国外优秀信息科学与技术系列教学用书

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——Infosys 实施软件项目的过程

（影印版）

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Processes for Executing Software Projects at Infosys

■ Pankaj Jalote

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出 版 说 明

20 世纪末，以计算机和通信技术为代表的信息科学和技术对世界经济、科技、军事、教育和文化等产生了深刻影响。信息科学技术的迅速普及和应用，带动了世界范围信息产业的蓬勃发展，为许多国家带来了丰厚的回报。

进入 21 世纪，尤其随着我国加入 WTO，信息产业的国际竞争将更加激烈。我国信息产业虽然在 20 世纪末取得了迅猛发展，但与发达国家相比，甚至与印度、爱尔兰等国家相比，还有很大差距。国家信息化的发展速度和信息产业的国际竞争能力，最终都将取决于信息科学技术人才的质量和数量。引进国外信息科学和技术优秀教材，在有条件的学校推动开展英语授课或双语教学，是教育部为加快培养大批高质量的信息技术人才采取的一项重要举措。

为此，教育部要求由高等教育出版社首先开展信息科学和技术教材的引进试点工作。同时提出了两点要求，一是要高水平，二是要低价格。在高等教育出版社和信息科学技术引进教材专家组的努力下，经过比较短的时间，第一批由教育部高等教育司推荐的 20 多种引进教材已经陆续出版。这套教材出版后受到了广泛的好评，其中有不少是世界信息科学技术领域著名专家、教授的经典之作和反映信息科学技术最新进展的优秀作品，代表了目前世界信息科学技术教育的一流水平，而且价格也是最优惠的，与国内同类自编教材相当。这套教材基本覆盖了计算机科学与技术专业的课程体系，体现了权威性、系统性、先进性和经济性等特点。

目前，教育部正在全国 35 所高校推动示范性软件学院的建设，这也是加快培养信息科学技术人才的重要举措之一。为配合软件学院的教学工作，结合各软件学院的教学计划和课程设置，高等教育出版社近期聘请有关专家和软件学院的教师遴选推荐了一批相应的原版教学用书，正陆续组织出版，以方便各软件学院开展双语教学。

我们希望这些教学用书的引进出版，对于提高我国高等学校信息科学技术的教学水平，缩小与国际先进水平的差距，加快培养一大批具有国际竞争力的高质量信息技术人才，起到积极的推动作用。同时我们也欢迎广大教师和专家们对我们的教材引进工作提出宝贵的意见和建议。联系方式：hep.cs@263.net。

高等教育出版社

二〇〇二年九月

Dedicated to
N. R. Narayana Murthy
and his co-visionaries

Preface

Worldwide, the demand for software is increasing at a rapid pace, with no end in sight for this growth in appetite. The growth has spawned a dramatic increase in software development activity which, in turn, has sharpened the focus on the processes used for building software, collectively known as the software process. Although opinions differ on the nature and formality of the software process, there is now general agreement that use of proper processes is extremely important for an organization that seeks to deliver high-quality software and increase its own productivity.

The heightened importance of the software process has created a need for process improvement, which requires methods for process analysis and assessment. One of the most extensive and influential software process improvement and assessment frameworks is the Capability Maturity Model (CMM) for software developed by the Software Engineering Institute (SEI) at Carnegie Mellon University. The CMM categorizes software process maturity into five levels—from level 1 (the lowest) to level 5 (the highest). For each level, the CMM specifies some key process areas (KPAs), which represent the areas on which an organization should focus if it wants to move to a particular level. Each KPA is associated with goals that represent the requirements to be satisfied by the process for that KPA. The KPAs for different maturity levels can be used for assessing the capability of the existing process as well as for identifying the areas that need to be strengthened so as to move the process from a lower level of maturity to a higher level.

The CMM framework is quite general and not prescriptive. Although organizations can implement CMM in different ways, relating the characteristics mentioned in the CMM to real-life practices and processes can prove difficult. This book describes the set of processes used for executing a project at Infosys Technologies Ltd., a large software house headquartered in Bangalore, India. Infosys was formally assessed at CMM level 4 in December 1997 by two SEI-authorized lead assessors.

Rather than just explaining the various technical and management processes employed by Infosys, this book describes the processes as they

appear at various stages in the life cycle of a project. Because the life cycle of a project includes both technical and management processes, this approach ensures that most processes affecting a project are explained. This approach is also one to which both practitioners and students can more easily relate. It does leave out the organization-level processes for supporting and managing the process activities. Some aspects of these processes have been described, wherever their inclusion would not break the flow of the book. In addition, an article describing the management of the CMM framework implementation at Infosys is included as Appendix B.

The book includes 15 chapters. Chapter 1 gives a brief overview of the CMM and describes some organization-level support for processes at Infosys. The remaining chapters focus on project execution and are organized into three parts. Part I (Chapters 2 and 3) deals with processes that are executed before the project formally commences. Part II (Chapters 4 through 10) deals with project planning activities. Part III (Chapters 11 through 15) examines project execution and termination. Most chapters focus on some key task in a project and have been kept as independent as possible of the other chapters.

It is not the intent of this book to provide an extensive coverage of literature or detailed explanations of the CMM. The main goal is to describe the processes of an organization that employs the CMM framework. The book also illustrates how simple and known approaches can be combined effectively to have a highly mature overall process. It does not suggest that Infosys's approach is "optimal" or "better than someone else's" or "an ideal implementation of the CMM." Likewise, it does not recommend that these processes be used by others—that decision is left for the readers.

The positive feedback I received on my earlier textbook, *An Integrated Approach to Software Engineering* (Springer Verlag, 1997), which had a case study running through the book, convinced me of one thing: In software engineering, it is invaluable to have "real examples with real outputs" and a "complete example," if possible, when explaining concepts. This book employs the same approach. Most of the examples are "real" in that they have been picked from real projects, and one actual project—the weekly activity report (WAR) project—is used through much of the book to illustrate how different processes interrelate. Although the processes described are used at Infosys, any sensitive numbers (for example, on quality and productivity) included may have been sanitized to maintain the company's confidentiality.

This book should prove useful to all practitioners who are interested in the software process or the CMM framework. It should be immensely helpful to those practitioners who are trying to implement the CMM in their own organizations. To help ISO organizations in their effort to move to CMM, a general study describing possible gaps in an ISO organization with respect to different levels of the CMM has been provided in Appendix A. As the book discusses how projects are executed in a successful organization, it should also be of

interest to professionals who are now managing software projects. For instructors and students, it can serve as a supplementary text for a project-oriented course on software engineering, as the book provides a good view of how software is developed in a business environment, along with a case study.

It is perhaps proper to explain my own involvement with Infosys. As Vice President (Quality) at Infosys, I was one of the main architects behind the company's successful transition from ISO to CMM level 4. It should be pointed out that although Infosys supplied all of the material I requested, I take full responsibility for any mistakes, misrepresentations, and inaccuracies that may be present in the book. Such issues are bound to occur when one tries to describe the "essence" of an organization's process manual, along with a case study, in such a compact book. Any deviations in these descriptions from the actual processes of Infosys are entirely my responsibility, as I decided which portions of processes to include and in what manner.

Any comments or queries about the book are welcome and can be sent to me at jalote@iitk.ac.in. For any information regarding Infosys, visit www.itlinfosys.com or send mail to public-relations@itlininfosys.com.

Pankaj Jalote

Acknowledgments

First and foremost, I would like to express my gratitude to Infosys, whose generous cooperation and help made this book possible. After its assessment was over, I proposed this book to the Directors of Infosys. To their credit, despite the risks associated with making the processes public, they agreed to let me use Infosys's documents related to processes in this work. In particular, I am grateful to Mr. K. Dinesh, the Director responsible for quality and productivity, who gave his full backing to the process activities and to this project.

Many others have contributed greatly to making this book become a reality. My sincere thanks to members of the Quality Department at Infosys, in particular Bhashyam and Raghavan, who manage the process activities, and to all of my colleagues who participated in defining the various processes and provided feedback on chapters. They include Meera, Savita, Ramkumar, Nitya, Subbu, Seshan, Varsha, Dr. Bala, Ram Prasad, Saiju, Vasu, and many others. My special thanks to Devarajan, project leader of the WAR project, who helped me with the case study.

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With fondness, I acknowledge the help provided by my wife Shikha (who is herself an excellent software engineer) in editing and reviewing, and my daughters Sumedha and Sunanda, who had to do without their legitimate share of my time for many, many months.

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郑重声明

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Part II Project Planning

Part III Project Execution and Termination

1

Introduction

Software organizations in the world employ nearly 7 million engineers and generate annual revenue of more than $600 billion, an amount that has been growing at an annual rate exceeding 25% for the past three years. About half of this revenue is generated by the software products industry, which builds general-purpose software products, and roughly half is generated by the software service industry, which builds customized software products for clients. The software industry today is viewed as one of the most promising industry segments and one holding tremendous future potential.

If we consider developing a software product as a project, then the software industry constantly focuses on project execution. Assuming that the average software project consumes about 7 person-years of effort (during which a software product consisting of 20,000 to 80,000 lines of code can be built), then the software industry, with its more than 7 million engineers, executes in excess of 1 million software projects per year! Clearly, executing software projects efficiently is of paramount importance to the software industry as a whole.

The processes used for executing a software project clearly have a major effect on the quality of the software produced and the productivity achieved in the project. Consequently, a need exists to evaluate processes used in an organization for executing software projects and to improve them. The Capability Maturity Model (CMM) for software developed by the Software Engineering Institute (SEI) is a framework that can be used for both purposes [17]. The CMM classifies the maturity of the software processes in five levels—level 1 to level 5, with level 5 being the highest maturity. Of the more than 700 assessments that were performed between 1992 and 1997 and whose assessment results were formally reported to the SEI, only about 20 organizations worldwide have been assessed at level 4 or level 5 [21].

This book describes the processes used for executing software projects at Infosys, a highly successful software company that has been assessed at level 4. Infosys is a large software house employing more than 3,000 people and having offices and development centers in 6 countries and customers in more than 15

countries. Its total revenue has been growing at a rate of 70% annually for the last five years, and its market capitalization increased more than 25-fold from early 1996 to early 1999. By any yardstick, it is a highly successful software company. By describing the processes used for project execution at Infosys, the book describes one possible implementation of the CMM.

No silver bullets are available that will solve all the problems related to software projects [2]. Nevertheless, many proven and promising techniques for all aspects of software development and project management can be used together to handle projects effectively. This book therefore illustrates how known approaches can be effectively combined to create a highly mature, yet simple-to-use overall process.

In this chapter, we introduce the two topics that are central to the book: the CMM and the process infrastructure of Infosys. The rest of the book deals with processes used for project execution at Infosys, their relationship to the CMM, and examples of their use. First, however, we briefly discuss the role of processes in project execution.

1.1 Process-Based Approach for Project Execution

A software development project is one in which a software product to fulfill some needs of a customer should be developed and delivered within a specified cost and time period. In other words, the three main characteristics of a project are its cost, schedule, and quality, where "quality" represents how well the product satisfies the customer. A project is generally initiated when some estimates for these parameters are established.

A project is successful if it meets or exceeds the expectations on all three fronts—cost, schedule, and quality. The software industry can cite many examples of projects that did not succeed. Although the situation has considerably improved over the years, many projects still fail to reach completion within budget, deliver within schedule, or fulfill quality expectations. One anlaysis of project data [18] shows that about one-third of projects have cost and schedule overruns of more than 125%. Examples of projects that are runaways (that is, out of control) have also been documented [5].

Possible reasons for project failures include improper estimation, loose requirements management, weak project management, improper risk management, and poorly engineered solutions, among others. Many of these reasons can be combined in one category called "process failure." That is, a software project often fails because the process followed in the project was not suitable. For example, the major reasons for runaways are unclear objectives, bad

planning, new technology, no project management methodology, and insufficient staff [5]. At least three of these five reasons can be considered as "process failure" (the other two—insufficient staff and new technology—can be considered as risks whose management is also a part of the process). For a project to succeed, a key success parameter is the set of processes followed in the project. If suitable process models are chosen for the important tasks in the project, and the chosen processes are executed properly, then the chances of a project succeeding become extremely high.

As having a high productivity can generally reduce cost and minimize the schedule for a project, high quality and productivity (Q&P) can be viewed as the twin aims of a project for delivering a software product. Although processes are needed to satisfy the project goals, they are also essential for satisfying the objectives of an organization that is in the business of executing software projects. Of course, the organization will want all of its projects to succeed. It is larger than its projects, however, and has some desired objectives over and above the twin objectives of a project. First, an organization generally wants predictability. That is, it is not enough that a project have high Q&P; the organization also seeks a predictable Q&P. Without predictability, good estimation is not possible, and building reasonable estimates is essential to any project-oriented business. Second, an organization desires continuous improvement in Q&P.

Q&P of an organization depends on three factors: process, people, and technology. This relationship, which is sometimes called the quality triangle, is depicted in Figure 1.1 [24]. The quality triangle is similar to the process-technology-leadership triangle, also known as the iron triangle [13].

As the process has a major effect on the Q&P delivered by an organization, one way to improve Q&P is to improve the processes used by the organization. In much of this book, as well as in much of the CMM for software, the focus is on the process aspect. (The personal software process proposed by Humphrey concentrates on improving the estimation and software development capability of individual software engineers [9], whereas the People Capability Maturity

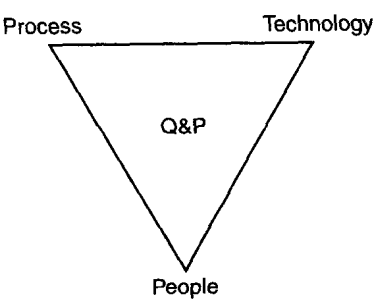

Figure 1.1 The process, people, and technology triangle