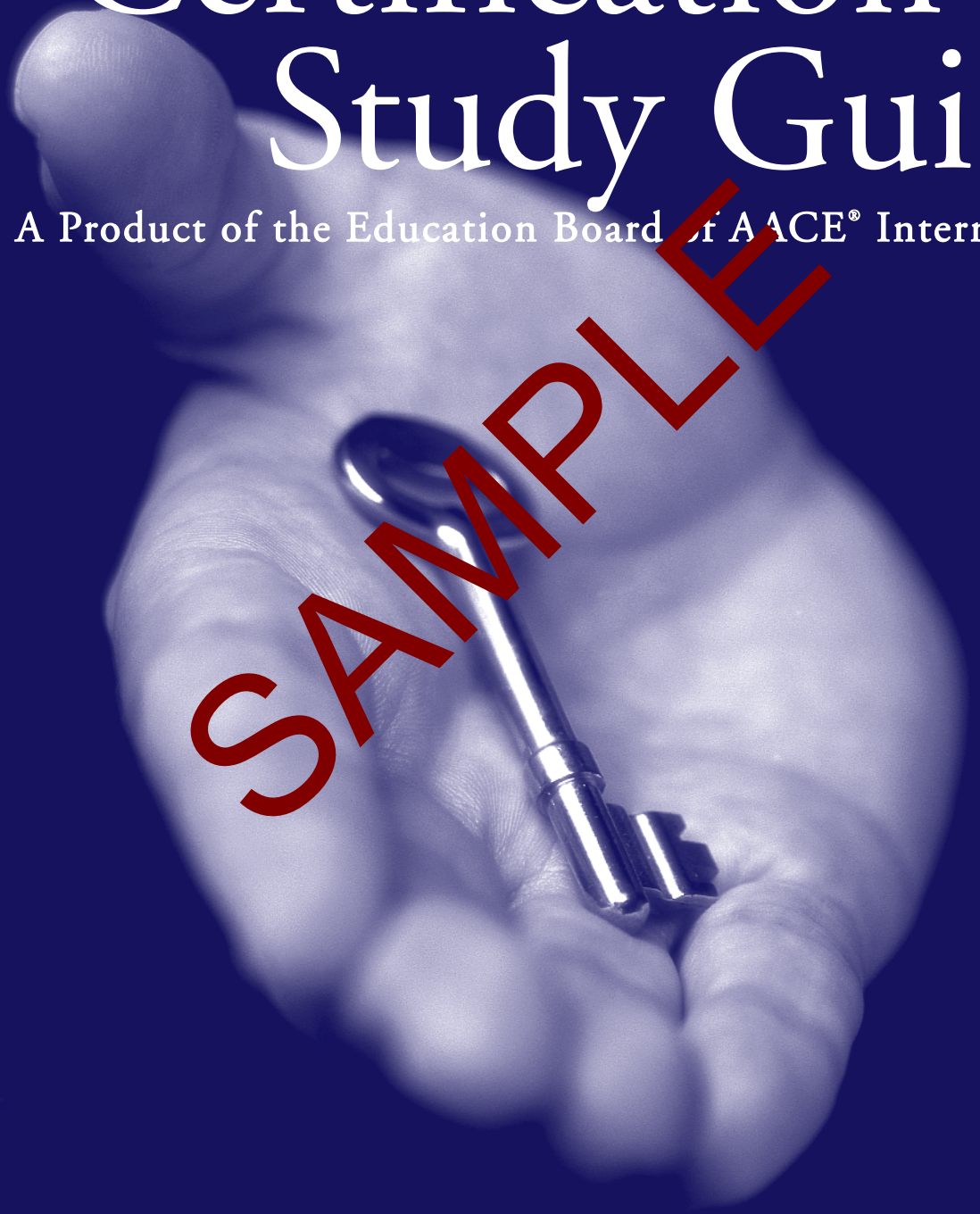
Decision and Risk Management Professional™

DRMP™ Certification Study Guide

A Product of the Education Board of AACE® International



AACE® INTERNATIONAL

The Authority for Total Cost Management™

AACE® International

Decision and Risk Management Professional™ (DRMP) ™

Certification Study Guide

Editor
Sean T. Regan, CCP CEP MRICS

First Edition
2013

Decision and Risk Management Professional™ (DRMP) ™
Certification Study Guide

First Edition

1265 Suncrest Towne Centre
Morgantown, WV 26505-1876 USA
Phone : +1 (304) 296-8444
Fax: +1 (304) 291-5728
E-mail : info@aacei.org
Web : www.aacei.org

ISBN: 978-1492231387

A Special Publication
of
AACE® International–The Authority for Total Cost Management

Decision and Risk Management Professional™ (DRMP)™ Certification Study Guide

2013

A continuing project of the AACE International Education Board

Acknowledgments

The 2013/2014 AACE International Education Board is grateful to the following individuals and companies who have assisted in the development of the **DRMP Certification Study Guide**, *First Edition*:

Editor: Sean Regan, CCP CEP MRICS

Authors:
Leroy Doris
Neil Opfer, CCP CEP PSP
Sean T. Regan, CCP CEP MRICS
Ted Turner

Reviewers:
Larry Dysert, CCP CEP
John K. Hollmann, PE CC

2013/2014 Education Board Member

Peter W. Griesmyer (Chair)
Chris A. Boyd, CCP
Dr. John O. Evans, III PSP
Dr. Mark Hastak, PE CCP
Donald F. McDonald, Jr., PE CCP PSP
Sunu M. Pillai, CCP EVP PSP
Rohit Singh, PE CCP
An Ma Co EVP (Co-Chair)
Ma Chen, E CCP
Clive Francis, CCP
Don Mah, PE
Brian Payne, PE CCP CFCC
ean T. Regan, CCP CEP MRICS
James Zack, CFCC FAACE FRICS

AACE International and the Education Board would like to give special thanks to Jacobs Engineering, IHI E&C and LG International, LLC, for the time and support they provided to the writers and editors of this document. Without their support and the dedication of their writers, reviewers and editors the timeframe in which this document was written could not have been met.

2012/2013 Education Board Members:

Peter W. Griesmyer (Chair)
Chris A. Boyd, CCP
Clive Francis, CCP
Dr. Mark Hastak, PE CCP
Brian Payne, PE CCP CFCC
Sean Regan, CCP CEP MRICS
Ann Marie Cox, EVP (Co-Chair)
Dr. John O. Evans, III PSP
Prof. John (Jeff) Hannon, CEP
Donald F. McDonald, Jr. PE CCP PSP
Sunu M. Pillai, CCP EVP PSP
James Zack, CFCC FAACE FRICS

Special thanks to Clarisse Burns for formatting, proofing and editing the beta test edition of this study guide; and to Marvin Gelhausen for formatting, proofing and editing this first edition.

Dedication

Kevin M. Curran

This study guide is dedicated to the memory of Kevin M. Curran. At the time of his passing in 2011, Kevin was co-chair of AACE's Decision and Risk Management Professional (DRMP) Certification Task Force. His willingness to dedicate his time and effort to advancing the profession while being president of Decision Sciences Corporation (DSC) was much appreciated. Through this dedication, we wish to acknowledge Kevin's many contributions to AACE International and the Risk Management (RM) profession. While leading the development of many innovative risk analysis methods for DSC, he also conducted hundreds of seminars and presentations. He contributed many articles for *AACE Transactions* and the *AACE* **Cost Engineering** *Journal.* He also drafted the chapter on Investment Decision Making in *the AACE* **Total Cost Management Framework** and a chapter on *Effective Project Management Through Applied Cost and Schedule Control* (Bent and Humphreys). A longtime member of AACE International, Kevin received AACE's *Technical Excellence Award* in 2010, for outstanding technical contributions to the association. He will be missed.

AACE International Decision and Risk Management Professional (DRMP) Certification Study Guide

Table of Contents

List of Figures

PREFACE

AACE International developed the "**Decision and Risk Management Professional (DRMP) Certification Study Guide**" for two reasons. First it is to aid professionals studying for AACE International's (AACE) specialty certification in Decision and Risk Management (DRM). Second, to assemble and summarize various topics considered essential for DRMP knowledge, as outlined in AACE International's **Recommended Practice 11R-88**, "*Required Skills and Knowledge of Cost Engineering,*" and included in the current edition of AACE International's "**Skills and Knowledge of Cost Engineering**."

The "**Decision and Risk Management Professional (DRMP) Certification Study Guide**" (study guide) serves the needs of DRM professionals who are preparing to take the AACE International DRMP certification examination. It is organized in a concise and easy-to-follow format and covers the major skills and knowledge used by a DRM professional.

The information contained in the study guide parallels the related topics of the "**Skills and Knowledge of Cost Engineering**" and the **"Certified Cost Professional (CCP) Certification Study Guide**." Previously, the **CCP Study Guide** was published as the **CCC/CCE Study Guide**. As of this writing, the AACE Certification Board is in the process of rebranding the CCC/CCE certification designation. As of this writing, CCP is the targeted new designation. These publications can be combined for a course of study in both cost engineering and decision and risk management, which include sample problems related to the subject matter.

Most terms and phrases incorporated in this study guide are generic to the profession; where applicable, however, professionals should understand the definitions provided in **AACE Recommended Practice 10S-90**, and the terms found in the glossary of this study guide. The terms and phrases used in industry and software may not conform to the readers' understanding, so consult the DRMP Glossary found in Appendix A.

The goal of the AACE International Education Board is to continually improve this publication, making it a living document that will be revised as needed to support the DRMP exam, while maintaining its strengths. AACE's Education Board encourages everyone to offer comments and suggestions for improvements to future editions; please forward comments to the AACE International Education Board at education@aacei.org.

Two abbreviations are used throughout this study guide, and are defined as follows:

- e.g., exempli gratia, "for example;" and,
- i.e., id est, "that is."

Introduction to the DRMP™ Certification Study Guide

This is the study guide for the AACE International (AACE) Decision and Risk Management Professional (DRMP) certification examination.

This study guide follows a systematic approach in its development:

- It establishes DRM terminology, ensuring its use is consistent with **AACE Recommended Practice 10S-90**, *Cost Engineering Terminology*);
- It follows AACE International's Recommended Practices related to DRM review and process;
- It ensures consistency with AACE International's **Total Cost Management (TCM) Framework**, as summarized in figure 1; and
- It ensures consistency with AACE International's **Skills and Knowledge of Cost Engineering**, as summarized in figure 2.

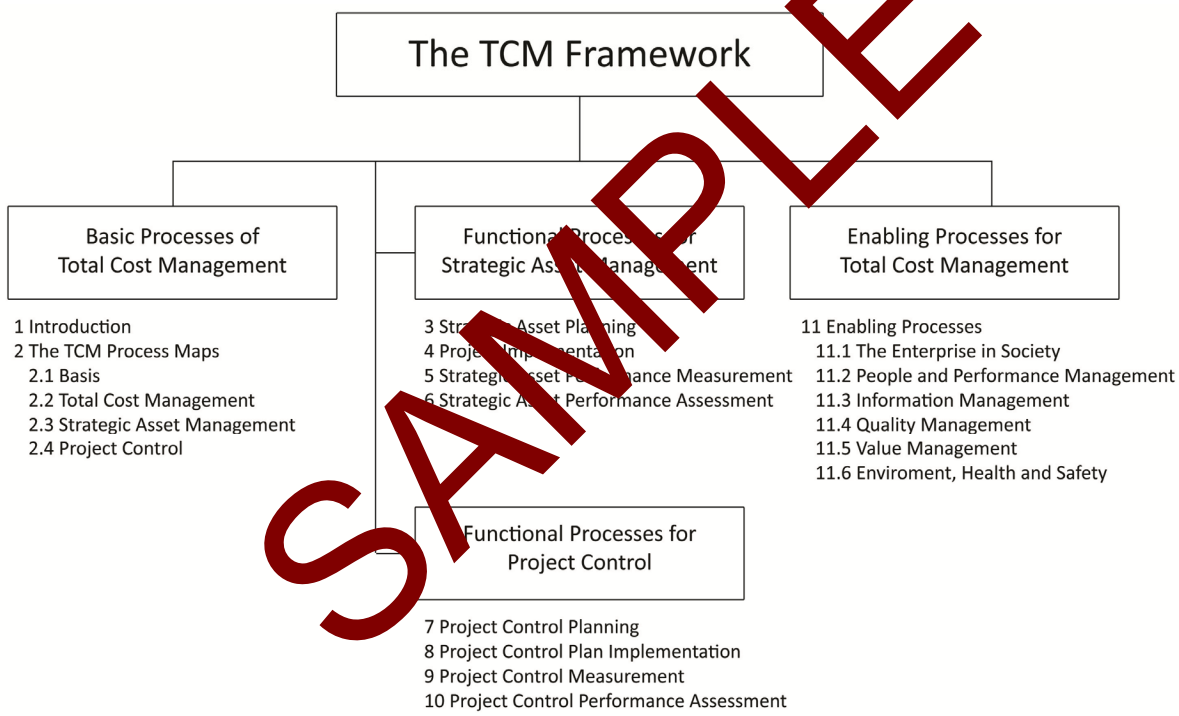


Figure 1—The Outline Structure of AACE's TCM Framework

The **TCM Framework** is based on a series of integrated processes, two of which are fundamental to DRMP certification: Investment Decision Making (Section 3.3) and Risk Management (Section 7.6); these are sub-elements of chapters 3 and 7. All processes in TCM are integrated, and decision-making and risk management are linked to all the chapters of the **TCM Framework**. Investment Decision-Making and Risk Management (RM), similarly, are distinct elements of the **Skills and Knowledge of Cost Engineering**, as outlined in figure 2; A Decision and Risk Management Professional (DRMP) must have skills and knowledge in most of the other elements of figure 2, just as cost engineering professionals must have skills and knowledge in Decision and Risk Management DRM).

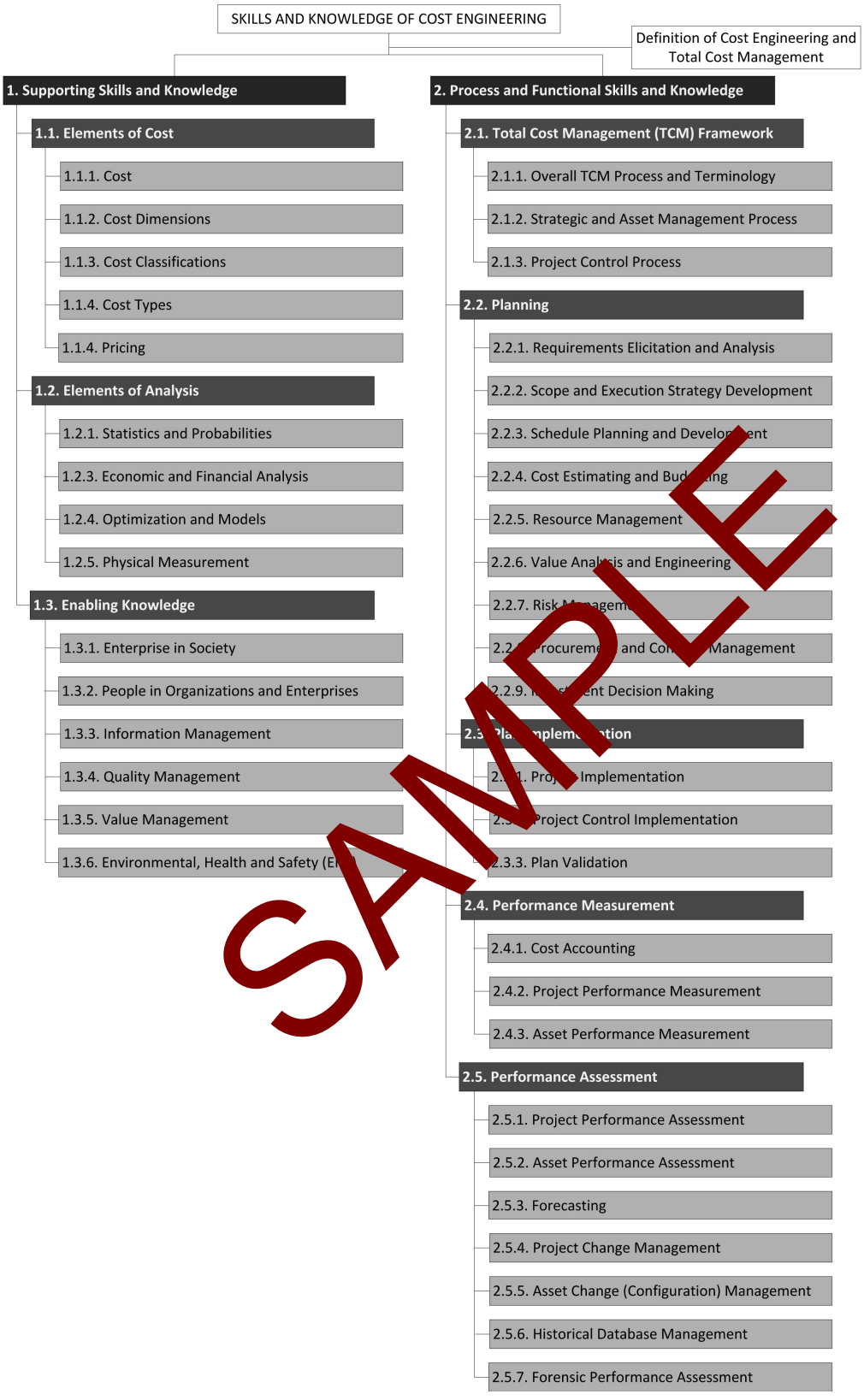


Figure 2—The Outline Structure of AACE's Skills and Knowledge of Cost Engineering outlined in AACE RP 11R-88

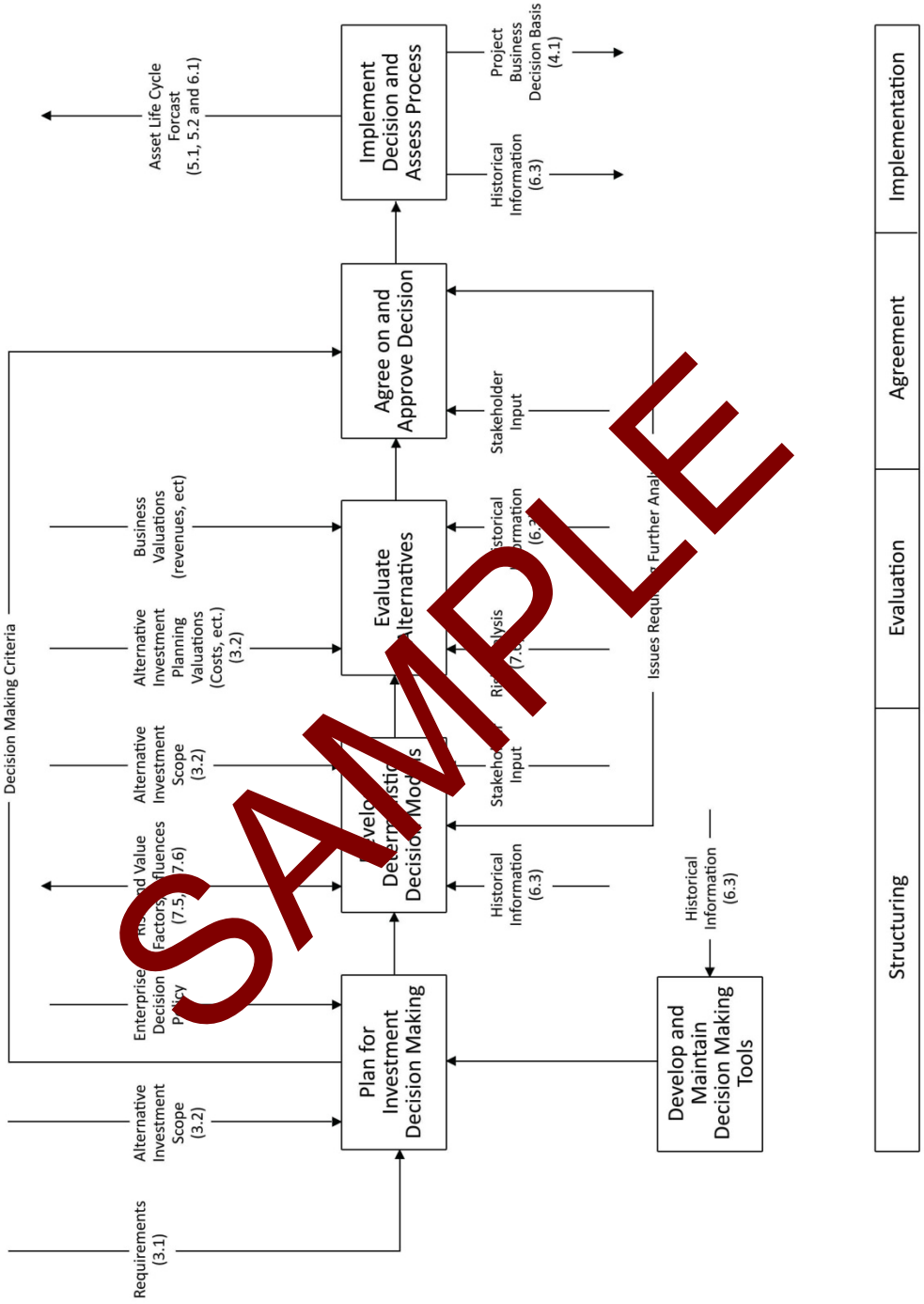


Figure 3—The TCM Framework Process Map for Investment Decision Making (TCM Framework, Section 3.3)

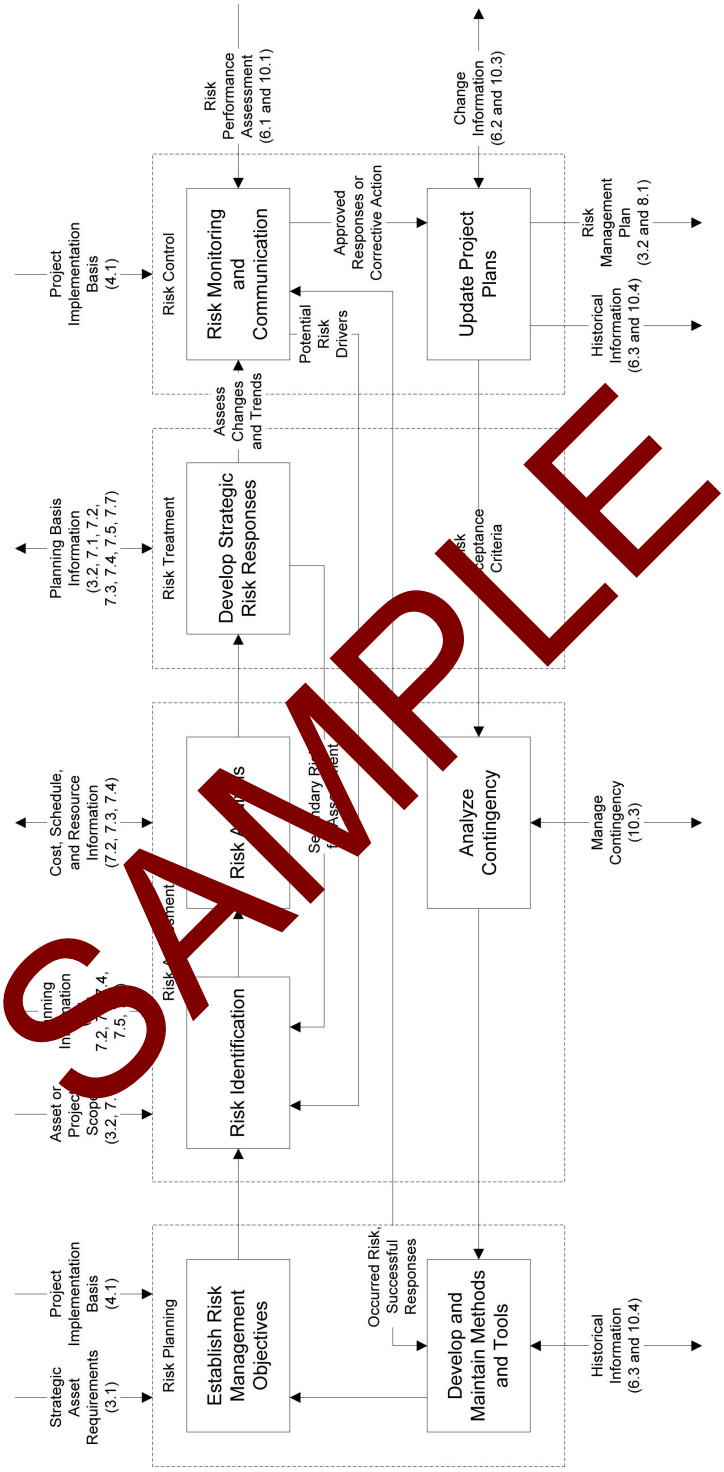


Figure 4—The TCM Framework Process Map for Risk Management (TCM Framework, Section 7.6)

Learning Objectives

The overall learning objectives of this study guide are:

- Understand Decision and Risk Management (DRM) within the *Total Cost Management Framework*;
- Understand the evolution of Decision and Risk Management (DRM);
- Describe what is essential to planning and implementing a Decision and Risk Management (DRM) process, and apply its practices within a capital management or project organization in various enterprise settings;
- Understand the essentials of Decision and Risk Management (DRM) as they apply to many Total Cost Management (TCM) processes; and,
- Provide the basis for AACE International's DRMP certification within the *Total Cost Management Framework,* as summarized in figure 2.

References

Following is a list of references providing the basis of knowledge outlined in this study guide:

1. AACE International **Recommended Practice 10S-90**, *Cost Engineering Terminology*.
2. AACE International **Recommended Practice 11R-88**, *Required Skills and Knowledge of Cost Engineering*.
3. AACE International **Recommended Practice 14R-03**, *Responsibility and Required Skills for a Planning and Scheduling Professional*.
4. AACE International **Recommended Practice 18R-97**, *Cost Estimate Classification System–As Applied in Engineering, Procurement and Construction for the Process Industries*.
5. AACE International **Recommended Practice 23R-03**, *Planning and Scheduling Identification of Activities*.
6. AACE International **Recommended Practice 24R-03**, *Planning and Scheduling, Developing Activity Logic*.
7. AACE International **Recommended Practice 27R-03**, *Schedule Classification System.*
8. AACE International **Recommended Practice 52R-06**, *Time Impact Analysis–As Applied in Construction*.
9. AACE International **Recommended Practice 40R-08**, *Contingency Estimating: General Principles*.
10. AACE International **Recommended Practice 41R-08**, *Risk Analysis and Contingency Determination Using Range Estimating*.
11. AACE International **Recommended Practice 42R-08**, *Risk Analysis and Contingency Determination Using Parametric Estimating*.
12. AACE International **Recommended Practice 43R-08**, *Risk Analysis and Contingency. Determination Using Parametric Estimating–Example Models as Applied for the Process Industries*.
13. AACE International **Recommended Practice 44R-08**, *Risk Analysis and Contingency Determination Using Expected Values*.
14. AACE International **Recommended Practice 47R-11**, *Cost Estimate Classification System–As Applied in Engineering, Procurement and Construction for the Mining and Mineral Processing Industries*.
15. AACE International **Recommended Practice 56R-08**, *Cost Estimate Classification System– As Applied for the Building and General Construction Industries*.
16. AACE International **Recommended Practice 57R-09**, *Integrated Cost and Schedule Risk Analysis*

Using Monte Carlo Simulation (MCS) of a CPM Model.
17. AACE International **Recommended Practice 58R-10**, *Escalation Principles and Methods Using Indices*.
18. AACE International **Recommended Practice 62R-11**, *Risk Assessment.*
19. AACE International **Recommended Practice 63R-11**, *Risk Treatment.*
20. AACE International **Recommended Practice 64R-11**, *CPM Schedule Risk Modeling and Analysis: Special Considerations*.
21. AACE International **Recommended Practice 65R-11**, *Integrated Cost and Schedule Risk Analysis and Contingency Determination Using Expected Value*.
22. AACE International **Recommended Practice 66R-11**, *Selecting Probability Distribution Functions for Use in Cost and Schedule Risk Simulation Models.*
23. AACE International **Recommended Practice 67R-11**, *Contract Risk Allocation.*
24. AACE International **Recommended Practice 68R-11**, *Escalation Estimating Using Indices and Monte Carlo Simulation (MCS)*.
25. AACE International **Recommended Practice 71R-12**, *Required Skills and Knowledge of Decision and Risk Management*.
26. AACE International **Recommended Practice RM-02** (draft), *Risk Management Planning.*
27. American National Standards Institute/Electronic Industries Alliance Standard (ANSI/EIA) 748 B July 2007, Earned Value Management Systems (EVMS).
28. Amos, S. (Ed.). **Skills & Knowledge of Cost Engineering**, *5th Edition*, (2004).
29. Bramble, B. and M. Callahan, **Construction Delay Claims**, *3rd Edition*, (2007).
30. Brienzo, Kenneth, AACE **Professional Practice Guide No. 2**, **Risk**, *2nd Edition*, (2007).
31. Fleming, Q. and J. Koppelman, **Earned Value Project Management**, *3rd Edition*, (2005).
32. Hollmann, J. (Ed.). **Total Cost Management Framework: An Integrated Approach to Portfolio, Program, and Project Management**, (2006).
33. International Standards Organization (ISO), **ISO/IEC Guide 73** *Risk Management–Vocabulary–Guidelines*, (2008).
34. Pritchett, M. (Ed.). **CCP Certification Study Guide**, *3rd Edition*. (See especially Section 4, *Progress and Cost Control*.) (2006).
35. Project Management Systems Committee (PMSC), **Earned Value Management Systems Application Guide**, National Defense Industry Association (NDIA), Arlington VA. (2007).
36. Regan, S.T., **Earned Value Management System Manual,** 1st *Edition,* (2012).
37. SAVE International, **Value Methodology Standard** (*Glossary*), 2003.
38. Uppal, Kul, **AACE Professional Practice Guide No. 8, Contingency**, *3rd Edition*, (2010).
39. Wickwire, J., T. Driscoll, and S. Hurlbut. **Construction Scheduling: Preparation, Liability and Claims**, *2nd Edition*, (2007).

This study guide assumes candidates have a basic knowledge of Decision and Risk Management (DRM); it addresses DRM knowledge and skills that are non-industry specific. This study guide further aims to help candidates learn basic terminology, processes, and practices for DRM. A candidate's company or industry, however, may dictate or emphasize other DRM processes for capital asset, project, program, or portfolio management. This study guide is organized according to the DRM body of knowledge, described at the beginning of each section. The recommended examination preparation includes a review of many of the references listed above. Candidates must also draw from their personal Decision and Risk Management (DRM) and Cost Engineering (CE) experience.

What is Decision and Risk Management?

Importance of Decision and Risk Management (DRM) in Skills and Knowledge Certification

In the asset and project management arena, as covered in this study guide, making decisions and managing risks are largely inseparable. While they can and are shown separately in processes such as Total Cost Management (TCM), in fact, quality decisions of any complexity cannot be made effectively without considering risks and all risk processes support decision-making (e.g., to treat price, or otherwise to deal with risks, in plans and actions). The decisions may be of minor or major consequence, from deciding on risk response strategies, to funding a mega-project, and the risks considered in any decision may similarly be of minor or major consequence. In any case, Decision and Risk Management (DRM) must be combined in a meaningful body of knowledge.

In terms of relative importance, decision-making is the nexus of AACE International's **Total Cost Management Framework**. Decision-making is the link between the total cost management strategic asset management and project control processes; it leads to project, program, or portfolio initiation. Research shows that the success or profitability of a project is largely determined by the quality of the sanction decision and the planning and analysis behind it, including Risk Analysis (RA). Once the asset-, portfolio-, program-, project-, or activity-decision is made, failure to manage risks during execution can lead to loss of planned value. Failure to manage risks can further diminish success of the specific work or the profitability of the entire enterprise, depending on the scope and impact of the risk. So, decision-making and risk management are entwined with the asset and project management area and are equally important.

Brief History

Decision and Risk Management (DRM) is as old as human history. Consider this quote from Agricola's "De Re Metallica" of 1556, one of the first practical texts on industrial methods, in this case mining and chemistry, "the man who, in common with others, has laid out his money on several mines in a region renowned for its wealth of metals rarely spends it in vain, for fortune usually responds to his hopes in part. For when out of 12 veins in which he has a joint interest—one yields an abundance of metals, it not only gives back to the owner the money he has spent, but also gives a profit besides; certainly there will be for him rich and profitable mining if of the whole number, three, or four, or more veins should yield metal."[1] Here, we find quantitatively sound investment decision-making advice that considers profitability (opportunity) and risk management. The text provides similar examples from Roman history as well.

Several centuries later, the concept of the consideration of risks in market economics is well established. Exemplified in Adam Smith's 1776 treatise on the, "*Wealth of Nations*," (e.g., "The ordinary rate of profit always rises more or less with the risk). It does not; however, seem to rise in proportion to it, or so as to compensate it completely."[2]

[1] Hoover, Herbert. and L. Hoover, "*De Re Metallica: Translated From the First Latin Edition of 1556*," **The Mining Magazine**, London, 1912.

[2] Smith, Adam, "*An Inquiry into the Nature and Causes of the Wealth of Nations*," 1776.

Decision and Risk Management (DRM) as processes and business functions began to evolve with the development of industrial engineering and quality management as exemplified by the quality and continuous improvement models of Dr. Walter Shewhart whose Plan-Do-Check-Act (PDCA) of the 1920s is the foundation of AACE International's **Total Cost Management Framework**. By the 1940s, references to "risk management," as a distinct business function became more common (albeit often in the context of marketing or insurance). As post-war capital investment boomed in the 1950s, so too did interest in capital investment and project risks.

Arguably, AACE International's founding in 1956 can be ascribed to a need to better understand capital investment economics and to make better decisions in consideration of project risks and uncertainty. AACE International's **Skills and Knowledge of Cost Engineering** puts a strong emphasis, as does the DRM professional, on engineering economics. AACE International's first *Recommended Practice* in 1958 established cost estimate accuracy classifications, wherein typical "accuracy ranges" were quoted for each phase of capital project scope development.[3]

The development of robust project phase-gate (or stage-gate) scope development processes (covered in the **TCM Framework**, Section 4.1), which have the sole purpose of methodically reducing the uncertainty around investment decisions, is one of the industry's most significant and effective DRM achievements. This work started with the previously referenced estimate classifications and was supported by the ground-breaking empirical cost risk research of one of AACE International's founders, John Hackney, in the 1960s, and many others (RAND, GE, etc.) through the 1980s.

Methodical schedule risk analysis began to evolve during this period. The Program Evaluation and Review Technique (PERT) was developed by the US Navy in 1958, to manage the Polaris Missile Program. Its objective was to simulate the schedule risk of the missile research and development program work using a flow diagram technique that, in turn, lent itself to scheduling and network analysis.[4]

By the late 1980s, software to perform Monte Carlo Simulation (MCS) using personal computer-based spreadsheets was introduced, such that when combined with estimating, scheduling, decision-tree, and other models, provided cost engineers with practical tools to perform sophisticated quantitative decision and risk analyses.[5] Formal capital asset and project DRM processes, systems, tools, and organizational concepts evolved and proliferated rapidly in the 1990s.

Despite measurable improvement in project cost and schedule accuracy, however, when best practices are performed, projects and portfolio outcomes are still highly uncertain, particularly for the growing numbers of mega-industrial and public infrastructure investments. Research has increasingly turned to the field of behavioral psychology to understand better the human input to and practices of DRM. The skills and knowledge of DRM professionals, therefore, require an understanding of the biased and sometimes irrational behavior of stakeholders, decision makers, and team members. Research in the fields of systems engineering— complexity theory being an example—also holds promise for practical analytical tools. DRM professionals will need continually to refresh their skills and knowledge.

---

[3] Gorey, J.M., "Estimate Types," **AACE Bulletin**, Vol. 1, No.1, November 1958.
[4] Fleming, Q. and J. Koppelman, **Earned Value Project Management**, *3rd Edition*, 2005.
[5] Hollmann, J, "*Estimate Accuracy; Facing Reality*," **Transactions**, AACE Annual Meeting, July 2012.

What is Risk Management?
According to the **Total Cost Management Framework** (Section 7.6), Risk Management (RM) is a systematic and iterative process comprising four steps:

- **Plan**—establish Risk Management (RM) objectives;
- **Assess**—identify and analyze risk;
- **Treat**—plan and implement risk responses; and,
- **Control**—monitor, communicate, and enhance Risk Management (RM) effectiveness.

This Risk Management (RM) process is illustrated in figure 4. The goal of RM is to increase the probability that a planned asset, project, or portfolio achieves its objectives. In Total Cost Management (TCM), potential deviations from plans are all considered potentially adverse to overall performance. In this sense, perceived opportunities may also pose a threat. If properly managed, however, the project- or asset-management team may be able to capitalize on "opportune" uncertainties.

The RM process is applied in conjunction with the other asset and project control planning processes, such as scope development, cost estimating, schedule planning, schedule development, resource planning, procurement planning, and financial systems integration. Within the context of total cost management's strategic asset management process, the term, Enterprise Risk Management (ERM), recognizes that the RM process should be applied to overall enterprise, portfolio, and program-level objectives, not just to a single business unit, asset, or project.

The RM process, from a project control standpoint, is designed to address uncertainty in both project input and outcomes. The process, however, generally applies and is critical to addressing uncertainty in the input to and outcomes of any decision. As discussed in the **TCM Framework**, Section 3.3 on "*Investment Decision Making*," a key challenge in strategic asset planning is bringing an awareness of risk and probability concepts to decision whether they result in an implemented project or not. Traditional deterministic economic analysis used in decision-making may be somewhat meaningless when there are significant risks.

Uncertainty and Risk (The Definition Debate)
An initial challenge that any DRMP must deal with is the fact that the definitions of uncertainty and risk differ among practitioners and industries. It is generally accepted that uncertainty is infinitely broad, however, from a project perspective we are only interested in uncertainty that may impact objectives or, more simply, *uncertainty that matters*.

For the purpose of the RM process within the **TCM Framework**, risk is defined as:

"An uncertain event or condition that could affect a project objective or business goal."

The effect of risk may be either positive or negative, (i.e., an opportunity or threat). This definition is fairly consistent within the project management and finance fields, (e.g., ISO, PMI, etc.), which have achievement of a target as their goal. Other fields, however, such as safety and insurance, tend to equate risk and uncertainty with negative effects or threats.

To summarize the various views, an early paper by AACE International defined risk as, "an ambiguous term that can mean any of the following:

- All uncertainty (threats and opportunities);
- Undesirable outcomes of uncertainty (risks + opportunities); and/or,
- The net impact or effect of uncertainty (threats - opportunities).

The paper further recommended that, "the convention used in any work should be clearly stated to avoid misunderstandings."[6] This is still sound advice. The **Total Cost Management Framework** provides extensive coverage of the "definition debate," which has many points of view that DRMP candidates must be aware of.

What is Decision Management?

Total Cost Management (TCM) investment decision-making is a process for analyzing investment alternatives and determining whether, how, and when to allocate the limited resources of the enterprise. This process is illustrated in figure 3. While the total cost management section on decision-making specifically addresses investment decisions during enterprise planning, (e.g., capital planning and budgeting), the general process is applicable to other strategic or tactical decisions that may be made in any process described in the **TCM Framework**. Decision Management (DM) can be viewed as a systematic way of planning, making, implementing, monitoring, and improving major investment decisions; the process of decision-making, however, and the practices of Decision Analysis (DA) in consideration of risk can be applied to any decision, (e.g., to take a corrective action as part of project control, for which an objective methodology is practical).

For major investment decisions, the primary input to the investment decision-making process is the scope description for one or more asset solutions that satisfy requirements. The output of the investment decision-making process is a defined scope of the selected alternative and the assumptions, (i.e., business decision basis or business case, upon which the investment decision was made). This output information is the basis of the project implementation process (**TCM Framework**, *Section 4.1*, *Project Implementation)*, phase-gate scope development processes, as well as the basis for asset performance measurement and assessment.

For non-project alternatives, the output is the basis for implementing asset changes, (e.g., a change to process activities, etc). Decision Risk Management (DRM) in Total Cost Management (TCM) tends to focus on for-profit corporations since the enterprise context is focused on maximizing wealth creation as the dominant objective. Profitability is often the key outcome metric of interest. Despite this focus, the TCM investment decision-making process applies to techniques useful for evaluations in small business, not-for-profit organizations, government, and personal lives.

The prevalent general methodology for decision-making (the focus of **TCM Framework**, Section 3.3) is Decision Analysis (DA). This is a systematic and typically quantitative process for selecting the optimal of two or more alternatives to address a problem or opportunity; such alternatives can take the form of two or more actions—buy vs. don't buy, divest vs. don't divest—or two or more options—a choice between projects, equipment types, vendors, contractors, etc. Alternatives can also be high-profile and strategic, such as whether to divest a corporate subsidiary or infuse it with additional capital in an attempt to increase competitiveness and profitability, or as low-level as the selection between two

[6] AACE International. "*Risk Management Dictionary*," **Cost Engineering**, vol. 42, (2000).

sources for parts. The tools of Decision Analysis (DA) are scalable, the same methods and techniques can be applied across a full spectrum of decision complexities and sizes.

Decision and economic analysis often consider economic costs; DA is a type of economic analysis. Economic costs are a relative view of costs rather than an absolute measure of money. In this sense, economic costs recognize that costs represent opportunities lost, or opportunity costs, and that the value of money is relative to the time, currency, and context in which it is expended, how it is accounted for and taxed, and the definition of value that is applied in the valuation process.

Decision Analysis (DA) as generally applied is a process comprising four steps:

- **Structuring**—identify and frame the problem or opportunity;
- **Evaluation**—analyze the alternatives identified in structuring;
- **Agreement**—develop formal agreement on the selected alternative from evaluation, develop the implementation plan, obtain decision-maker approval; and,
- **Implementation**—implement the selected alternative, and perform continuous improvement of the DA process.

Structuring in Total Cost Management (TCM) is primarily addressed in requirements elicitation and asset planning processes (**TCM Framework**, *Sections 3.1 and 3.2*). Implementation in DA is primarily addressed in **TCM Framework**, *Section 4.1*, on project implementation. The decision management professional applying DA is therefore dealing with all these processes as an integrated set, not just decision-making by itself.

DA should be initiated whenever a problem or opportunity arises for which one solution is clearly not the best choice. Care must be taken to ensure that one alternative or solution is not simply assumed to be the best one. The apparent best alternative or solution often contains hidden drawbacks or deficiencies, which are only identified through a detailed DA. An apparent subpar solution or alternative, conversely, might hide significant improvements compared to one or more other alternatives. The Value-Engineering (VE) process (**TCM Framework**, *Section 7.5*) is integral to DA.

The purpose of the DA process is to facilitate good decision-making. A good decision is one that is logical and consistent with the strategies and objectives of the enterprise, is consistent with the information available at the time, and is likely, therefore, to be compatible with the decision policy of the enterprise. Owing to inherent uncertainty, a good decision does not guarantee a good outcome, but making good decisions over the long term can be expected to maximize the progress of the enterprise toward its objectives.

DA is not prescriptive as to specific evaluation techniques. Methods such as decision trees, Multi-Criteria Decision Analysis (MCDA), and others are common. To deal with uncertainty, the best methods are typically probabilistic in nature.

Conclusion

The preceding discussions are only highlights of the Decision and Risk Management (DRM) processes, practices, and terms. For more complete coverage, students are referred to the appropriate sections of the **TCM Framework**, an AACE International publication.

DRMP Certification Examination Structure

Introduction

To be certified as a Decision and Risk Management Professional (DRMP), a candidate must meet the minimum eligibility requirements and successfully pass a written examination as determined by the AACE International Certification Board. This study guide provides the information needed to prepare for the DRMP examination.

Basis of the Examination

The purpose of any professional certification or licensing program is to provide a mechanism to formally and objectively evaluate and publicly recognize the capabilities of an individual in a defined skill area. Certification as a Decision and Risk Management Professional (DRMP) recognizes certificate holders who have demonstrated their expertise in Decision and Risk Management (DRM), which includes the following:

- Decision and Risk Management (DRM)supporting skills and knowledge;
- Risk management (RM) skills and knowledge;
- Decision-making skills and knowledge; and
- Other functional skills and knowledge.

To define DRM more specifically in terms of expected skills and knowledge, AACE International has published *Recommended Practices*. DRM is a supplement of cost engineering as applied to the process of total cost management, which is a dynamic, integrated process incorporating many functions and is affected by advances in philosophies, methodologies, and technology. A professional specializing in DRM is expected to keep abreast of these advances and demonstrate this knowledge in the examination.

In summary, the definition of DRM and **AACE Recommended Practice 11R-88**, "*Required Skills and Knowledge of Cost Engineering*" (DRM portion), form the basis of the DRMP certification examination, which addresses the following:

- Minimum knowledge covered by the basic skills documents; and
- Advanced knowledge based upon DRM experience.

Examination Structure

The DRMP exam is delivered through computer based testing (CBT) and consists of multiple choice questions and a written exercise.

1. **MULTIPLE CHOICE EXAMS**: The exam is delivered through computer based testing (CBT)* and is comprised of multiple-choice and compound, scenario questions. The topics covered in the exam are: *basic cost engineering and statistics* (*DRM body of knowledge*, *Sections 1 and 4*); *economic analysis; and DRM practices* (*DRM body of knowledge*, *Sections 2 and 3*).
2. **MEMO ASSIGNMENT**: The memo assignment will allow the candidate to choose from an onscreen list of suggested scenarios and will require the candidate to demonstrate both communication skills and insight regarding a challenging DRM workplace scenario. The memo

will be written in the text box provided onscreen and should demonstrate a candidate's ability to organize thought and communicate effectively. The memo will need to be addressed properly, include a purpose statement, describe the potential impact of any described problem or issue, propose a clear actionable solution with supporting rationale and include a closing statement. In addition to demonstrating technical knowledge, successful candidates will be recognized for applying appropriate Enabling Knowledge. See also Appendix F for additional and more comprehensive guidance notes.

The exam is closed book. Candidates are permitted to bring any style of calculator, including programmable calculators, to use during the exam. Candidates will have a maximum of 5 hours to complete the exam.

The examination is not based upon use or knowledge of specific software, but rather embodies the knowledge and experience of a DRM practitioner using such tools. All materials provided during the examination, including work paper, must be turned in upon completion of the examination.

Recognizing that there are many industries and fields within the profession—engineering, construction, manufacturing, process facilities, mining, utilities, transportation, aerospace, environment and government—candidates can expect questions from any of these practices. The exam takes into account the fact that no one can be expected to be conversant in all practice areas through its multiple-option format and extensive use of questions of general applicability.

DRMP candidates are expected to have fairly broad skills, knowledge, and experiences in cost engineering in addition to specific DRM skills and knowledge. While it is not required, candidates will benefit from first passing the Certified Cost Professional (CCP) examination because of the exams' shared skills and knowledge of Total Cost Management (TCM) and cost engineering in general and economic analysis in particular. However, passing the DRMP is not a substitute for nor does it indicate achievement of the CCP. DRM professionals cannot provide effective support to decision makers and project leaders without understanding the context of the relevant asset and project management process.

DRM goes beyond the CCP exam in respect to skills and knowledge of DRM process steps (as shown in figures 3 and 4) and incorporates methods such as Decision Analysis (DA), Risk Analysis (RA), and contingency analysis. These methods require strong quantitative skills and knowledge, particularly in the areas of probability, statistics, and modeling. Finally, communication skills are vital to making sure risks and their impacts are identified and understood, particularly among stakeholders, decision makers, and managers who have strong expectations and biases. Before investing in the effort and expense required for taking the exam, candidates should review objectively their understanding, skill, and experience of this diverse body of knowledge.

Chapter 1.0 Supporting Skills and Knowledge

Introduction

The practice of Decision and Risk Management (DRM) takes place throughout the life cycle of asset and project management and is tied to all the processes in Total Cost Management (TCM). The first steps in TCM, whether for an asset portfolio or for a single project, are to gather requirements for asset or project performance from varied stakeholders and to establish objectives and measures that will indicate if the requirements have been met.

Profit, usually measured in some form of return on asset investments, is the most common high-level objective and is the basis for most decisions. Profit is driven by revenue, capital, and expense costs (in TCM, cost is an investment of resources of various types such as labor and materials), and the time-value of money over the life cycle of an asset or asset portfolio. Other requirements and objectives may address quality, health, safety, environment, security, reputation, or other performance attributes of a portfolio, program, or project. The DRM professional must therefore understand both asset and project lifecycle processes and the many attributes of success to be planned, analyzed, and measured.

DRMP candidates will need to evaluate all measures using a wide variety of analytical methods. Because DRM deals with uncertainty, most of the analyses involve the application of probability and statistics. While DRMP candidates are not expected to be expert statisticians, they should be competent with the basic statistical concepts, such as common probability distributions, attributes and basic descriptive statistical definitions. The probability and statistical concepts are typically applied to various analytical models of profit, (e.g., NPV, Net Present Value), cost, (e.g., capital estimates); schedule, (e.g., Critical Path Method (CPM) schedules); and so on. The models may be as simple as cash flow, cost and time, or as complex as multi-attribute decision models that convert all success measures—cost, time, safety, environment, reputation, etc.—to monetary equivalents or some other common metric. Monte Carlo Simulation (MCS) is often applied to the underlying analytical models. Because profit is often the ultimate decision criterion and measure of risk, DRMP candidates must have strong skills and knowledge of economic and financial analysis, particularly engineering economics, (e.g., NPV), applying the time-value of money. Analytical methods of systems engineering in future are likely to become more prominent as they become more practical in DRM.

The TCM processes take place in varied cultural, political, enterprise, organizational, and team settings. There are many stakeholders to be consulted, considered, and dealt with, both internal and external to the organization. These stakeholders often have competing, sometimes conflicting, needs and expectations; each brings different biases to the analysis. DRM professionals must be versed in organizational, cultural, political, behavioral, and psychological bodies of knowledge. Understanding the human dimensions of DRM is likely to become more prominent as research leads to more practical applications.

DRM professionals may be working in an asset-owner, contractor, or consulting organization. Owners tend to be more focused on the strategic asset management side of TCM, making portfolio, program, and project investment decisions; the quality of those decisions are often strong drivers of success. Contractors tend to focus on the project control side of TCM. The owner's profit derives from return on capital assets—the strategic decision is the investment decision, and the biggest risks are often market, product, and production related. Conversely, the contractor's profit derives from return on human

capital—the strategic decisions are the resourcing and bid decisions, and the biggest risks tend to be execution related. DRMP candidates must understand both perspectives.

While other AACE specialty certifications focus on one measure or sub-process of TCM—Certified Estimating Professional (CEP) on cost, Planning and Scheduling Professional (PSP) on time, Earned Value Professional (EVP) on measurement and control, Certified Forensic Cost Consultant (CFCC) on contracting—the DRMP may be the most demanding of general or supporting skills and knowledge of the entire spectrum of TCM processes (estimating, scheduling, contracting) and measures of interest (quality, cost, time, etc.). The need to understand behavioral and psychological aspects is great (performing risk elicitation, addressing decision-maker bias, etc.). The skills and knowledge portion of the *DRMP body of knowledge* is as broad as the CCP—with a deeper focus on probability, statistics, and DRM modeling methods on the analytical side, psychology and behavior on the management side. DRMP candidates holding CCP certifications will have a head start in preparing for the DRMP exam. The value of DRMP certification can generally be determined by the fact that top capital management and project decision-makers and leaders solicit DRMP support and input; DRM is an esteemed career, in part owing to its proximity to decision-makers.

In summary, the DRMP should have a firm understanding of the following principle supporting skills and knowledge concepts:

- **Elements of Costs**
    - Cost definitions;
    - Asset and project life cycles;
    - Portfolio, program, project scope, deliverables;
    - Owner vs. contractor views of costs;
    - Monetary vs. economic/opportunity costs;
    - Cost vs. pricing;
    - Influence curve;
    - Classifications: operating, capital, expense; and,
    - Types: labor, material, equipment.

- **Elements of Planning and Scheduling**
    - Schedule definitions;
    - Activities and durations;
    - Logic: milestones, Critical Path Method (CPM), Critical Chain, Program Evaluation and Review Technique (PERT), GERT, Precedence Diagramming Method (PDM);
    - Delay;
    - Acceleration, crashing;
    - Cost/schedule integration and tradeoff;
    - Integrated schedules;
    - Programs and portfolios; and,
    - Resource planning.

- **Elements of Analysis**

    - Statistics and probability;
    - Economic and financial analysis; and,
    - Optimization and modeling.

- **Enabling Knowledge**

    - Ethics;
    - Organizational/leadership/teams;
    - Culture/bias;
    - Performance/productivity/human factors;
    - Psychology/sociology/group dynamics/elicitation/bias;
    - Psychology of estimating and Decision Analysis (DA);
    - Quality/cost of quality;
    - Value;
    - EH&S/sustainability;
    - Legal;
    - Insurance (including bonding, etc.);
    - Contracting;
    - Finance (Forex, hedging, etc.);
    - Markets, economics;
    - Technology (R&D, complexity, e[illegible]; and
    - Stakeholder management.

Terms to Know

- Action owner;
- Asset lifecycle;
- Capital asset;
- Cash flow;
- Cost;
- Decision Analysis (DA);
- Decision and Risk M[illegible]ement (DRM);
- Ethics;
- Foreign Exchange (Forex);
- Internal Rate of Return (IRR);
- Linear regression;
- Merge bias;
- Monte Carlo Simulation (MCS);
- Net Present Value (NPV);
- Organization Breakdown Structure (OBS);
- Portfolio;
- Precedence Diagramming Method (PDM);
- Program;
- Program Evaluation and Review Technique (PERT);

- Project;
- Project control (in TCM);
- Project lifecycle;
- Pricing;
- Qualitative analysis;
- Quality;
- Quantitative analysis;
- Requirements;
- Residual risk;
- Resources;
- Responsibility Assignment Matrix (RAM);
- Return on Investment (ROI);
- Risk Breakdown Structure (RBS);
- Risk events;
- Risk Management (RM);
- Risk owner;
- Secondary risk;
- Strategic asset management (in TCM);
- Total Cost Management (TCM);
- Types of risk;
- Value; and
- Work Breakdown Structure (WBS).

Key Points for Review

- Understand the breadth of DRM skills and knowledge required to support all TCM processes and cost engineering functions.
- Understand the principal elements of cost and resources as related to DRM.
- Understand the principal elements of planning and scheduling as related to DRM.
- Understand the basic principles of analysis using probability and statistics in DRM.
- Understand profitability measurement concepts (IRR/NPV/ROI) with emphasis on the uncertainty aspects related to DRM.
- Understand the optimization and modelling practices related to DRM.
- Understand the principles of ethics as required in DRM.
- Understand management theories and decision-making related to DRM.
- Understand the cultural and political drivers and biases and decision-making related to DRM.
- Understand the psychological and sociological drivers of biases related to DRM.
- Understand the relationship of DRM to quality management.
- Understand the relationship of Value Engineering (VE)/Value Management (VM) to DRM.
- Understand the role of insurance, bonds, and payment guarantees to DRM.
- Understand the relationship of contracting to DRM processes.
- Understand the relevancy of foreign exchange and currency hedging to DRM.
- Understand the relevancy of markets and economics to DRM.
- Understand the relevancy of technology and complexity to DRM. And,
- Understand the relevancy of stakeholder management to DRM.

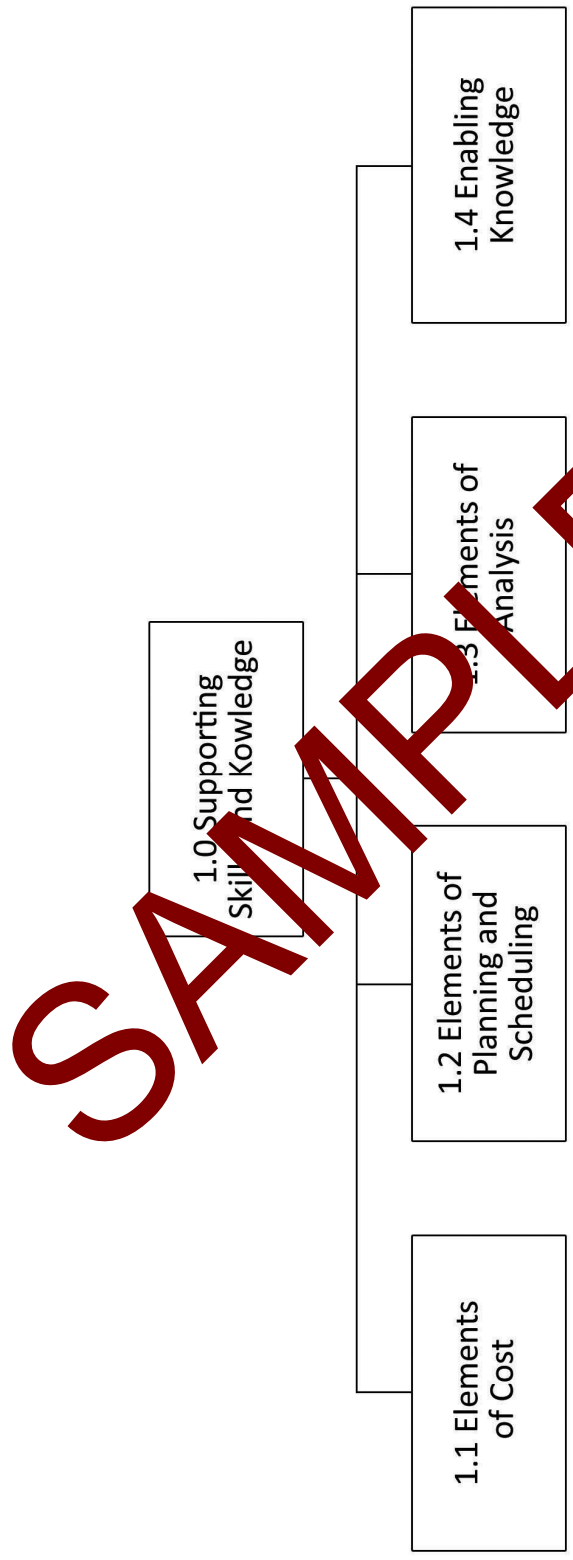


Figure 5—DRM Body of Knowledge Diagram for Supporting Skills and Knowledge

Section 1.1 Elements of Costs

Introduction

The term, elements, refers to any general knowledge of costs that needs to be understood to support the practice of Decision and Risk Management (DRM): definitions, attributes, perceptions, implications. DRMP candidates will find this material outlined in **AACE Recommended Practice 11R-88**, "*Elements of Cost*."

Cost Definitions

Cost in Total Cost Management (TCM) is any resource invested or expended in an asset, be it monetary, time, effort, or other resource expenditure. The investment is put into effect through the execution of programs and projects. The cost, therefore, in TCM and cost engineering, is not about money, but about managing resource investments in assets through the execution of projects.

From a more traditional viewpoint, and as defined in AACE International's bylaws, cost engineering is the application of scientific principles and techniques to problems of estimation; cost control; business planning and management science; profitability analysis; and project management, planning, and scheduling.

While TCM defines cost broadly as synonymous with an investment of resources, most people view cost from a monetary perspective, (i.e., an expenditure of money), but even that is not a narrow view because most resources such as people, time, and materials can be evaluated in monetary terms for Decision Analysis (DA), Risk Analysis (RA), and other DRM practices.

In project control, the definition of monetary expenditure prevails, (i.e., literal payment within time constraints for materials, labor, and other things for which money is paid). In strategic asset management, and DA, the economic view tends to prevail in which cost is a conceptual valuation of any input to an asset or project; this may incorporate subjective judgment. Concepts such as these and the opportunity costs or the time value of money applied in engineering economics also demonstrate that costs should not be viewed too narrowly, as expended money, per se.

In summary, costs can be viewed literally as a monetary expenditure, or as a more conceptual monetary measure, (e.g., Expected Monetary Value (EMV)) used to value any input to or investment in an asset or project. In project control, the monetary expenditure definition prevails, (i.e., literal payment within time constraints for materials, labor, and other things for which money is paid). In strategic asset management and DA, the economic view tends to prevail in which cost is a conceptual valuation of any input to an asset or project; this may involve subjective judgment.

These definitions from varied viewpoints lead to the following elements of costs covering resources, deliverables, investment vehicles, and so on. DRMP candidates should know and understand the following:

- Cost definitions (covered previously);
- Asset and project life cycles;
- Portfolio, program, project scope, deliverables;
- Owner vs. contractor view of costs;
- Monetary vs. economic/opportunity costs;
- Cost vs. pricing;
- Influence curve;
- Classifications (operating, capital, expense); and,
- Types (labor, material, equipment).

Other Elements of Cost

Most of the elements of costs in the preceding list are covered in AACE International's **TCM Framework**, while the Skills and Knowledge text and are defined in **AACE Recommended Practice 10S-90**. A few of the important concepts are discussed in the following paragraphs:

In early decision-making or portfolio planning, a single cost value may be used to express the entire asset investment or project valuation. For more detailed planning and project control, it becomes more important to structure the costs further into material, labor, and other resource categories to understand how they influence the total cost of the activity or asset and to understand how they can be controlled. The DRM breakdown can provide insight into decision drivers or what is influenced by risk. This structuring typically sorts the costs into categories such as direct, indirect, fixed, and variable costs. Some costs, in practice, may fall into more than one of these groups.

In business practice, cost element information may be grouped in ways that provide the basis for management decisions. Typical groupings are listed in table 1. Any cost structure or breakdown should be tailored to the individual project and company's method of doing business.

Grouping	Description
1. Cost center	Cost centers are groups of activities within a project that provide a convenient point for collecting and measuring costs. Cost centers could be departments in an engineering organization, such structural design groups, or they could be process-related, such as a metal stamping operation.
2. Labor craft	Labor crafts may be grouped into types of labor on a construction site, such as electricians, plumbers, and the like, or grouped into types of manufacturing operations, such as machinists, tool-and-die technicians, and the like.
3. Material type	Material type might be a manufacturing company's raw materials, purchased parts, etc., or, for a construction project, the concrete, 1½-inch-and-smaller pipe, etc.
4. Inventory	Inventory can be the value of purchased material and equipment waiting to be used in manufacturing or installed into a facility under construction. It can also be the cost of finished goods waiting to be sold.
5. Overhead	Overhead is indirect costs allocated to labor and material cost elements. The cost of maintaining a manufacturing facility or the cost of the home office of a construction company with several projects underway is examples of overhead.
6. Equipment	Equipment is the value of all machine tools, and other devices needed to support a manufacturing operation or a construction project.
7. Sub-contracts	It is important to separately collect and report work that is contracted out to others in support of the project. This could be labor or material, direct or indirect work.
8. Other direct costs	Examples of direct costs are travel expenses, start-up costs, plant protection, etc. Sometimes it is convenient to charge directly a cost that may also be treated as an indirect cost.
9. Commitments	Commitments are a group of future costs represented by obligations to obtain sub-contracted or purchased material and services. It is important to make this information available when changes to production or construction plans occur.

Table 1—Example Cost Element Groupings in Cost Estimating

Another key concept for DRMPs to understand is the difference between cost and pricing. Pricing refers to the amount of money asked or given for a product, (e.g., exchange value). Pricing is the tools and techniques used to establish a monetary value for an output, the price that will be an amount expended, or an input cost to the buyer. The price or money asked by the seller includes their own input cost plus profit and/or other margins.

Pricing is a step in the cost estimating and budgeting process of the **TCM Framework**, *Section 7.3*. TCM indicates that, "pricing includes charging techniques that various stakeholders in the plan (bidders, contractors, etc.) apply to costs in the estimate to allow for overhead and profit, to improve cash flow, or to otherwise address market conditions and serve their business interests." In considering risks and supporting decision-making, DRMP candidates should be aware that prices may be unbalanced by the bidder or seller; the values may reflect their business and cash flow objectives and not cost

expenditures. DRMP candidates often support pricing decision-making by the bidder or seller, and it is common for a seller to include allowances for their contingency in bid or sale prices.

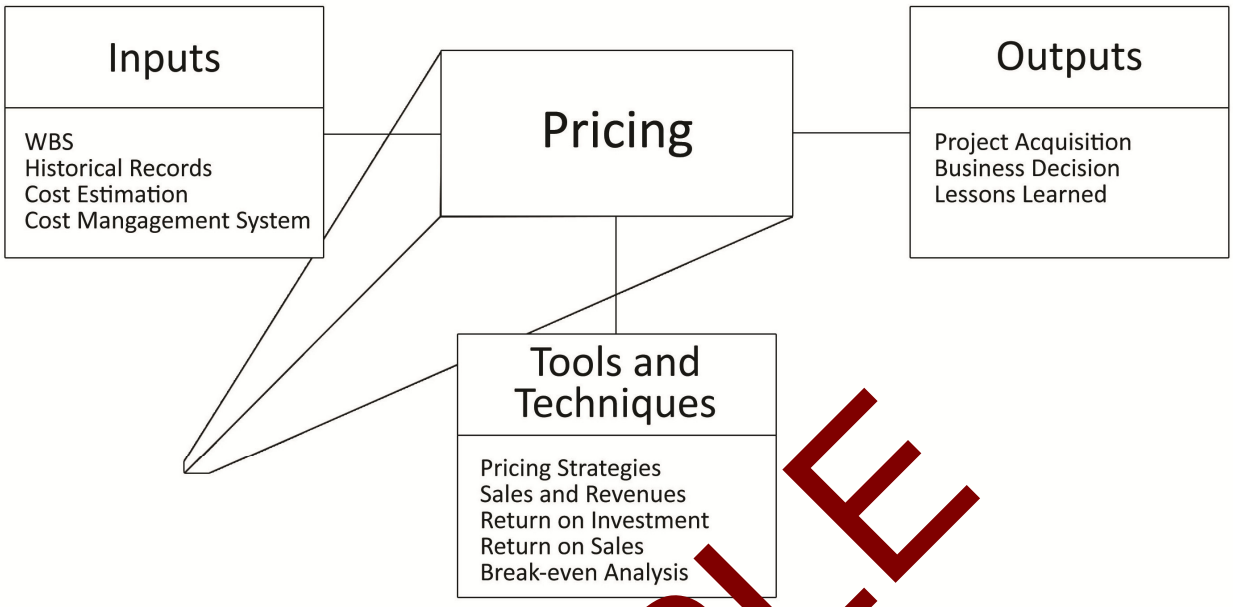


Figure 6—Risk Technique Sample

DRMPs should also understand the concept of the influence curve as shown in figure 7. The decision-maker and team leaders have more ability to influence the value or cost of an investment or activity early in its scope definition, with minimal cost or risk impact. As incremental commitments and decisions are made, it is difficult to recycle the scope definition through the development process because change tends to be disruptive, decreases productivity, and increases uncertainty and risk. This concept is a foundation of phase-gate decision-making processes, wherein uncertainty is reduced in a planned way by better scope definition while making sure scope decisions are made in a timely way—don't decide before you plan.

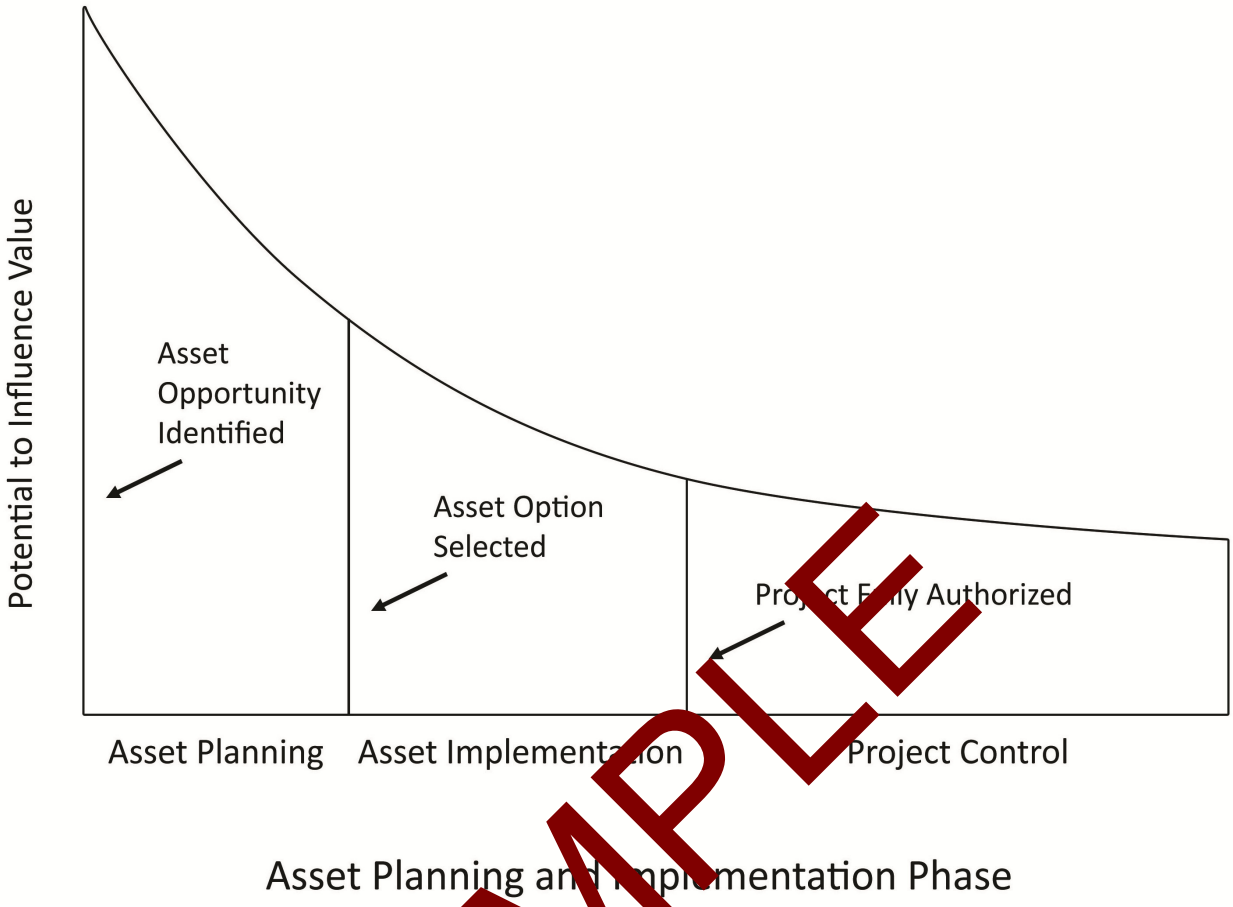


Figure 7—Influence Curve

DRMPs need to understand how Decision Analysis (DA) and Risk Management (RM) may be influenced by various cost classifications. For example, most investment decisions hinge on the analysis of profit as reflected in Net Present Value (NPV) or Internal Rate of Return (IRR) analysis.

In developing a model for DA, the DRMP candidates should understand how various costs affect profitability calculations and that cost information provided by team members, such as accounting, may reflect bases different from those anticipated, (e.g., accrued vs. expended). Some costs are also subject to greater uncertainty than others, (e.g., fixed vs. variable). Following are typical classifications that play into product or project revenue, cost and profitability calculations:

- Operating (production, manufacturing, maintenance, etc.) vs. capital;
- Capital vs. expense;
    - Depreciation;
    - Amortization;
    - Accrual;
- Fixed vs. Variable;
- Direct vs. Indirect;
    - Activity-Based Costing (ABC); and,
    - Job costing.

Terms to Know

- Asset;
- Cash flow;
- Cost;
- Cost category;
- Cost Breakdown Structure (CBS);
- Cost objective;
- Direct cost;
- Economic cost;
- Expected Monetary Value (EMV);
- Expenditure;
- Fixed cost;
- Indirect cost
- Influence curve;
- Monetary equivalent;
- Opportunity cost;
- Price;
- Profitability;
- Project;
- Resource;
- Statement of Work (SOW);
- Time value of money;
- Unbalancing;
- Value;
- Variable cost; and,
- Work Breakdown Structure (WBS).

Key Points for Review

- Know the definitions of cost and the understanding of the definitions as they relate to an asset, (i.e., investment decision-making), or activity, (i.e., project control).
- Understand how the concept of cost differs when viewed from a literal cash expenditure viewpoint versus an economic valuation perspective.
- Understand how cost information may be structured or classified in a variety of ways to provide insight to and the basis for decision and risk analysis and management decisions.
- Understand the process of pricing, the distinction between cost and price, and how it relates to DRM insight and analysis. And,
- Understand the concepts behind the influence curve and its implications for DRM.

Please see Sample Questions for Section 1.1 on page 27

Please see Solutions to Sample Questions for Section 1.1 on page 28

Sample Questions for Section 1.1

1. Which of the following is not a component of the pricing process?

   A. Input.
   B. Decision Analysis (DA).
   C. Tools and techniques.
   D. Output.

2. Cost is a measure of the value of an asset or labor?

   A. True.
   B. False.

3. Correctly sequence the Phase-gate Milestones (1 through 3) and Implementation Phase names (A through C) to help describe what, in TCM, is known as the Influence Curve.

   1. Asset option selected.
   2. Project authorized.
   3. Asset opportunity identified.

   A. Asset Implementation
   B. Asset Planning.
   C. Project Control

4. Which of the following accounting treatments of costs are influenced by capital versus expense classifications?

   A. Depreciation, amortization, asset.
   B. Depreciation, amortization, accrual.
   C. Depreciation, asset, accrual.
   D. Asset, amortization, accrual.

Please see Solutions to Sample Questions for Section 1.1 on page 28

Solutions to Sample Questions for Section 1.1

1. B. Decision Analysis (DA) is not part of the pricing process matrix.

2. B. Cost is a measure of the Expected Monetary Value (EMV) or worth of an activity or asset.

3.

Phase-gate Milestone	*Implementation Phase*
1. Asset opportunity identified.	A. Asset Planning.
2. Asset option selected.	B. Asset Implementation.
3. Project authorized.	C. Project control.

4. B. Depreciation, amortization, accrual.

