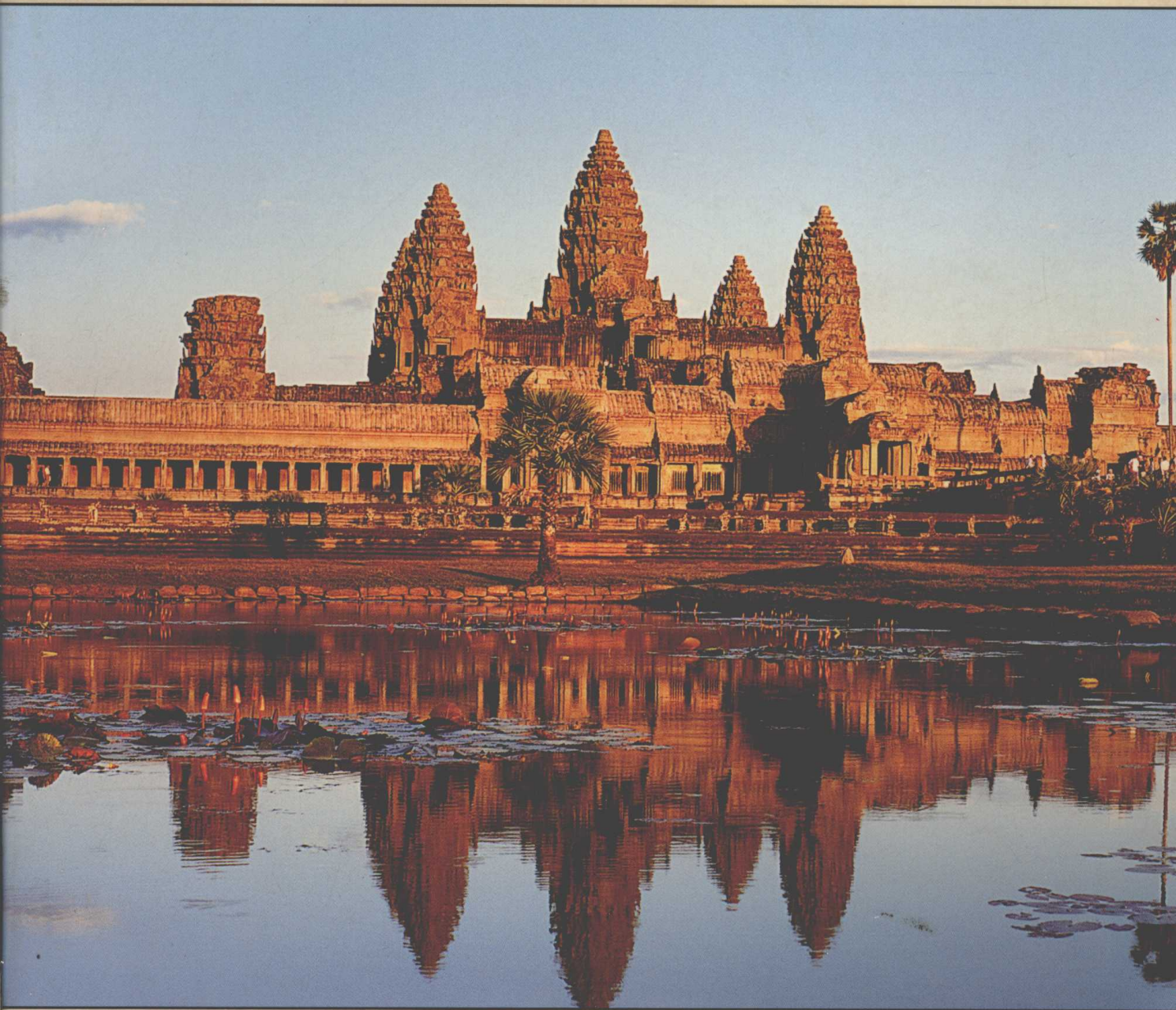


# PROJECT MANAGEMENT

*Processes, Methodologies, and Economics*

SECOND EDITION



Avraham Shtub • Jonathan F. Bard • Shlomo Globerson

# **Project Management**

## ***Processes, Methodologies, and Economics***

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# Nomenclature

AC	annual cost	DOH	direct overhead costs
ACWP	actual cost of work performed	DSS	decision support system
AHP	analytic hierarchy process	EAC	estimate at completion
AOA	activity on arrow	ECO	engineering change order
AON	activity on node	ECR	engineering change request
AW	annual worth	EMV	expected monetary value
BAC	budget at completion	EOM	end of month
B/C	benefit/cost	EOY	end of year
BCWP	budgeted cost of work performed	ERP	enterprise resource planning
BCWS	budgeted cost of work scheduled	ETC	estimate to complete
CBS	cost breakdown structure	ETMS	early termination monitoring system
CCB	change control board	EUAC	equivalent uniform annual cost
CCBM	critical chain buffer management	EV	earned value
CDR	critical design review	EVPI	expected value of perfect information
CE	certainty equivalent, concurrent engineering	EVSI	expected value of sample information
C-E	cost-effectiveness	FFP	firm fixed price
CER	cost estimating relationship	FMS	flexible manufacturing system
CI	cost index; consistency index; criticality index	FPIF	fixed price incentive fee
CM	configuration management	FW	future worth
COO	chief operating officer	GAO	General Accounting Office
CPIF	cost plus incentive fee	GDSS	group decision support system
CPM	critical path method	GERT	graphical evaluation and review technique
CR	capital recovery, consistency ratio	HR	human resources
C/SCSC	cost/schedule control systems criteria	IPT	integrated product team
CV	cost variance	IRR	internal rate of return
DOD	Department of Defense	IRS	Internal Revenue Service
DOE	Department of Energy		

<b>ISO</b>	<b>International Standards Organization</b>	<b>PDR</b>	<b>preliminary design review</b>
<b>IT</b>	<b>information technology</b>	<b>PERT</b>	<b>program evaluation and review technique</b>
<b>LCC</b>	<b>life-cycle cost</b>	<b>PMBOK</b>	<b>project management body of knowledge</b>
<b>LOB</b>	<b>line of balance</b>	<b>PMI</b>	<b>Project Management Institute</b>
<b>LOE</b>	<b>level of effort</b>	<b>PMP</b>	<b>project management professional</b>
<b>LP</b>	<b>linear program</b>	<b>PO</b>	<b>project office</b>
<b>LRC</b>	<b>linear responsibility chart</b>	<b>PT</b>	<b>project team</b>
<b>MACRS</b>	<b>modified accelerated cost recovery system</b>	<b>PV</b>	<b>planned value</b>
<b>MARR</b>	<b>minimum acceptable (attractive) rate of return</b>	<b>PW</b>	<b>present worth</b>
<b>MAUT</b>	<b>multiattribute utility theory</b>	<b>QA</b>	<b>quality assurance</b>
<b>MBO</b>	<b>management by objectives</b>	<b>QFD</b>	<b>quality function deployment</b>
<b>MIS</b>	<b>management information system</b>	<b>RAM</b>	<b>reliability, availability, and maintainability; random access memory</b>
<b>MIT</b>	<b>Massachusetts Institute of Technology</b>	<b>R&amp;D</b>	<b>research and development</b>
<b>MPS</b>	<b>master production schedule</b>	<b>RDT&amp;E</b>	<b>research, development, testing, and evaluation</b>
<b>MTBF</b>	<b>mean time between failures</b>	<b>RFP</b>	<b>request for proposal</b>
<b>MTTR</b>	<b>mean time to repair</b>	<b>ROR</b>	<b>rate of return</b>
<b>NAC</b>	<b>net annual cost</b>	<b>SI</b>	<b>schedule index</b>
<b>NASA</b>	<b>National Aeronautics and Space Administration</b>	<b>SOW</b>	<b>statement of work</b>
<b>NBC</b>	<b>nuclear, biological, chemical</b>	<b>SOYD</b>	<b>sum-of-the-years digits</b>
<b>NPV</b>	<b>net present value</b>	<b>SV</b>	<b>schedule variance</b>
<b>OBS</b>	<b>organizational breakdown structure</b>	<b>TQM</b>	<b>total quality management</b>
<b>O&amp;M</b>	<b>operations and maintenance</b>	<b>WBS</b>	<b>work breakdown structure</b>
<b>PDMS</b>	<b>product data management system</b>	<b>WP</b>	<b>work package</b>
		<b>WR</b>	<b>work remaining</b>



# Preface

We all deal with projects in our daily lives. In most cases, organization and management simply amount to constructing a list of tasks and executing them in sequence, but when the information is limited or imprecise and when cause-and-effect relationships are uncertain, a more considered approach is called for. This is especially true when the stakes are high and time is pressing. Getting the job done right the first time is essential. This means doing the upfront work thoroughly, even at the cost of lengthening the initial phases of the project. Shaving expenses in the early stages with the intent of leaving time and money for revisions later might seem like a good idea but could have consequences of painful proportions. Seasoned managers will tell you that it is more cost-effective in the long run to add five extra engineers at the beginning of a project than to have to add 50 toward the end.

The quality revolution in manufacturing has brought this point home. Companies in all areas of technology have come to learn that quality cannot be inspected into a product; it must be built in. Recalling the 1980s, the global competitive battles of that time were won by companies that could achieve cost and quality advantages in existing, well-defined markets. In the 1990s, these battles were won by companies that could build and dominate new markets. Today, the emphasis is partnering and better coordination of the supply chain. Planning is a critical component of this process and is the foundation of project management.

Projects may involve dozens of firms and hundreds of people who need to be managed and coordinated. They need to know what has to be done, who is to do it, when it should be done, how it will be done, and what resources will be used. Proper planning is the first step in communicating these intentions. The problem is made difficult by what can be characterized as an atmosphere of uncertainty, chaos, and conflicting goals. To ensure teamwork, all major participants and stakeholders should be involved at each stage of the process.

How is this achieved efficiently, within budget, and on schedule? The primary objective in writing our first book was to answer this question from the perspective of the project manager. We did this by identifying the components of modern project management and showing how they relate to the basic phases of a project, starting with conceptual design and advanced development, and continuing through detailed design, production, and termination. Taking a practical approach, we drew on our collective experience in the electronics, information services, and aerospace industries. The purpose of

this book is to update the developments in the field over the last 10 years and to expand on some of the concerns that are foremost in the minds of practitioners. In so doing, we have incorporated new material in many of the chapters specifically related to the *Project Management Body of Knowledge—PMBOK* published by the Project Management Institute. This material reflects the tools, techniques, and processes that have gained widespread acceptance by the profession because of their proven value and usefulness.

Over the years, numerous books have been written with similar objectives in mind. We acknowledge their contribution and have endeavored to build on their strengths. As such, we have focused on integrative concepts rather than isolated methodologies. We have relied on simple models to convey ideas and have intentionally avoided detailed mathematical formulations and solution algorithms—aspects of the field better left to other parts of the curriculum. Nevertheless, we do present some models of a more technical nature and provide references for readers who wish to gain a deeper understanding of their use. The availability of powerful, commercial codes brings model solutions within reach of the project team.

To ensure that project participants work toward the same end and hold the same expectations, short- and long-term goals must be identified and communicated continually. The project plan is the vehicle by which this is accomplished and, once approved, becomes the basis for monitoring, controlling, and evaluating progress at each phase of the project's life cycle. To help the project manager in this effort, various software packages have been developed; the most common run interactively on microcomputers and have full functional and report-generating capabilities. In our experience, even the most timid users are able to take advantage of their main features after only a few hours of hands-on instruction.

A second objective in writing this book has been to fill a void between texts aimed at low- to midlevel managers and those aimed at technical personnel with strong analytic skills but little training in or exposure to organizational issues. Those who teach engineering or business students at both the late undergraduate and early graduate levels should find it suitable. In addition, the book is intended to serve as a reference for the practitioner who is new to the field or who would like to gain a surer footing in project management concepts and techniques.

The core material, including most of the underlying theory, can be covered in a one-semester course. At the end of Chapter 1, we outline the book's contents. Chapter 3 deals with economic issues, such as cash flow, time value of money, and depreciation, as they relate to projects. With this material and some supplementary notes, coupled with the evaluation methods and multiple criteria decision-making techniques discussed in Chapters 5 and 6, respectively, it should be possible to teach a combined course in project management and engineering economy. This is the direction in which many undergraduate engineering programs are now headed after many years of industry prodding. Young engineers are often thrust into leadership roles without adequate preparation or training in project management skills.

Writing a textbook is a collaborative effort involving many people whose names do not always appear on the cover. In particular, we thank all those faculty who adopted

the first edition of the book and provided us with their constructive and informative comments over the years. With regard to production, much appreciation goes to Lillian Bluestein for her thorough job in proofreading and editing the draft manuscript. We would also like to thank Chen Gretz-Shmueli for her contribution to the discussion in the human resources section. Finally, we are forever grateful to the phalanx of students who have studied project management at our universities and who have made the painstaking efforts of gathering and writing new material all worthwhile.

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