AACE INTERNATIONAL RECOMMENDED PRACTICE

11R-88

REQUIRED SKILLS AND KNOWLEDGE OF COST ENGINEERING

AACE INTERNATIONAL

AACE International Recommended Practice No. 11R-88

REQUIRED SKILLS AND KNOWLEDGE OF COST ENGINEERING

TCM Framework: General Reference
(All Sections)

Rev. June 18, 2013

Note: As AACE International Recommended Practices evolve over time, please refer to www.aacei.org for the latest revisions.

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Disclaimer: The opinions expressed by the authors and contributors to this recommended practice are their own and do not necessarily reflect those of their employers, unless otherwise stated.

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This recommended practice has the following purposes:

- define what *core* skills and knowledge of cost engineering a person is required to have in order to be considered a professional practitioner, and in doing so,
- establish the emphasis of *core* subjects for AACE International education and certification programs.

It is also hoped that enterprises will find this useful as a reference or guide for developing their own competency models. *Knowledge* is an understanding gained through experience or study, and *skills* are abilities that transform knowledge into use. *Core* subjects are those whose usage is occasional to frequent and are considered by AACE International as being required for professional practitioners of cost engineering to know and be able to use.

This recommended practice lists these core subjects and provides general *performance statements* (i.e., "be able to" describe, perform, etc.) to represent the level of proficiency expected in each subject area. These statements are representative or guiding examples only

This text is an outline that is intended to be the structural foundation for products and services developed by the Educational and Certification Boards. It will continue to be modified as current practice changes.

BACKGROUND AND SCOPE UPDATE

The original recommend practice *Required Skills and Knowledge of a Cost Engineer* was developed by the AACE International Education Board and published in 1978 based on their evaluations of a membership survey. Until that time, AACE International lacked a formal definition of professional cost engineering in terms of skills and knowledge. Based on the recommended practice findings, the Education Board then published the first *Skills and Knowledge of Cost Engineering* text to provide an educational product to elaborate on the core skills and knowledge subjects. The earlier text has been regularly updated by the Education Board.

Since the original publication, the AACE Technical Board was given the charter to define the technology of cost engineering and total cost management. In 2005, the Technical Board completed development of the *Total Cost Management Framework* which describes a systematic process (i.e., TCM process) through which the skills and knowledge of cost engineering are applied. It also provides an integrated structure upon which the Technical Board can organize its development of recommended practices, including this one.

This update of the *Required Skills and Knowledge of a Cost Engineer* retains most of the content of the earlier versions while incorporating those elements of the TCM process that the AACE associate boards (Technical, Education and Certification) determined are required for a professional practitioner of cost engineering to know. It also incorporates a more systematic organization of the subjects, based on TCM developments, to better differentiate between general *supporting knowledge* used in more than one practice or process (e.g., statistics, elements of cost, etc.), and specific *practice knowledge* used in particular functions or processes (e.g., cost estimating, planning and scheduling, etc.)

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INTRODUCTION

A professional cost engineering practitioner must first be able to articulate the meaning of the terms *cost engineering* and *total cost management (TCM)*. Practitioners will frequently be asked these questions. Given the importance of this first knowledge requirement to the understanding this recommended practice, the questions are answered here. Elaboration of all other skills and knowledge requirements is left for subsequent Education Board products.

What are Cost Engineering and TCM?

The AACE International *Constitution and Bylaws* defines cost engineering and total cost management as follows:

> **Section 2.** The Association is dedicated to the tenets of furthering the concepts of *Total Cost Management* and *Cost Engineering*. Total Cost Management is the effective application of professional and technical expertise to plan and control resources, costs, profitability and risk. Simply stated, it is a systematic approach to managing cost throughout the life cycle of any enterprise, program, facility, project, product or service. This is accomplished through the application of cost engineering and cost management principles, proven methodologies and the latest technology in support of the management process.
>
> **Section 3.** Total Cost Management is that area of engineering practice where engineering judgment and experience are utilized in the application of scientific principles and techniques to problems of business and program planning; cost estimating; economic and financial analysis; cost engineering; program and project management; planning and scheduling; and cost and schedule performance measurement and change control.

In summary, the list of practice areas in Section 3 are collectively called *cost engineering*; while the "process" through which these practices are applied is called *total cost management* or TCM.

How is cost and schedule management an "engineering" function?

Most people would agree that "engineers" are engineering (or more generally, the "application of scientific principles and techniques") and cost engineers are responsible for creating functional things (or *strategic assets* as we call them in TCM). However, engineering has multiple dimensions. The most obvious is the dimension of physical design and the calculation and analysis tasks done to support that design (e.g., design a bridge or develop software). However, beyond the physical dimension of design (e.g., the bridge structure), there are other important dimensions of *money*, *time*, and other *resources* that are invested in the creation of the designed asset. We refer to these investments collectively as *costs.* Using the above example, someone must estimate what the bridge might cost, determine the activities needed to design and build it, estimate how long these activities will take, and so on. Furthermore, someone needs to monitor and assess the progress of the bridge design and construction (in relation to the expenditure of money and time) to ensure that the completed bridge meets the owner's and other stakeholder's requirements. Someone must also monitor and assess the cost of operating and maintaining the bridge during its life cycle.

Returning to the *Constitution and Bylaws* definition, understanding and managing the cost dimensions requires skills and knowledge in "business and program planning; cost estimating; economic and financial analysis; cost engineering; program and project management; planning and scheduling; and cost and schedule performance measurement and change control." No significant asset has ever been built without dealing with these cost dimensions in some way, and the more systematically and professionally these dimensions are addressed, the more successful the asset performance is likely to be. Therefore, cost *engineering* recognizes that cost is a necessary extension of traditional engineering (and other creative functions such as systems analysis, etc.), and that there is an intimate connection between the physical and cost dimensions of the asset.

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Do cost engineering practitioners need to have a traditional "engineering" background?

The skills and knowledge required to deal with *costs* (i.e., cost estimating, planning and scheduling, etc.) are quite different from those required to deal with the physical design dimension. From that difference, the field of *cost engineering* was born. Cost engineering practitioners work alongside of and are peers with engineers, software analysts, play producers, architects, and other creative career fields to handle the cost dimension, but they do not necessarily have the same background. Whether they have technical, operations, finance and accounting, or other backgrounds, cost engineering practitioners need to share a common understanding, based on "scientific principles and techniques", with the engineering or other creative career functions.

Do cost engineering practitioners all have the same function?

Cost engineering practitioners tend to be: a) specialized in function (e.g., cost estimating, planning and scheduling, etc.); b) focused on either the asset management or project control side of the TCM process; and c) focused on a particular industry (e.g., engineering and construction, manufacturing, information technology, etc) or asset type (e.g., chemical process, buildings, software, etc.). They may have titles such as cost estimator, quantity surveyor, parametric analyst, strategic planner, planner/scheduler, value engineer, cost/schedule engineer, claims consultant, project manager, or project control lead. They may work for the business that owns and operates the asset (emphasis on economics and analysis), or they may work for the contractor that executes the projects (emphasis on planning and control). But, no matter what their job title or business environment, a general knowledge of, and skills in, all areas of cost engineering are required to perform their job effectively. In summary, the purpose of this document is to define these *required skills and knowledge of professional cost engineering.*

THIS DOCUMENT'S OUTLINE STRUCTURE AND ITS RELATIONSHIP TO PARTICULAR FUNCTIONS AND AACE INTERNATIONAL CERTIFICATIONS

Figure 1 illustrates the hierarchical structure of the Required Skills and Knowledge of Cost Engineering. The first level of the structure differentiates between general *supporting knowledge* used in more than one practice or process, and specific *practice knowledge* used for particular functions or process steps. Succeeding levels further break down the content to whatever level is appropriate for each skills and knowledge area. The location of a skill or knowledge element in the level of the outline does not reflect on its relative importance.

On the process and functional side, the structure is organized in accordance with the plan, do, check, (or measure), and assess (PDCA) process model that serves as the basis for the TCM process through which all the skills and knowledge of cost engineering are applied. It is not structured by a practitioner's work function. For example, cost estimators will not find all of their required skills and knowledge under one heading. Their particular function's required skills and knowledge will include elements of supporting knowledge, as well as elements of planning, measuring, and assessing that are appropriate to their function.

This document includes the required skills and knowledge that certified cost engineers and consultants (CCE/CCCs) must have. Its scope is broad and represents the comprehensive skills and knowledge that business management may expect someone with overarching responsibilities in an organization to have (e.g., supporting overall capital program or project system management).

For specialty certifications [e.g., planning and scheduling professionals (PSP)], the Certification Board will document appropriate skills and knowledge requirements. These will include elements from this overall outline as they apply to the scope of the particular function. They may also include more detailed skills and knowledge than included here. The scope of those requirements will not be as broad, but will be deeper, representing the skills and knowledge that business management may expect from a manager of or expert in the particular function.

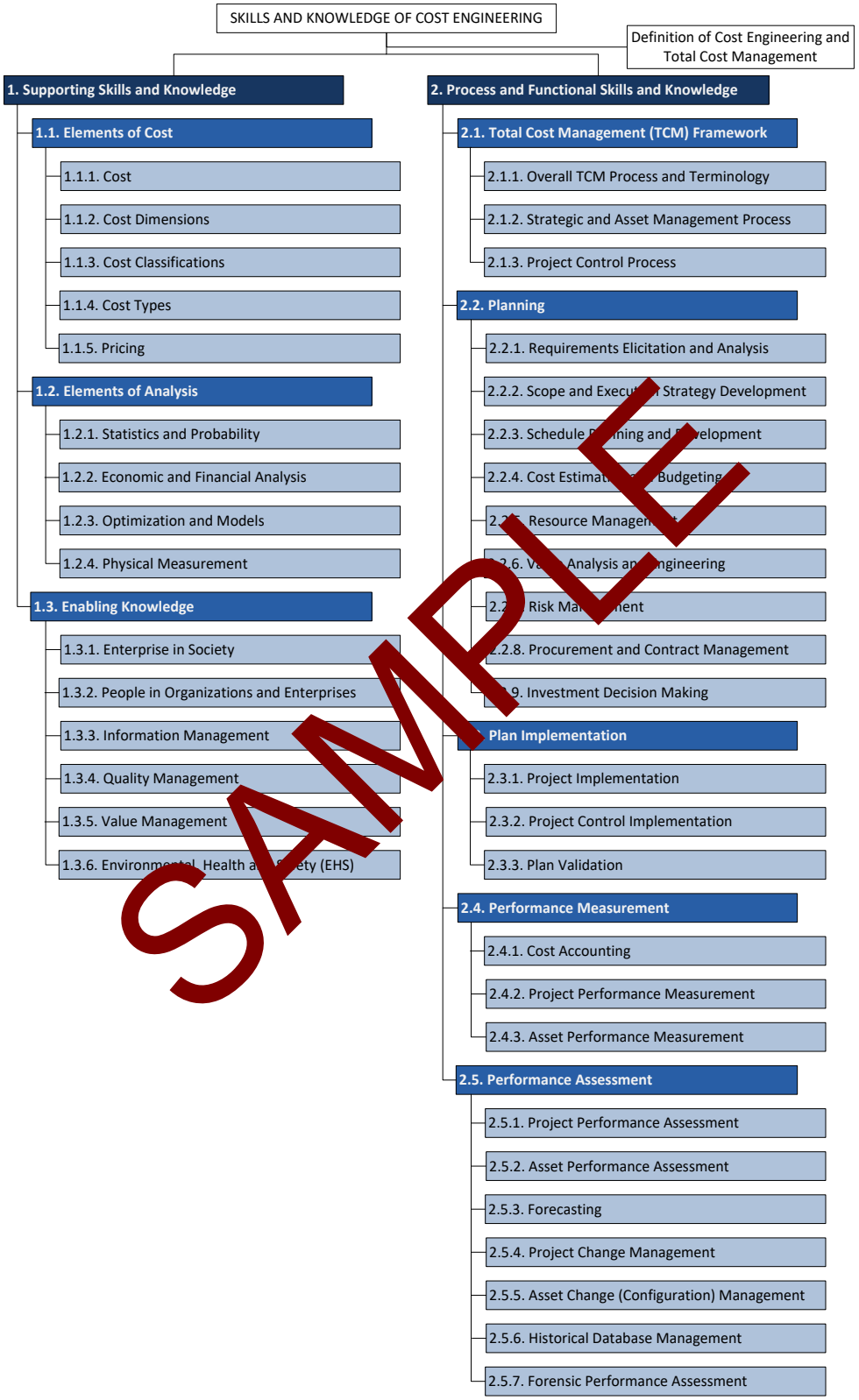

Figure 1. High Level Outline of the *Skills and Knowledge of Cost Engineering*

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Note: The outline that follows signifies key concepts and performance statements for which the practitioner should have at least a basic understanding.

1. Supporting Skills and Knowledge
1.1. Elements of Cost
1.1.1. Costs: be able to define/explain these general concepts in relation to each other and to assets and/or activities.
1.1.1.1. Resources
1.1.1.2. Time
1.1.1.3. Cost
1.1.2. Cost Dimensions:
1.1.2.1. Lifecycle: be able to describe this term and differentiate the life cycle of an asset and a project
1.1.2.2. Process (product vs. project): be able to describe and differentiate the cost characteristics and types (see cost types below) that make up product and project cost
1.1.2.2.1. Be able to distinguish among products, co-products, and byproducts.
1.1.2.3. Responsibility: be able to describe and differentiate the cost perspectives of an owner and a contractor/supplier
1.1.2.4. Valuation: be able to describe and differentiate cost from cash/monetary versus economic/opportunity costs (also see economic analysis perspectives.
1.1.2.5. Influence: be able to explain the concept of the cost influence curve
1.1.2.6. Legal:
1.1.2.6.1. Be able to explain how cost and schedule analysis practices might differ when applied for forensic versus traditional planning and control purposes.
1.1.2.6.2. Be able to describe some potential legal consequences that may result from using poor or unethical cost management practices (e.g., anti-trust, claims, Sarbanes-Oxley, etc)
1.1.3. Cost Classifications: for the following classifications, be able to:
1.1.3.1. Explain the general differences between the ways costs are classified for various cost management purposes
1.1.3.2. Given a problem with appropriate cost classification inputs (e.g., indirect cost using ABC classification method), be able to calculate how the cost would be accounted for in a project or product estimate.
1.1.3.2.1. Operating (Production, Manufacturing, Maintenance, etc.) vs. Capital
1.1.3.2.2. Capital vs. Expense
1.1.3.2.2.1. Depreciation
1.1.3.2.2.2. Amortization
1.1.3.2.2.3. Accrual
1.1.3.2.3. Fixed vs. Variable
1.1.3.2.4. Direct vs. Indirect
1.1.3.2.4.1. Activity-Based Costing (ABC)
1.1.3.2.4.2. Job Costing
1.1.4. Cost Types: for the following cost types, given cost type and classification inputs, be able to apply them in a project or manufacturing estimating application (i.e., for project or product cost)
1.1.4.1. Materials:
1.1.4.1.1. Materials types: be able to describe the types and their cost drivers:
1.1.4.1.1.1. Raw
1.1.4.1.1.2. Bulk
1.1.4.1.1.3. Fabricated
1.1.4.1.1.4. Engineered or designed

