Cost Engineering Skills & Knowledge

Introduction to Total Cost Management Workshop

By Cost Engineering
Day Plan

07:30 – Arrival
07:45 – Introduction & TCM
08:00 – AACE International Certification
08:15 – Introduction to Cost Engineering
10:00 – Role of the Cost Engineer
10:15 – Essence of Total Cost Management (TCM) Solutions
12:15 – End
Day Plan

Arrival

Introduction & TCM

AACE International Certification

Introduction to Cost Engineering

Role of the Cost Engineer

Essence of Total Cost Management (TCM) Solutions
About Martin van Vliet

Degree:
• Civil Engineering

Experience:
• VP Global Sales, Cost Engineering Consultancy B.V.
• More than 17 years of industrial experience in consulting various industries such as oil & gas, petrochemical, power, mining & minerals, chemicals, construction and pharmaceutical.

Professional Field:
• Member of the board of Cost Engineering Consultancy
• Member of NAP/DACE, AACEI, ICEC and AcostE
• Teacher of Cost Engineering courses

Cost Engineering Consultancy:
• Cost Engineering LinkedIn Group (> 12.200 members), Facebook, Twitter
• mvanvliet@costengineering.eu
• www.costengineering.eu or www.costmanagement.eu
Introduction Cost Engineering

Expertise
• Operating in Capex, Opex and Turn Arous & Maintenance Projects
• Estimate Preparation, Review & Validation throughout project life cycle
• Cost Management / Project Control
• Organizational Development
• Risk & Escalation Analysis

Cost Data Development
• Industry Standards & Custom Database Development
• Historical Project Database Development

Education
• Approved AACE International Education Provider (AEP)

Professional Services

Cleopatra Enterprise
• Cost Estimating and Cost Management software for Cost Engineers, by Cost Engineers
References

- Bulk storage
- Mining & Minerals
- Construction Industry (Civil)
- EPC(M)
- Food and Nutrition
- Government
- Offshore & Marine
- Shipbuilding
- Oil & Gas industry
- Heavy industry
- Pharmaceutical industry
- Petro-/chemical industry
- Power & Energy
“...the effective application of professional and technical expertise to plan and control resources, costs, profitability and risks. 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.”
“It costs time”
“It costs resources”
“ It costs money”

EVERYTHING invested in assets and projects is a COST

That is why it is called TOTAL COST Management (TCM)
For Business, TCM is An Integrated Recipe for Managing Portfolios, Programs, and Projects in Alignment with Business Strategy!
For AACE, TCM is a Framework For Its Technical, Education and Certification Products.
Presentation Outline

Understanding TCM

Applying TCM

TCM Benefits
Top-to-Bottom Business Benefits

- **Profitable Asset Portfolios**
  - Makes sure your resources go where they’ll get the best return
    - ROI (Return On Investment)
    - IRR (Internal Rate of Return)
    - RONA (Return on Net Assets)

- **Integrated/Aligned Programs**
  - Makes sure your projects are all integrated, aligned and coordinated

- **Controlled Projects**
  - Makes sure each project gives business the results that were planned for

...and, makes sure everything is aligned with Business Strategy!
Return on Assets is largely driven by practices used before projects begin

- With TCM, owners understand and manage the costs of their asset base over the entire asset life cycle

Successful Projects are required if the planned return is to be achieved

- With TCM, owners and contractors control the costs of their projects over the entire project life cycle
Presentation Outline

TCM Benefits

Understanding TCM

Applying TCM
Plan-Do-Check-Assess (PDCA)

Based on the time-tested Deming or Shewhart cycle. In essence, TCM is a quality management process.
Continuous Improvement

Every TCM process employs feedback and improvement!

Integrated

Every TCM process has P,D,C & A steps that are *All* linked back to business strategy!
TCM Covers the Entire Asset and Project Life Cycle
Presentation Outline

TCM Benefits

Understanding TCM

Applying TCM
Use it as a guide for process development or re-engineering

- A “go-by” that can be modified to suit each company's processes, phasing, org., lexicon, etc.
- Can be applied in parts, but take care that the resulting process is integrated

Use it as a business reference
Day Plan

Start

Introduction

AACE International Certifications

Introduction to Cost Engineering

Role of the Cost Engineer

Essence of Total Cost Management (TCM) Solutions
Day 1: The role of the Cost Engineer
Day 2: Basics of Cost Estimating
Day 3: Introduction to Statistics, Economics & Finance
Day 4: Basics of Planning & Cost Control
Day 5: Introduction to Project Management
Day 6: Other Cost Engineering Related Topics
Day 7: Other Cost Engineering Related Topics & Practical Case
Day 8: Continuation Practical Case by Professional
Day 9: Preparation Exam
Day 10: Recap of basic statistics and economics, Advanced Statistics, Economics and Finance (optional for CCP)
Literature


4) AACE International Recommended Practice, 11R-88, *Required Skills and Knowledge of a Cost Engineer*

5) AACE International Recommended Practice, 10S-90, *Cost Engineering Terminology*

6) AACE International Recommended Practice, 34R-05, *Basis of Estimate*
Topics

- Structure of AACEI courses
- Certification
- Approved Education Provider (AEP)
- Type of courses
Structure of AACEI Courses

- AEP:
  - Approved Education Provider

What does it offer:
- A provider approval system whose standards ensure quality continuing education programming
- Continuous quality improvement through course review and ongoing support from AACE staff
- Ability to award AACE Professional Development Hours (PDHS)
- Course promotion and organizational recognition on AACE Internationals website
Education: Function overview
(According AACEI)

CCP:
Certified Cost Professional
(formerly known as CCC/CCE)
(also recognized by ICEC)

EVP: Earned Value Professional
PSP: Planning & Scheduling Professional
CFCC: Certified Forensic Claims Consultant
CEP: Certified Estimating Professional
CST: Certified Scheduling Technician
DRMP: Decision and Risk Management Professional

CCT:
Certified Cost Technician
Education/Certification CCT

Requirements:
- 4 Full years of experience in a cost/schedule related field, of which up to 4 years may be substituted by a college/university.
- Submit application and fees (done by Cost Engineering Consultancy)
- Pass the exam (3 hours exam, 70% must be achieved)

Exam structure:
- 100 multiple choice questions on Supporting skills and Knowledge (open book)
  - Allowing each candidate to bring the AACE International Certified Cost Technician Primer and the S&K of Cost Engineering textbooks with them to testing center
  - Downloaded reference books should be printed and bound in a notebook; no loose paper, iPads, Kindles, etc. will be permitted for resource materials.
  - Candidates are also permitted to bring any style of calculator, including programmable calculators, to use during the exam
- Once the exam is launched there is no break (however, the candidate may take a bio break if needed, but the timer will continue to advance).

Study Materials:
- 1) Skills and Knowledge of Cost Engineering, 5th edition Revised
- 2) AACE International Certified Cost Technician Primer
- 3) The main questions in the CCT exam are about definitions
Requirements:
- 8 Full years of professional experience, of which up to 4 years may be substituted by a college/university.
- Submit Technical paper (2500 words)
- Submit application and fees (done by Cost Engineering Consultancy)
- Pass the exam (5 hours exam, 70% must be achieved on both parts)

Exam structure:
- The exam is delivered through computer based testing (CBT)
- Part 1 is 120 continuous simple and complex multiple choice questions (closed book), BUT onscreen formula sheet is accessible during the exam
  - Basic Cost Engineering Skills & Knowledge, Economic Analysis, Project Management, and Cost Estimating and Control
- Part 2 Technical paper
  - The topic should be something with which you are already familiar, such as a project you have done at work or something in which you have acquired a great deal of expertise in your professional career.
  - The chosen topic is not as important as your ability to communicate through your paper.
  - Be sure to follow the recommendations described in the Certification Paper Requirements (How to Write a Technical Paper) guide
Start

Introduction

AACE International Certification

Introduction to Cost Engineering

Role of the Cost Engineer

Essence of Total Cost Management (TCM) Solutions
AACE International defines Cost Engineering as:

“That area of engineering practice where engineering judgment and experience are utilized in the application of scientific principles and techniques to the problems of cost estimating, cost control and profitability”. 
Applying methods and techniques for:

- Estimating
- Planning
- Cost Control / Cost Management
- Contracting / Tendering
- Quantity Survey
- Risk Assessment
- Value Engineering
Case

• What is the function of this letter scale?
• Design a new one for half the price!

Value Engineering

The Letter Scale

What is the price of this letter scale?

New price € 50,-
Value Engineering

Solution

- Estimated value:
- +/- € 0,20
What is Estimating?
As long there is money involved in the world of supply and demand, at least that long the question will be asked:

“How much does it cost and what is my ROI?”
Cost Estimate:

- A cost estimate is the prediction of the probable costs of a project, of a given and documented scope, to be completed at a defined location and point of time in the future.
What is a Cost Estimate?

- Cost Estimate
  - Involves assumptions and uncertainty
  - and therefore some level of error
  - Involves probabilities
  - and therefore ranges of costs
  - Involves a given scope
  - contingency covers variability within the defined scope - not changes in scope
What is a Cost Estimate?

What’s in a name?

Name of the estimating types:

- Scouting Estimate / Conceptual Estimate
- Target Estimate / Approximate Estimate
- Order of Magnitude Estimate
- Budget Estimate / Check Estimate

Always ask:

- What is the purpose of this estimate?
- What should be the basis?
- What should be the accuracy?
- What.........?
What is a Cost Estimate?

OPEX
Operational Expenditure
(Maintenance costs)

Such as:
- Operators
- Inspection
- Maintenance
- Repairs
- Modifications
- Materials

CAPEX
Capital Expenditure
(Investments costs)

Such as:
- Design costs
- Purchase costs
- Equipment & Materials
- Fabrication
- Installation
- Commissioning
- Start-up
An estimate has no value if one does not know the basis for the data, the ‘estimating basis’.

Basis of Estimate:
- Used estimating method
- Description of the battery limits
- Scope description & Design package
- Price level and currency with exchange rates
- Location
- What is NOT included!
To maintain order it is necessary to divide costs into categories e.g.:
- Material vs. labour vs. subcontracts
- Direct costs vs. indirect costs vs. home office costs

The control structure should be established as early as possible in the project.

The process of the project’s control structure is an on-going process requiring updates.

Large projects will often use:
- Work breakdown structures (WBS)
- Resource breakdown structures (RBS)
Cost elements are divided in three different cost categories, the basic resources, to provide insight in what makes up cost:

- **Material**: The physical composition of the asset.
- **Labour**: The work needed to complete the activity or asset.
- **Other**: Resources needed to support the activity and/or asset. For example the facilities needed to produce an activity or asset, which would include the tooling, electricity, taxes, and maintenance, necessary to keep the facility available for use.
Further structuring the resources is important in order to understand how they influence the total cost and how they can be controlled:

- **Direct Costs:** Resources that are expended solely to complete the activity or asset.

- **Indirect Costs:** Resources that need to be expended to support the activity or asset but that are also associated with other activities and assets.

- **Fixed Costs:** Cost elements that must be provided independent of the volume or production that they support.

- **Variable Costs:** Cost elements that must be provided and are dependent on the volume production that they support.
Another way of classifying costs is using a work breakdown structure (WBS) (to group cost elements)

- The WBS is generally a required project management tool on most contracts
- WBS provides a framework for planning and controlling the resources needed to perform the technical objectives
- WBS facilitates a summary of project data regarding the cost and schedule performance.
Discrete part or product manufacturing refers to the production of separate, individual products, whereas continuous manufacturing is concerned with large units to be further processed, such as a roll of sheet steel, or units in fluid form with no distinct shape.
Ratio of costs between two similar facilities of different capacities equals the ratio of the capacities multiplied by an exponent:

\[
\frac{B}{A} = \left(\frac{\text{CapB}}{\text{CapA}}\right)^e
\]

Rewrite to:

\[
B = A \left(\frac{\text{CapB}}{\text{CapA}}\right)^e
\]

Where:

- \(B\) = Cost facility being estimated
- \(A\) = Known cost similar facility
- \(\text{CapB}\) = Capacity facility being estimated
- \(\text{CapA}\) = Capacity similar facility
- \(e\) = Exponent or proration factor
Sometimes called Top-Down estimate is based on limited Project scope – uses rules of thumb or parametric models or Historical data bases to provide relevant cost data – to develop cost per square foot / m2 for a building or cost for a similar piece of equipment.

<table>
<thead>
<tr>
<th>Type of Plant</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid Process Plant</td>
<td>3.10</td>
</tr>
<tr>
<td>Solid-Fluid Process Plant</td>
<td>3.63</td>
</tr>
<tr>
<td>Fluid Process Plant</td>
<td>4.74</td>
</tr>
</tbody>
</table>
Parametric estimating entails the analysis of cost, programmatic and technical data to identify cost drivers and develop cost models. The approach essentially correlates cost and manpower information with parameters describing the item to be costed. This process results in sets of formulae known as “Cost Estimation Relationships” (CERS), which are applied to produce cost outputs for different elements of an estimate.
Sometimes called bottom-up. With this method, detailed estimates are made at relatively low levels in the work breakdown structure (WBS), typically at work-package or task level. This approach is closely related to scheduling, planning and resource allocation and is both time-consuming and costly. It requires a good knowledge of the activity and there also needs to be a reasonable level of definition for the exercise to be meaningful.
Estimating is a mix of:
- Technical terminology
- Tricks
- Common sense
- Experience

Particularly for estimating the experience component is very important!
Current Project Life Cycle

Identification phase

- Project initiation note
  - ± 40% Screening estimate
  - Economics Step 1
- Feasibility study
  - ± 25% Study estimate
  - Economics Step 2
- Development plan
  - ± 25% Budget estimate
  - Economics Step 3
  - Initial commit. plan
  - initial execution plan

Definition phase

- Basis for design
- Project specification
  - ± 10% Control estimate
  - commit. plan
  - Economics Step 4
  - Project execution plan
- Detailed design
- Materials procurement
- Construction
  - Commission. start-up handover

Execution phase

- Commit. & cost control
  - ± 5% Counter estimate
  - Step 5
- Operations reference plan
- Project debrief
- Close out
- Contract control
  - Purchase order control
  - Reporting

Operational phase

- Step 6
- Identical to Execution phase

Abandon phase

- Step 7
- Identical to Execution phase
- Abandon project
### AACE Cost Estimate Classification System - Process Industries

<table>
<thead>
<tr>
<th>ESTIMATE CLASS</th>
<th>PRIMARY CHARACTERISTIC</th>
<th>SECONDARY CHARACTERISTIC</th>
<th>END USAGE</th>
<th>METHODOLOGY</th>
<th>EXPECTED ACCURACY RANGE</th>
<th>PREPARATION EFFORT</th>
</tr>
</thead>
</table>
| 5              | 0% to 2%               | concept screening        |           | capacity factored, parametric models, judgment, or analogy | L: -20% to -50%  
H: +30% to + 100% | 1                  |
| 4              | 1% to 15%              | study or feasibility     |           | equipment factored or parametric models | L: -15% to -30%  
H: +20% to + 50% | 2 to 4              |
| 3              | 10% to 40%             | budget, authorization or control | semi-detailed unit cost with assembly level line items | L: -10% to -20%  
H: +10% to + 30% | 3 to 10             |
| 2              | 30% to 70%             | control or bid / tender  |           | detailed unit cost with forced detailed take-off | L: -5% to -15%  
H: +5% to + 20% | 4 to 20             |
| 1              | 50% to 100%            | check estimate or bid / tender | detailed unit cost with detailed take-off | L: -3% to -10%  
H: +3% to + 15% | 5 to 100            |
### Estimating Cycle

<table>
<thead>
<tr>
<th>AACE Classification Standard</th>
<th>ANSI Standard Z94.0</th>
<th>AACE Pre-1972</th>
<th>Association of Cost Engineers (UK) ACostE</th>
<th>Norwegian Project Management Association (NFP)</th>
<th>American Society of Professional Estimators (ASPE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 5</td>
<td>Order of Magnitude Estimate -30/+50</td>
<td>Order of Magnitude Estimate</td>
<td>Order of Magnitude Estimate Class IV -30/+30</td>
<td>Concession Estimate</td>
<td>Exploration Estimate</td>
</tr>
<tr>
<td>Class 4</td>
<td>Budget Estimate -15/+30</td>
<td>Study Estimate</td>
<td>Study Estimate Class III -20/+20</td>
<td>Authorization Estimate</td>
<td>Level 1</td>
</tr>
<tr>
<td>Class 3</td>
<td>Preliminary Estimate</td>
<td>Budget Estimate Class II -10/+10</td>
<td>Master Control Estimate</td>
<td>Level 2</td>
<td></td>
</tr>
<tr>
<td>Class 2</td>
<td>Definitive Estimate -5/+15</td>
<td>Definitive Estimate</td>
<td>Definitive Estimate Class I -5/+5</td>
<td>Current Control Estimate</td>
<td>Level 3</td>
</tr>
<tr>
<td>Class 1</td>
<td>Detailed Estimate</td>
<td></td>
<td></td>
<td></td>
<td>Level 4</td>
</tr>
</tbody>
</table>

**Figure 3a. – Comparison of Classification Practices**
The following terms are used within estimating:

- Allowance
- Indirect Cost
- Accuracy
- Contingency
- Escalation
- MOD - Money of the Day
- RT/CVM - Real Term / Constant Value money
Allowances are often included in an estimate to account for the predictable but undefinable costs associated with project scope. Allowances are most often used when preparing deterministic or detailed estimates.

Some typical examples of allowances:

- Design allowance for engineered equipment
- Material take-off allowance
- Overbuy allowance
- Unrecoverable shipping damage allowance
- Allowance for undefined major items
Indirect Cost Definition

- Costs not directly attributable to the completion of an activity. Indirect costs are typically allocated or spread across all activities on a predetermined basis.

- In construction, all costs which do not become a final part of the installation, but which are required for the orderly completion of the installation and may include, but are not limited to, field administration, direct supervision, capital tools, start-up costs, contractor's fees, insurance, taxes, etc.

- In manufacturing, costs not directly assignable to the end product or process, such as overhead and general purpose labor, or costs of outside operations, such as transportation and distribution. Indirect manufacturing cost sometimes includes insurance, property taxes, maintenance, depreciation, packaging, warehousing and loading.
What is Accuracy?

- Accuracy is the degree to which a measurement or calculation varies to its actual value

- Precision is the degree to which a series of calculated values show similar results
What is Estimate Accuracy?

- Estimate accuracy is an indication of the degree to which the final *actual* cost outcome for a given project varies from its *estimated* cost.

- Every estimate is a “prediction” of the *expected* final cost of a project for a given scope of work.

- Every estimate is associated with *uncertainty*, and therefore is also associated with a probability of overrunning or underrunning the predicted cost.
What defines the accuracy?

Available information/Scope:

- Construction site data
- Design information
- Detail information
- etc.
An estimate should never be regarded as a single point number (or cost)

An estimate is a range of potential cost outcomes, and associated probabilities of occurrence

Thus – the accuracy range of an estimate is a probabilistic assessment of how far a project’s final actual cost can be expected to vary from the estimate

• The range is driven by uncertainty
Estimate Accuracy is traditionally expressed as a +/- percentage around the point or base estimate with a stated confidence that the actual cost will fall within this range.

- +/- measures are merely a useful simplification given that individual projects will have unique frequency distributions of outcomes.

Always ask whether the +/- % range is:
- applied to the point or base estimate (before contingency)?
- total or reference estimate (including contingency)?
The funds which are added to the point estimate to achieve a given probability of not overrunning the estimate (given relative stability of the project scope and the assumptions upon which the estimate is based)

In essence, contingency is an amount of funds to reduce the chances of overrunning the point estimate to an acceptable level of risk
- The difference between the selected funding value and the point estimate is the amount of contingency
- Management must determine the “level”

Does not include Escalation
Most misunderstood element in an estimate
An amount used to deal with uncertainties
Required because estimating is not an exact science
Its purpose is to improve the accuracy of project evaluations
Not to improve the accuracy of an estimate
Typically contingency does not include:

- Significant changes in scope
- Major unexpected work stoppages (strikes, etc.)
- Disasters (hurricanes, tornadoes, etc.)
- Excessive, unexpected inflation
- Excessive, unexpected currency fluctuations
### Table 1: Comparison of AACEI and EPRI Cost Estimate Stages

<table>
<thead>
<tr>
<th>AACEI Project Stage</th>
<th>AACEI Expected Accuracy Range L=Low, H=High</th>
<th>AACEI Suggested Contingency</th>
<th>EPRI Project Stage</th>
<th>EPRI Suggested Contingency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concept Screening</td>
<td>L: −20% to −50%  H: +30% to +100%</td>
<td>50%</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Feasibility Study</td>
<td>L: −15% to −30%  H: +20% to +50%</td>
<td>30%</td>
<td>Simplified Estimate</td>
<td>30-50%</td>
</tr>
<tr>
<td>Authorization or Control</td>
<td>L: −10% to −20%  H: +10% to +30%</td>
<td>20%</td>
<td>Preliminary Estimate</td>
<td>15-30%</td>
</tr>
<tr>
<td>Control or Bid/Tender</td>
<td>L: −5% to −15%  H: +5% to +20%</td>
<td>15%</td>
<td>Detailed Estimate</td>
<td>10-20%</td>
</tr>
<tr>
<td>Check Estimate or Bid/Tender</td>
<td>L: −3% to −10%  H: +3% to +15%</td>
<td>5%</td>
<td>Finalized Estimate</td>
<td>5-10%</td>
</tr>
</tbody>
</table>
Table shows a cumulative probability distribution table produced by a typical risk analysis model. In this example, the original point estimate (before contingency) is $23.3 million. The point estimate of $23.3M results in a 20 percent probability of not exceeding this value.

If we wanted to achieve a 50 percent probability of underrun, we would need to fund the project at $25.4M. This would mean adding a contingency amount of $2.1M in the estimate.

<table>
<thead>
<tr>
<th>Cumulative Probability of Underrun</th>
<th>Project Estimate</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Indicated Funding Amount (Million $)</td>
<td>Estimated Contingency (Million $)</td>
</tr>
<tr>
<td>10%</td>
<td>$22.3</td>
<td></td>
</tr>
<tr>
<td>20%</td>
<td>$23.3</td>
<td></td>
</tr>
<tr>
<td>30%</td>
<td>$24.2</td>
<td></td>
</tr>
<tr>
<td>40%</td>
<td>$24.8</td>
<td></td>
</tr>
<tr>
<td>50%</td>
<td>$25.4</td>
<td>$2.1</td>
</tr>
<tr>
<td>60%</td>
<td>$26.0</td>
<td></td>
</tr>
<tr>
<td>70%</td>
<td>$26.6</td>
<td>$3.3</td>
</tr>
<tr>
<td>80%</td>
<td>$27.4</td>
<td></td>
</tr>
<tr>
<td>90%</td>
<td>$28.6</td>
<td></td>
</tr>
</tbody>
</table>
Contingency does not increase the overall accuracy of the estimate
Contingency reduces the level of risk associated with the estimate
Risk analysis identifies specific project areas associated with risk and opportunity
Estimate Accuracy Range

- **Point Estimate**: $23.3M
- **Low Range (80% Confidence)**: $18.5M
- **High Value (80% Confidence)**: $32.5M

**Estimate Range (before Contingency)**: -20% to +40%

**Accuracy Range (@ 80% Confidence)**

**Point Estimate**

- **Minimum Cost**: $18.5M (-20%)
- **Maximum Cost**: $32.5M (+40%)

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**Diagram Notes**:
- P10: 50% Chance of Underrun
- P90: 50% Chance of Overrun
- P50: Contingency Median

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Estimate w/Contingency

<table>
<thead>
<tr>
<th>Cost Range</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimate w/Contingency</td>
<td>$23.3M</td>
</tr>
<tr>
<td>Low Range (80% Confidence)</td>
<td>$18.5M</td>
</tr>
<tr>
<td>High Value (80% Confidence)</td>
<td>$32.5M</td>
</tr>
</tbody>
</table>

Estimate Range (on Estimate w/Contingency) -27% to +27%

Accuracy Range (@ 80% Confidence)
Probability of the Estimate

- 10/90 estimate
- 50/50 estimate
- 90/10 estimate

- 90% chance on overrun
- Chance on over- and underrun are equal
- 10% Chance on overrun
Probability of the Estimate

- **Order of magnitude Type C Class 4**
  - 90/10
  - Base ~2 - 8%
  - Budget Type B Class 3/2 ~1 - 5%

- **Study Type**
  - 90/10
  - Base +40%

- **Control Estimate Class 1**
  - 90/10
  - Base +10%

- **Budget Control**
  - 90/10
  - Base ~0%

- **Zero baseline**
  - 10/90

- **Base**
  - 50/50
  - 90/10

- **50/50 Base**
  - 90/10
• Profit
• Add on as
  • Taxes, productivity costs, overtime, and other adjustments as defined by estimator
• Money of the day:
The market value of the project at time of estimate preparation. (No escalation)

• Real Term / Constant Value money:
The project value in relation to chosen future reference point. (M.O.D. + escalation)
Inflation/Escalation

- Measure for changes in current or estimated prices as a result of inflation.
- Forecast of expected price increase.
- Necessary in case of spread commitments.
Escalation – Provision for an increase in the cost of equipment, material, labor, etc. over the costs specified in the contract, due to continuing price-level changes over time.

Escalation has the same effect on project costs as interest does on the value of a savings account – each year becomes a new base for calculating escalation for the following year.

Escalation is compounded for multiple years.
Example: Item costs $1 today, inflation rate of 5%/year for next five years, what will item cost five years from now?

\[ C_1 \times (1 + i)^n = C_2 \]

\[ $1 \times (1 + .05)^5 = 1.28 \]
Example: Project estimated to cost $10M in 2012 dollars, inflation rate = 5% each year.

- Cash flow is projected as:
  - In 2014: $1,000,000 (2 years escalation)
  - In 2015: $6,000,000 (3 years escalation)
  - In 2016: $3,000,000 (4 years escalation)

- Calculate escalation!
Calculation of Previous Example

2014 = $1M \times ((1.05)^2 - 1) = $102,500
2015 = $6M \times ((1.05)^3 - 1) = $945,750
2016 = $3M \times ((1.05)^4 - 1) = $646,519

Total escalation costs = $1,694,769
Terminology: Cost Types

- Direct
- Allowances
- Indirect
- Escalation
- Contingency
- Markup
What do Cost Controllers do?

- Allocation & Control of Budgets – Resources (Man-hours/Materials) & Cost
- Analysis & Forecasting
- Scope Change Management
- Preparation of Bid Packages & Evaluation
- Ad-Hoc Cost Studies
- Cash Flow and Currency Fluctuation Reporting
Cost Control / Cost Management

Requisition & Commitment – Typical process...

Commitment = Order or Contract

Requisition

Project

Buyers

Supplier

Goods or Services then Invoice

99
Cost Control / Cost Management

Analysis
- Physical Progress
- Earned Value
- Not just what is SPENT, what is actually ACHIEVED

Forecasting
- Commitments & Expenditures
- Updated Budgets (Review Scope Changes)
- Updated Schedule
- Review Process (Engineering Review – Communication)
Everyday Cost Controllers Questions

- What is our budget?
- What have we committed?
- What changes have happened?
- What changes are likely to happen?
- What did we spend?
- What have we achieved?
- What will we spend?
- What is our contingency?
- What is the out-turn likely to be?
- What is our exposure if the project stops?
Day Plan

Start

Introduction

AACE International Certification

Introduction to Cost Engineering

Role of the Cost Engineer

Essence of Total Cost Management (TCM) Solutions
Birth of the Cost Engineer

- Merchants should seek advise from engineers
- Engineers often see their designs too optimistic
- The merchants protect themselves by cost experts, and than it all went a bit wrong!
  - medical disabled technicians became Cost Engineers
  - technologists saw the Cost Engineers as spoilers
  - Cost Engineers could shoot the technologists
  - the Cost Engineer is the only engineer who knows that the outcome of his calculations will be wrong
Don’t design a plant with golden valves!

Skip all luxury!

That is the job of Cost Engineers and Value Engineers
Biggest overrun I have ever seen Chevron Gorgon:

- **Original Budget:** $US37b
- **Last Cost Estimate:** $US54b
- **Overrun:** $US17b or 45%
Complex projects with budgets greater than $500 million have a much higher failure rate than their more straightforward counterparts. In some sectors, up to 75% of complex projects fail: that is, they exceed their original budgeted cost or schedule by 25%. This represents a vastly inadequate return on billions of dollars of investment for both private enterprise and taxpayers.

Projects fail for many reasons. These include: lack of communication among stakeholders and participants; critical skills and knowledge gaps for key personnel; poor conceptual planning; insufficient implementation of project controls and risk management; and the ineffective transfer of lessons learnt between similar projects. To increase the success rate of complex projects, these issues need to be addressed across the whole industry.
Our research shows that the majority of projects are facing delays and/or cost escalations and these overruns are prevalent in all of the segments and geographies.

64% of the projects are facing cost overruns.

73% of the projects are reporting schedule delays.

We evaluated the performance of megaprojects on two criteria – cost and time – to gauge the proportion of projects that are forecast to fail to deliver on budget and schedule. Of the 365 megaprojects, cost data was available for 205 projects and time data for 242.

The study revealed that the majority of the projects were delayed and/or faced cost overruns when measured against estimates made during the initial stages of the project life cycle.
A staggering 39% of projects with budgets over US$10 MM failed

Why Cost Engineering

Less than 30% of Projects Achieve All Business Objectives

As Reported by IPA, Inc.
The Role and Challenges of the Modern Cost Engineer
The Role of the Cost Engineer

- The Cost Engineer is accountable for the quality, the consistency, and the timeliness of the products resulting from the responsibilities.

- These products are primarily the following: Estimates, plans, schedules, budgets and project status report.

- The quality, consistency and timeliness are usually formalised in work processes and procedures.
Current Approach to Deal with Complexity (over the wall syndrome)
Potential of Decisions to Influence Value

Potential of Changes to Destroy Value

Project Life Cycle (Better Scope Definition/Time)

More involvement results in better scope definition
Better Scope Definition Drives
Better Absolute, Bottom-Line Cost Performance

From: Hollmann, John K., Best Owner Practices For Project Control.

Front End Loading (FEL)

Percentage Above or Below Industry Average Cost

20%
15%
10%
5%
0%
-5%
-10%

FEL Index

BEST       GOOD      FAIR      POOR      SCREENING

5% Lower Cost = 1% Better ROE
Suddenly, a heated exchange took place between the King and the project manager.

What was object:

“dig a ditch next to the wall” or “defend the castle from attack”

Good Scope and Communication is ESSENTIAL!
From only calculating to...
...to What-if Analysis
...to Regression Analysis
...to Key Metrics Analysis

<table>
<thead>
<tr>
<th>Key quantities</th>
<th>Unit</th>
<th>Grand total quantity</th>
<th>per piece of equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - Number of Mechanical Equipment</td>
<td>pc</td>
<td>5.00</td>
<td>1.00</td>
</tr>
<tr>
<td>5 - Concrete volume - foundation</td>
<td>m³</td>
<td>69.00</td>
<td>13.80</td>
</tr>
<tr>
<td>8 - Excavation volume</td>
<td>m³</td>
<td>292.00</td>
<td>58.40</td>
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<tr>
<td>9 - Backfill volume</td>
<td>m³</td>
<td>223.00</td>
<td>44.60</td>
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<tr>
<td>10 - Structural Steel - structure</td>
<td>kg</td>
<td>1,500.00</td>
<td>300.00</td>
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<tr>
<td>14 - Length of pipe</td>
<td>m</td>
<td>817.60</td>
<td>163.52</td>
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<tr>
<td>15 - Number of fittings</td>
<td>pc</td>
<td>2,482.03</td>
<td>496.41</td>
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<tr>
<td>16 - Number of valves - manual</td>
<td>pc</td>
<td>425.64</td>
<td>85.13</td>
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<tr>
<td>17 - Number of valves - control valves</td>
<td>pc</td>
<td>4.00</td>
<td>0.80</td>
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<tr>
<td>18 - Number of valves - safety relief devices</td>
<td>pc</td>
<td>3.00</td>
<td>0.60</td>
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<td>19 - Number of field instruments</td>
<td>pc</td>
<td>10.98</td>
<td>2.20</td>
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<tr>
<td>20 - Number of welds</td>
<td>pc</td>
<td>877.45</td>
<td>175.49</td>
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<tr>
<td>21 - Number of x-rayed welds</td>
<td>pc</td>
<td>42.13</td>
<td>8.43</td>
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<tr>
<td>22 - Insulation - Equipment</td>
<td>m²</td>
<td>201.40</td>
<td>40.28</td>
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<tr>
<td>23 - Insulation - Pipe</td>
<td>m</td>
<td>723.80</td>
<td>144.76</td>
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<td>24 - Painting - Pipe</td>
<td>m</td>
<td>40.00</td>
<td>8.00</td>
</tr>
<tr>
<td>26 - Fire proofing</td>
<td>m²</td>
<td>24.00</td>
<td>4.80</td>
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<tr>
<td>33 - Cable length - Electrical LV</td>
<td>m</td>
<td>442.00</td>
<td>88.40</td>
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<tr>
<td>35 - Length of trays</td>
<td>m</td>
<td>32.00</td>
<td>6.40</td>
</tr>
</tbody>
</table>
...to on the Fly Dashboard Reporting
...To Achieve an Integrated Work Process

WBS, OBS, Project Control Accounts, Charter &/or Code of Accounts, etc

Estimating System

Risk Management System (Qualitative & Quantitative)

Scheduling System

3D Modelling

Document Control

Progressing System

Accounting System

Time Management System (Timesheets)

Cost Management System

Procurement / Contract System

Historical Database (Qualitative and Quantitative Information)
...To Integrated workprocess (serious gaming)
My Question to You...

Are you in Total Control?