

AACE International Recommended Practice No. 12R-89

**MODEL MASTER'S DEGREE PROGRAM WITH EMPHASIS IN
COST ENGINEERING**

TCM Framework: General Reference

Prepared by the AACE Education Board

This recommended practice is the result of several years of planning and effort by the AACE Education Board. It was originally published in **Cost Engineering** journal and because of favorable response from academia and industry was accepted as an AACE recommended practice in June 1989.

MODEL MASTER'S DEGREE PROGRAM WITH EMPHASIS IN COST ENGINEERING

TCM Framework: General Reference



November, 1990

INTRODUCTION

This model course of study for a master's degree program with emphasis in cost engineering is a product of the Education Board of the American Association of Cost Engineers. The purpose of this document is to support post-graduate education in cost engineering by providing the following:

- guidance to faculty and students in the formulation of master's degree programs that will concentrate on cost estimating, cost control, planning and scheduling, and project management;
- a basis for evaluation of university programs for purposes of qualifying such schools for AACE education support;
- a basis for qualifying proposed degree programs of individuals who have applied for AACE graduate-level scholarships; and
- a basis for course selection or self-study where no college program exists.

The curriculum for this course of study is based upon the content of "Required Skills and Knowledge of Cost Engineering," a document that defines cost engineering performance standards, which was adopted in 1987 as an AACE Recommended Practice.

A master's-level program in cost engineering should include prerequisite undergraduate courses like engineering economics, basic scheduling and cost estimating, introduction to computers, business law, financial accounting, and technical writing. These courses are identified in the model. An important aspect of the program is that it recognizes the worth of hands-on experience and continuing education courses and stipulates that "in lieu of college credit, the student may be qualified through attendance at company training programs, commercial short courses, self-study programs, or qualification exams."

Five primary subject areas are recognized as required for the cost engineering knowledge base:

- motivational management;
- statutory aspects of personnel management;
- fundamentals for business project management;
- advanced economic analysis; and
- advanced cost estimating.

These subjects are considered essential for the professional cost engineer. Electives allow for an emphasis in computer applications, contract preparation and administration, operations management, statistics, value engineering, productivity, and applied project management. The model also permits students to personalize their education by taking approved electives that create an emphasis in special topics in cost engineering. Optional in the program is a thesis, which could be a cost engineering survey or a research project on a cost engineering subject, depending on the requirements of the school implementing the master's degree program.

The course model provides course descriptions and outlines components of each subject. The Section I summary is an at-a-glance look at the entire program. The course of study for a master's degree program with emphasis in cost engineering and project management was approved in 1987 by the AACE Board of Directors. Subsequently, the course outline was published and a number of universities critiqued the model and indicated their interest in the program. In June 1989, AACE's Board of Directors approved the program as an AACE Recommended Practice.

SECTION I—SUMMARY

A. Undergraduate Prerequisite Subjects

Credits/course

2-3	Engineering Economics
3	Basic Cost Estimating
2-3	Basic Scheduling
3	Introduction to Computers
3	Business Law
3	Financial Accounting
3	Technical Writing
3	Speech Communication

22-24 credits

B. Cost Engineering Required Subjects

(15 credits in these subjects)

3	Motivational Management
3	Statutory Aspects of Personnel Management
3	Fundamentals for Business/Project Management
3	Advanced Economic Analysis
3	Advanced Cost Estimating

15 credits

C. Cost Engineering Elective Subjects

(Minimum of 15 credits from this group of subjects)

3	Advanced Computer Subjects
3	Computer Applications in Industry
3	Operations Research (Operations Management)
3	Statistics
3	Value Engineering
3	Methods and Productivity Improvement
3	Applied Project Management
3	Contract Documents
3	Contract Administration
3	Special Topics in Cost Engineering

15 credits minimum

D. Cost Engineering Survey or Research Projects (0-4 credits)

- Thesis or graduate report on cost engineering subject

E. General Electives

- Subjects as locally approved to round out degree program

SECTION II—COURSE CONTENT

Capsulized descriptions of content for each of the courses identified in Section I follow. It is recognized that each university may use titles and package courses differently than listed. The important thing is for the total content of the program to incorporate as many as possible of the components noted in the descriptions.

A. Undergraduate Prerequisite Subjects

These subjects are normally considered to be undergraduate level. An incoming candidate for a master's program who does not have college credit for any of these subjects should either add them to his/her total degree program or demonstrate proficiency in them to the satisfaction of the university. In lieu of college credit, the student may be qualified through attendance at company training programs, commercial short courses, self-study programs, or qualification exams.

1. **Engineering Economics.** The equivalent of a 2- to 3-credit course in the fundamentals of economic analysis. It should encompass at least these subjects:
 - Time value of money
 - Equivalence
 - Present value, future value
 - Rate of return
 - Depreciation/depletion
 - Methods for comparison of economic alternatives
 - Break-even analysis
 - Budgeting and cash flow
2. **Basic Cost Estimating.** The equivalent of a 3-credit course built around construction or manufacturing cost estimating which provides an introduction to definitive estimating. Includes these subjects:
 - Labor costs
 - Determination of work-hour requirements
 - Determination of materials requirements
 - Materials costs
 - Determining equipment requirements
 - Equipment costs
 - Equipment productivity
 - Overhead, indirect, and distributable costs
 - Risk costs and contingency
 - Inflation/Escalation
 - Profit
 - Practical exercise in pricing a construction project or a manufactured product
3. **Basic Scheduling.** The equivalent of a 2- to 3-credit course designed to provide basic proficiency in common scheduling techniques. These subjects should be included:
 - Barchart (Gantt) scheduling
 - Arrow diagram method (ADM) scheduling
 - Precedence diagram method (PDM) scheduling
 - Time-scaled networks
 - Line-of-balance charts
4. **Introduction to Computers.** The equivalent of a 3-credit course designed to provide basic computer literacy and programming capability. It should include these subjects:

- Computer hardware and software nomenclature and functioning
 - Programming using a common engineering language
 - Introduction to a representative group of personal computer commercial software programs applicable to cost engineering
5. Business Law. The equivalent of a 3-credit overview of the body of law and case studies relating to business organizational forms, contracts, financing sources, documents of title, secured transactions, investments, business taxation, insurance and bonding, bankruptcies and related subjects.
 6. Financial Accounting. The equivalent of a 3-credit course in basic financial accounting.
 7. Technical Writing & Effective Oral Communication. During the graduate study program the student must demonstrate competency in both written and oral communication gained through prior formal instruction or experience. Any deficiencies should be remedied through addition of formal classes to the degree program on these subjects.

B. Cost Engineering Required Subjects.

Subjects in this category are intended to provide a basic background in business or project management and are considered essential for the professional cost engineer. It is estimated that the equivalent of approximately 12 credits of the degree program will be devoted to pursuing these subjects.

1. Motivational Management. A course in which the student is introduced to behavioral science theories and their application to effective management of personnel. Typical included subjects are:
 - Behavioral science theories
 - Motivators and demotivators of personnel
 - Effective communication
 - Leadership/management styles
 - Progressive, corrective discipline
 - Conflict management
 - Team building
 - Participative management
 - Practical applications through case studies
2. Statutory Aspects of Personnel Management. This course is intended to supplement the Motivational Management course by presenting statutory/regulatory factors which affect personnel management, the knowledge of these factors being essential as a "cost avoidance" tool. Included topics are:
 - Unions and collective bargaining
 - Equal Employment Opportunity, Affirmative Action, and similar statutory programs
 - Policies involving alien workers
 - Termination policies and Unemployment Compensation
 - Occupational Safety and Health Act
 - Worker's Compensation
 - Special hiring/training programs involving disadvantaged population groups
 - Current legal atmosphere relating to special personnel management matters (smoking, sexual harassment, substance abuse, etc.)
3. Fundamentals for Business/Project Management. This course covers internal organizational forms (functional, task force and matrix); management under union, merit and open shop

conditions; employee benefit programs; planning and marketing of services; budgeting and cost control; business insurance and bonding; procurement practices; quality control; health, safety and morale programs; substance abuse control; environmental protection; programs for small, minority-owned, female-owned, and disadvantaged businesses; financial statements and other financial reporting.

4. **Advanced Economic Analysis.** This course is designed to demonstrate and apply principles of economic analysis to a variety of business situations and case studies. Typical of included subjects are:

- Life-cycle cost analysis
- Evaluation of purchase, lease, and rental options
- Profitability studies
- Benefit: cost studies
- Value analysis
- Budgeting and cash flow analysis
- Inflation/Escalation

5. **Advanced Cost Estimating.** This course is designed to demonstrate cost estimating techniques and applications not covered in Basic Cost Estimating. Included subjects are:

- Approximate estimating techniques
- Capital cost estimating
- Manufacturing and product cost estimating
- Operating cost estimating
- Indexes
- Risk analysis
- Integration of estimating with cost and schedule control
- Computerized estimating systems
- Probabilistic estimating

C. Cost Engineering Elective Subjects

Students will select a minimum of 15 credits from this group of subjects.

1. **Advanced Computer Subjects.** This subject area includes the following possibilities:

- High-level programming languages
- Database management
- Artificial intelligence
- Computer modeling
- Hardware design
- Software program development

2. **Computer Applications in Industry.** This subject area deals with computers and computer programs within a specific industry and can include applications using commercial software and/or development of special software programs.

3. **Operations Research (Operations Management).** This subject area includes many topics which may be combined into one or more courses or included as portions of other courses. Potential topics are:

- Decision theory
- Systems theory
- Linear and dynamic programming

- Learning curves
 - Queuing
 - Optimization
 - Forecasting
 - Statistical quality control
 - Inventory control
4. Statistics. A traditional course in statistics which includes these topics:
- Probability
 - Data collection
 - Frequency distribution
 - Sampling
 - Variance analysis
 - Correlation and regression
5. Value Engineering. Using life-cycle costs as a basis for evaluations, this course explains value engineering techniques. A practical exercise in which techniques are applied is normally a major element in this course.
6. Methods and Productivity Improvement. This subject area provides special tools to evaluate and improve project performance. Potential included topics are:
- Time and motion studies
 - Constructability, operability, and maintainability analysis
 - Work sampling and time-lapse photography
 - Foreman and worker delay reporting
 - Quality circles and problem-solving teams
 - Suggestion programs
7. Applied Project Management. Topics in this group apply the principles of earlier subjects to a type of project. Potential topics include:
- Project stakeholders and interests
 - Contract approaches for engineering, construction, and other services
 - Organizational structures for project management
 - Insurance and bonding
 - The impact of governmental regulation
 - Risk identification, evaluation, and control
 - Work breakdown structures and charts of accounts
 - Control schedules and budgets
 - Project plans:
 - Project controls
 - Materials management
 - Quality management
 - Subcontracting
 - Safety/loss control
 - Environmental protection
 - Construction equipment, tools, and heavy rigging
 - Security
 - Document control
 - Startup (if applicable)
 - The special challenges of the fixed-price contract
 - The special challenges of "fast tracking"
 - In-process management:

- Short-range planning
- Constructability
- Status reporting
- Schedule management
- Earned-value control
- Analysis, trending, and forecasting
- Change administration
- Contingency management
- Management reporting
- Historical data files
- Claims administration
- Project closeout

8. **Contract Documents.** This is a detailed study of standard (AIA, AGC, U.S. Government, etc.) and selected user-prepared contract forms to include bid forms, contract forms (short and long), general conditions, special or supplementary conditions, drawings, specifications and addenda. Special attention is given to key contract clauses. Variations of these contract forms for common methods for contracting work, materials, or services are covered.
9. **Contract Administration.** This subject area provides an understanding of the administration of contracts for engineering, construction, other services, equipment, materials, and supplies. Coverage includes roles and responsibilities of contracting parties, organizations for contract administration, contractor/vendor qualification, risk allocation, procurement strategies, incentive contracting, liabilities of contracting parties, change processing, document control, claims, and disputes.
10. **Special Topics in Cost Engineering.** Universities normally have a "Special Topics" course category which enables a student to pursue one or more credits of study in a subject area agreed to between the student and the advisor. Those involving a cost engineering topic may be credited to the electives group.

D. Cost Engineering Survey or Research Project

A master of science program will generally require a thesis. A master of engineering, construction management, building construction, or comparable program will normally require one or more survey reports. Whatever the requirements, these should be on a cost engineering subject. Credits are normally awarded for thesis work; they may or may not be awarded for survey reports.

E. General Electives

Remaining hours in the degree program may be devoted to any subject area of interest to the student and approved by the supervising graduate faculty committee.