Lessons Learned on Estimate Classifications

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AACE Toronto Section
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Outline

- Project Life Cycle & Cost Uncertainty
- Estimate Classes & Accuracy Ranges
- AACEI Estimate Classification Guides
- Nature of Process/ Mining Estimates
- Some Challenges for Mining Projects
- Commonalities with Other Industries
- Lessons Learned Review (and Closure)
Project Life Cycle & Estimating

- % Project Definition
- % Project Cost
- % Accuracy Range

Inception - % Time - Completion
Project Life Cycle & Estimating

- Concept
- Engineering
- Construction
- Commissioning

Time

Cost

Project Life Cycle Initial Cost
Project Life Cycle & Estimating

- Concept
- Acquisition
- Operation
- Closure

Time

Cost

Project Life Cycle Total Cost
Project Life Cycle & Estimating

- Project Development
- Estimating Process
- Other Planning Information
- Project Review (Stage Gate)
- Go
- No Go
Estimate Classes & Accuracy Ranges

Class 1

Class 2

Class 3 (FEL-3)

Class 4 (FEL-2)

Class 5 (FEL-1)

SCOPING STUDY

PREFEASIBILITY

FEASIBILITY

DEFINITIVE

BID CHECK

ENG’G RANGE

ACCURACY RANGE

0%
5%
10%
15%
20%
25%
30%
35%
40%
45%
50%
55%
60%
65%
70%
75%
80%
85%
90%
95%
100%
Estimate Classes & Accuracy Ranges

- Expected Accuracy Ranges by Project Type (illustrative only)

<table>
<thead>
<tr>
<th>Estimate Class</th>
<th>Commercial (Office Building)</th>
<th>Industrial (Oil Refinery)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scoping Study</td>
<td>± 20%</td>
<td>± 30%</td>
</tr>
<tr>
<td>Pre-Feasibility</td>
<td>± 15%</td>
<td>± 20%</td>
</tr>
<tr>
<td>Feasibility</td>
<td>± 10%</td>
<td>± 15%</td>
</tr>
<tr>
<td>Definitive</td>
<td>± 5%</td>
<td>± 10%</td>
</tr>
</tbody>
</table>
Estimate Classes & Accuracy Ranges

- Requirements are specified by the Client:
  - Study Class
  - Accuracy Range
  - Scope Responsibilities
  - Study Schedule
  - Review and Reporting

- Expectations are managed by the Consultant:
  - Exceptions noted in the proposal
  - Effective risk analysis program
  - Timely change control process
  - Build harmonious relationships
AACEI Estimate Classification Guides

- **Recommended Practices (RPs) [Industry Guidelines]**
  - RP #17R-97, Cost Estimate Classification System (generic system) [17R-97.pdf]
  - RP # 56R-08, (addendum) – As Applied For The Building And General Construction Industries [56R-08.pdf]
  - RP # 18R-97, (addendum) – As Applied In Engineering, Procurement, And Construction For The Process Industries [18R-97.pdf]
  - RP # 47R-11, (addendum) – As Applied In The Mining And Mineral Processing Industries [47R-11.pdf]
  - RP # 69R-12, (addendum) – As Applied In Engineering, Procurement And Construction For The Hydropower Industry (UNDER REVIEW) [69R-12 (DRAFT).pdf]
## AACEI Estimate Classification Guides

<table>
<thead>
<tr>
<th>ESTIMATE CLASS</th>
<th>MATURITY LEVEL OF PROJECT DEFINITION DELIVERABLES</th>
<th>END USAGE</th>
<th>METHODOLOGY</th>
<th>EXPECTED ACCURACY RANGE</th>
<th>PREPARATION EFFORT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 5</td>
<td>0% to 2%</td>
<td>Screening or feasibility</td>
<td>Stochastic (factors and/or models) or judgment</td>
<td>4 to 20</td>
<td>1</td>
</tr>
<tr>
<td>Class 4</td>
<td>1% to 15%</td>
<td>Concept study or feasibility</td>
<td>Primarily stochastic</td>
<td>3 to 12</td>
<td>2 to 4</td>
</tr>
<tr>
<td>Class 3</td>
<td>10% to 40%</td>
<td>Budget authorization or control</td>
<td>Mixed but primarily stochastic</td>
<td>2 to 6</td>
<td>3 to 10</td>
</tr>
<tr>
<td>Class 2</td>
<td>30% to 75%</td>
<td>Control or bid/tender</td>
<td>Primarily deterministic</td>
<td>1 to 3</td>
<td>5 to 20</td>
</tr>
<tr>
<td>Class 1</td>
<td>65% to 100%</td>
<td>Check estimate or bid/tender</td>
<td>Deterministic</td>
<td>1</td>
<td>10 to 100</td>
</tr>
</tbody>
</table>

**Notes:**
- [a] If the range index value of "1" represents +10/-5%, then an index value of 10 represents +100/-50%.
- [b] If the cost index value of "1" represents 0.005% of project costs, then an index value of 100 represents 0.5%.

**Table 1 – Generic Cost Estimate Classification Matrix**

Source: RP #17R-97
AACEI Estimate Classification Guides

- Maturity Level of Project Definition:
  - “primary” characteristic, depends on % of complete definition
  - based on key types of planning, design and other input information available to the estimating process
  - experience with similar past projects, i.e. historical costs
  - each industry tends to focus on the defining project elements e.g. P&ID for process plant
  - Industry specific deliverables/ maturity covered in “addenda”

- Project Definition Rating Index (PDRI)
  - provides a project specific weighted index of the maturity of scope definition compared to need for project success.
  - project stakeholders assess scope definition completeness

Source: RP #17R-97, 56R-08
AACEI Estimate Classification Guides

- **Systemic Risks:**
  - level of non-familiar technology in the project
  - complexity of the project
  - quality of reference cost estimating data
  - quality of assumptions used in preparing the estimate
  - experience and skill level of the estimator
  - estimating techniques employed
  - time and level of effort budgeted to prepare the estimate

- **Project-Specific Risks (may drive accuracy range):**
  - AACEI generally does not endorse standard accuracy ranges
  - AACEI advises specific determination by risk analysis method

Source: RP #17R-97
AACEI Estimate Classification Guides

- **Notes:**
  - mainly acquisition phase not total life cycle
  - general estimate handling (results may differ)
  - conservative accuracy ranges (guides only)
  - applies to project estimating not accounting
  - accepts internal handling by each enterprise
  - importance of primary/secondary measures
  - estimator to defines class basis maturity, etc.
  - need project specific scope and risk analysis
Nature of Process Estimates

- Process industries include firms involved with manufacturing and production of chemicals, petrochemicals, and hydrocarbon processing. The common thread is their reliance on process flow diagrams (PFDs) and piping and instrument diagrams (P&IDs) as primary scope defining documents.

- Estimates for process facilities center on mechanical and chemical process equipment, and they have significant amounts of piping, instrumentation, and process controls involved. As such, this addendum may apply to portions of other industries.

- It does not specifically address estimates for exploration, production, or transportation of mining or hydrocarbon materials, although it may apply to some of the intermediate processing steps.

Source: RP #18R-97
Nature of Mining Estimates

- Mining (mineral) project is defined in NI 43-101 as “any exploration, development or production activity, including a royalty interest or similar interest in these activities, in respect of diamonds, natural solid inorganic material, or natural solid fossilized organic material including base and precious metals, coal and industrial minerals”.

- Estimates for mining facilities center on mine development and mobile equipment and the ore handling and concentration facilities in the mill. Remote sites require installation of all services to construct and operate the mine, mill and infrastructure and involve most bulks, especially civil, structural, mechanical and electrical facilities.

- Covers entire mining projects from mine through initial processing and producing a marketable product, within the scope of the project. However, if the project is for a processing plant with no other mining aspect, it is assumed covered by Process RP 18R-97.

Source: RP #47R-11
Some Challenges for Mining Projects

- Geopolitical circumstances
  - mining projects often remote with logistical and cultural issues
  - resources may be seen as national legacies with attendant political, regulatory and socio-economic considerations
  - unforeseen environmental legacies and regulatory implications
  - volatility in metal prices can lead to abrupt study deferrals or resumptions with client pressure to “fast track “ implementation
  - feasibility studies may focus on technical issues at the expense of business and project delivery issues (e.g., execution plan deliverables)

Source: RP #47R-11
**Some Challenges with Mining Projects**

- **“Bias and error in mine project capital cost estimation”**
  - Castle (1985) compares the capital cost estimate in a project's feasibility study with the actual cost incurred for 17 international ferrous metal, non-ferrous metal, uranium, and coal mining projects initiated between 1965 and 1980. Of these, 12 experienced capital cost overruns, 10 by more than 15%. The average overrun was 35%.
  - Bennett (1997) finds that for 16 projects completed between 1990 and 1995 as-built capital costs exceeded the feasibility study cost estimate by an average of 27%.

Source: “Bias and error in mine project capital cost estimation”. By Jasper Bertisen & Graham A. Davis | April-June, 2008, - from Entrepreneur.com

- **“Vast majority of mining projects experience cost over-runs”**
  - Mining companies need to admit that a 10% cost overrun for mining projects has become an anachronism as more and more projects are coming in way over budget.
  - A financing firm "automatically factors in an average cost overrun of 25%"

Source: from session at the Northwest Mining Association convention in Reno, as reported on Mineweb.com, November 30, 2011
Some Challenges with Mining Projects

- mining feasibility studies
  - are regularly portrayed as being much more comprehensive and accurate than they are and often not fit for their intended purpose
  - tend to focus on technical issues at the expense of critical business and project delivery issues

- poor track record of mining industry
  - only half of projects meet their feasibility study expectations
  - a better approach (is needed) to the feasibility study process.

Some Challenges with Mining Projects

- NI43-101 regulations are unclear about capital estimates
  - regulations refer to resource estimates not capital estimates
    - technical report sections require sign-off by Qualified Person(s) (QP), accredited by the Canadian Institute of Mining (CIM)
  - typically, AACEI members (and RPs) are not recognized by CIM
  - capital cost estimators can work under QP direction if QP agrees
  - CIM may allow non members to sign as QPs (at their own risk?)
  - given legal implications, estimators (and companies) may balk
  - NI43-101 report is a key deliverable, increasing estimating effort
  - many (90-95%) reports on file (SEDAR) are not reviewed by the securities regulators and may not be compliant (per OSC)
Commonalities with Other Industries
Commonalities with Other Industries

- Geopolitical circumstances?
  - regulatory/public relations issues may occur in some projects, which can cause delays, higher costs and even cancellation
  - problems with environmental assessments/construction permits
  - unexpected delays and costs arising from building site discoveries, e.g. old waste dumps, archeological finds, protected species
  - public resistance to certain facilities, e.g. nuclear waste disposal
  - specialized professional support needed to advance the project
Commonalities with Other Industries

- Underestimation of capital costs?
  - Studies (1979-1988) found severe underestimation of capital costs for chemical process facilities, major public works projects, and energy projects (Merrow et al)
  - Sample of 47 megaprojects (1965-1985) found 88% over budget due to internal cost growth, and not external unforeseen factors such as scope changes or unplanned inflation (Merrow 1988)
  - Hufschmidt and Gerin (1970) examined cost overruns for a series of large government public works projects and found that cost overruns were common as a result of cost inflation rather than other factors
  - Pohl and Mihaljek (1992) examined 1,015 World Bank projects and found that 22% cost overrun due to high cost inflation in the 1970s
  - Cost overruns are also the norm in transportation infrastructure projects (Pickrell 1992; Flyvbjerg, Holm, and Buhl 2002), and in these cases unanticipated cost inflation was the main factor

Source: “Bias and error in mine project capital cost estimation”. By Jasper Bertisen & Graham A. Davis | April-June, 2008, - from Entrepreneur.com
Commonalities with Other Industries

- Problems with the estimating process?
  - estimates unfit for their intended purpose
  - project focus on technical over financial issues
  - professional recognition of project estimators
  - requirement for estimator sign-off of estimate
  - root causes of a bad estimate for the project
Commonalities with Other Industries

- `Bad' estimates usually not a problem with the estimating process

- Typical barriers:
  - Lack of scope definition
  - Poor communications
  - **Unrealistic client expectations**
  - Optimistic team members

Source: “Conclusion from “Bad Estimates Just Don’t Happen!”. By Joe Lucas, Est.03 (Slides), 2006 AACE International Transactions
Commonalities with Other Industries

- Estimator sign-off is contentious
  - “The estimator is the processor of the system. The inputs as well as
the choices of and resources fed to the processor determine the
output. Stamp the system. Accountability is not something invented
by, or the exclusive domain of the estimator.”
  - “If you are looking for an estimator to sign regarding accuracy, you'll
never get anyone to agree. Estimates by their very nature and name
cannot have a guaranteed accuracy, only a probability of accuracy.”
  - “If you are looking for an affirmation that the estimate was prepared
according to a set of standards, I believe you would get agreement.
DOE already (or at least did) require that estimates be prepared by a
CCE/CCC.”

Source: “Selected member responses to AACEI Forums thread (Why not
“stamp” estimates?), June/July 2012,
Lessons Learned

- **Review**
  - estimate classifications enable stage gating project evolution
  - estimate classifications focus mainly on initial project cost
  - Recommended Practices (RPs) are guides, not mandatory
  - AACEI RPs identify minimum expectations of scope maturity
  - both generic and industry specific (addenda) are required
  - estimate accuracy ranges depend on industry/ project risk
  - challenges in expectations may be analogous across industries
  - reported estimate accuracy is speculative, subject to change
  - estimates may vary despite compliance with respective RP
  - estimating is both a science and an art that limits accreditation
Lessons Learned (Open)
Lessons Learned on Estimate Classifications

Thank you!