maturity level 3 as measured by the Software CMM (or equivalent).<sup>2</sup> More recently, it has indicated its intention to have CMMI-SE/SW identified as an equivalent evaluation tool.<sup>3</sup> Given the considerable interest at all levels in adding the acquisition discipline to CMMI, the authors believe that CMMI will likely see application in improving government system acquisition organizations as well.

## Organization of the Book

The book is divided into four major parts.

Part I introduces integrated process improvement and provides a rationale for undertaking such an approach. This material is both a primer for the novice and ammunition to gain management support for the process improvement champion. It offers general guidance as well as specific hints on implementation, including pointers to support the migration from legacy process improvement activities and accomplishments. Part I also provides case studies and lessons learned from the pioneering organizations that blazed the trail toward integrated process improvement. If you wish to start your reading with the details of CMMI, you could save this first part for review at a later time.

Part II describes the work of the CMMI project. The philosophy, architecture, and models of CMMI products are presented, and examples of the models are annotated in detail to provide a better understanding of their

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2. “Software evaluations for ACAT 1 programs,” memorandum from Dr. J. S. Gansler, Under Secretary of Defense (Acquisition and Technology), Oct. 26, 1999.

3. “Use of CMMI evaluations by the Department of Defense,” memorandum from Dr. Delores M. Etter, Deputy Under Secretary of Defense (Science and Technology), Dec. 11, 2000.

contents. This part also includes much of the rationale for specific CMMI decisions and help in navigating the rather daunting CMMI models.

Part III builds on the first two parts and offers the authors' practical guidance in the use of the CMMI products. It suggests heuristics for choosing models and representations appropriate for a specific organization. It also describes CMMI assessments and explains how to tailor the CMMI products to fit an organization and enhance the probability of success in applying CMMI.

Part IV presents some musings on the future of CMMI. These informed speculations reflect some of the discussions held formally and informally during CMMI development. The ideas included are intended to invite discussion and spark innovation, but not, as the sportswriters say, "as the basis for any actual cash wager."

Like their predecessors, the CMMI models are by necessity large and complex products. This book, while not duplicating all their information, will help you understand the CMMI models and auxiliary materials. It provides a rationale for integrating process improvement, a guide to the structure and contents of the CMMI models, and some practical ideas for using the models effectively in your organization. We strongly encourage you to obtain copies of the models from the CMMI Web site ([www.sei.cmu.edu/cmmi](http://www.sei.cmu.edu/cmmi)) and browse through them as you are reading this book, especially Parts II and III. For readers who would like a flavor of the models, Appendixes A and B presents a concise summary of CMMI/SW/SE/IPPD content in both the continuous and staged representations.

The CMMI project is an ongoing effort, so any project as time-restricted as a book will necessarily be overcome by events. The authors have strived to provide information that is both timely and of lasting value, but understand the reality of the CMMI environment. To that end, the publisher has agreed to support this volume with updates through its Web site ([www.awl.com](http://www.awl.com)) and, when appropriate, further editions.

## **Our Intentions**

The authors have all been active in process improvement in the real world. We bring considerable practical experience to this effort, together with our ideas on improving the way process improvement is accomplished. Together we struggled through the creation of the CMMI products, benefiting from the wide variety of views brought by the CMMI



Product Development Team. Generally, this book describes the products and positions of the nearly 100 other experienced practitioners and researchers that made up that team. In some places, however, we express our own opinions. In those cases where the text may not reflect the consensus of the team, we have identified our unorthodoxy.

It is our hope that this book reflects the tremendous accomplishments of the entire CMMI Product Development Team. Most of all, we want you to obtain a clearer understanding of the practice and benefits of integrated process improvement based on CMMI products. Through the information in this book, we hope to help make your process improvement initiatives successful.

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Dennis, Aaron, and Rich

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