The "bankable feasibility study" is not a guarantee that a mining project will produce a planned outcome.

Risk Analysis

Quantitative risk analysis not only play a key role in the making of quality decisions for project approval, but will also provide grounded measures for project execution risk management.

Forward-looking

Forward looking information involves various risks and uncertainties. There can be no assurance that such information will prove to be accurate, and actual results and future events could differ materially from those anticipated in such information.

Important factors that could cause actual results to differ materially include:

- Fluctuations in commodity prices.
- Currency exchange rates.
- The need for co-operation of government agencies in the issuance of required permits and approvals.
- The possibility of delay in development work or in construction.
- Uncertainty of meeting anticipated milestones.

Typically, a bankable feasibility study is a comprehensive forward analysis of a project’s economics (+/-15% precision) to be used by financial institutions to assess the credit-worthiness for project financing.

The bankable part relates to the basis and conditions for a future financial agreement to collateralize mining assets for a project loan, to set a premium and a repayment schedule, with appropriate risk/reward factors.

Project Evaluation 2007 contains an article entitled “The Use and Abuse of (Mining) Feasibility Studies” by Mackenzie and Cusworth who state that most feasibility examples are unbalanced, or provide inaccurate views of one or both technical and business aspects. The authors subscribe to a project management framework (to include risk analysis) to overcome strategic and execution failures that often occur following feasibility studies.

I. Meaning of +/- 15% Accuracy

A +/-15% estimate is somewhere between the definition of a Class 5 and Class 2 estimate. Class has to do with both the content and quality of the estimate and the estimating confidence (precision).

Doesn’t contingency cover estimate shortfalls (+15%)? Contingency does NOT make the estimate “more accurate”.

Quantitative Risk Analysis is a process to assess and quantify the potential variances around project drivers.

II. The Hierarchy of Capital Cost Estimates

2. Class 5 (also called Design Basis Memorandum (DBM) Estimate).
3. Pre-Feasibility (Class 3 or 5, depending).
4. Class 2 or 3 (+/-15% has now gained acceptance as a bankable feasibility study).
5. Authorization for Expenditure (AFE) Estimate, may be a Class 1 or Class 2 and is designed to go for project sanction & EPC bids. It should be the most accurate and the most precise estimate obtainable given circumstances and conditions; and, is normally accompanied by a Project Execution Plan (PEP).

Normally, a feasibility study is prepared by a qualified engineer or estimator. It is a forward-looking document that captures a precision level but not necessarily an acceptable level of accuracy.
II.1 Class 5 (also called Design Basis Memorandum (DBM) Estimate).

The Study or Class 5 estimate is prepared in conjunction with the Design Basis Memorandum phase of the project. This type of estimate is defined as “an estimate, including contingency that has a probability of overrun by more than 10%, 1 time in 3.

II.2 Class 2 or 3 (+/-15% has now gained acceptance as a bankable feasibility study).

The AFE or Class 2 estimate is prepared in conjunction with the Basic Engineering phase of a project. At this point, all key design documents such as P&ID’s, layouts and electrical single lines have been established. The project execution plan, construction plan, and schedule have also been established. This type of estimate is defined as where “the final cost of the project will be within plus or minus 10% of the estimated value, 80% of the time”.

Figure 1

So, what does “bankable feasibility” really mean in terms of accuracy for owner and investor confidence in the development and construction of a mining project?

Figure 2

The definition of estimate classes describes the expected range of uncertainty around an estimate (in assessment and simulation this is the slope of the probability distribution).

Class II Accuracy
Final cost will be within +/- 10% of the estimate, 80% of the time.

Class V Accuracy
Estimate including contingency, has a probability of 10% overrun, 1 time in 3.
III. Bankable Feasibility Studies for Mining Projects - Things to remember

1. **Accuracy and precision are different.** Accurate estimates are precise, but precise estimates are not necessarily accurate.
2. **Beware of the Halo Effect:** the tendency to believe and place faith that your strategy and execution plan are sound, grounded.
3. **The Delusion of Absolute Performance:** any given formula cannot ensure high organizational performance.
4. **The Delusion of Lasting Success:** enduring success is not sustainable.
5. **Recognize the Role of Uncertainty:** adjust your thinking to accommodate uncertainty (risk & opportunity) and make better decisions.
6. **See your Project through Probabilities:** approach problems as interlocking internal and external probabilities.
7. **Separate Inputs from Outcomes:** actions and outcomes are imperfectly linked. It is easy to infer that bad outcomes must mean somebody made mistakes, or a good outcome must mean somebody made good decisions (or got lucky!).
8. **There are more things that can go wrong rather than right in execution:** determine the project drivers, assess & quantify risk and develop a risk management plan to build better valued projects.

“We have to get cost certainty or else…….) we are rarely told what the “or else” is, but it sounds pretty awful.

In these circumstances, the owners, their consultants and contractors to look for the value proposition in their development and construction projects.

Should your project go over budget, or goes long, make sure that the project achieves value in the completed cost. When the project delivers value that respects or justifies the cost, then it is a good project.
Cost Estimate Classification System - As Applied For Engineering Procurement and Construction for the Process Industry

As a recommended practice of AACE International, the Cost Estimate Classification System provides guidelines for applying the general principles of estimate classification to project cost estimates (i.e., cost estimates that are used to evaluate, approve, and/or fund projects).

The below details reflect generally accepted cost engineering practices. These were developed based on the practices of a wide range of companies in the process industries from around the world, as well as published references and standards. Company and public standards were solicited and reviewed by the AACE International Cost Estimating Committee. The practices were found to have significant commonalities and are conveyed herein.

Figure 4

Cost Estimate Classification Matrix for the Process Industries

<table>
<thead>
<tr>
<th>Estimate Class</th>
<th>Primary Characteristic</th>
<th>Secondary Characteristic</th>
<th>Accuracy Range</th>
<th>Preparation Effort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 2</td>
<td>35% to 75%</td>
<td>Concept Screening</td>
<td>Medium Accuracy (estimated between 20% and 40%)</td>
<td>2 to 3</td>
</tr>
<tr>
<td>Class 3</td>
<td>10% to 40%</td>
<td>Study or Feasibility</td>
<td>Medium Accuracy (estimated between 20% and 40%)</td>
<td>2 to 3</td>
</tr>
<tr>
<td>Class 4</td>
<td>5% to 15%</td>
<td>Budget, Authorization, or Control</td>
<td>Medium Accuracy (estimated between 20% and 40%)</td>
<td>2 to 3</td>
</tr>
<tr>
<td>Class 5</td>
<td>0% to 2%</td>
<td>Concept Screening</td>
<td>Medium Accuracy (estimated between 20% and 40%)</td>
<td>2 to 3</td>
</tr>
</tbody>
</table>

Notes: [a] The value represents typical percentage variation of actual costs from the cost estimate after application of contingency (typically at a 90% level of confidence) for given scope.
[b] If the range index value of 25% represents 0.025% of project costs, then an index value of 400 represents 0.4%.
[c] Estimate preparation effort is highly dependent upon the size of the project and the quality of estimating data and tools.

The five estimate classes are presented in Figure 4 above in relationship to the identified characteristics. Only the level of project definition determines the estimate class. The other four characteristics are secondary characteristics that are generally correlated with the level of project definition, as discussed in the generic standard.
### CLASS 1 ESTIMATE

**Description:**
Class 1 estimates are generally prepared for discrete parts or sections of the total project rather than generating this level of detail for the entire project. The parts of the project estimated at this level of detail will typically be used by subcontractors for bids or by owners for check estimates. The updated estimate is often referred to as the current control estimate and becomes the new baseline for cost/schedule control of the project. Class 1 estimates may be prepared for parts of the project to comprise a fair price estimate or bid check estimate to compare against a contractor’s bid estimate, or to evaluate/dispute claims. Typically, engineering is from 50% to 100% complete, and would comprise virtually all engineering and design documentation of the project, and complete project execution and commissioning plans.

**Level of Project Definition Required:**
50% to 100% of full project definition.

**End Usage:**
Class 1 estimates are typically prepared to form a current control estimate to be used as the final control baseline against which all actual costs and resources will now be monitored for variations to the budget, and form a part of the change/variation control program. They may be used to evaluate bid checking, to support vendor/contractor negotiations, or for claim evaluations and dispute resolution.

**Estimating Methods Used:**
Class 1 estimates involve the highest degree of deterministic estimating methods, and require a great amount of effort. Class 1 estimates are prepared in great detail, and thus are usually performed only on the most important or critical areas of the project. All items in the estimate are usually unit cost line items based on actual design quantities.

**Expected Accuracy Range:**
Typical accuracy ranges for Class 1 estimates are -3% to -10% on the low side, and +3% to +15% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances.

**Effort to Prepare (for US$20MM project):**
Class 1 estimates require the most effort to create, and as such are generally developed for only selected areas of the project, or for bidding purposes. A complete Class 1 estimate may involve as little as 600 hours or less, to perhaps more than 9,000 hours, depending on the project and the estimating methodology used. Bid estimates typically require more effort than estimates used for funding or control purposes.

**ANSI Standard Reference Z94.1 Name:**
Definitive estimate (typically -5% to +15%).

**Alternate Estimate Names, Terms, Expressions:**
Full detail, release, cautionary, firm price, bottoms-up, final, detailed control, forced detail, execution phase, master control, fair price, definitive, change order estimate.

### CLASS 2 ESTIMATE

**Description:**
Class 2 estimates are generally prepared to form a detailed control baseline against which all project work is monitored in terms of cost and progress control. For contractors, this class of estimate is often used as the “bid” estimate to establish contract value. Typically, engineering is from 30% to 70% complete, and would comprise at a minimum the following: progress flow diagrams, utility flow diagrams, piping and instrument diagrams, heat and material balances, final plot plan, final layout drawings, complete engineering progress and utility equipment lists, single line diagrams for electrical, electrical engineering and motor schedules, vendor quotations, detailed project execution plans, ransacking and work force plans, etc.

**Level of Project Definition Required:**
30% to 70% of full project definition.

**End Usage:**
Class 2 estimates are typically prepared as the detailed control baseline against which all actual costs and resources will now be monitored for variations to the budget, and form a part of the change/variation control program.

**Estimating Methods Used:**
Class 2 estimates always involve a high degree of deterministic estimating methods. Class 2 estimates are prepared in great detail, and often involve tons of thousands of unit cost line items. For those areas of the project still undefined, an assumed level of detail takeoff (forced detail) may be developed to use as line items in the estimate instead of relying on factoring methods.

**Expected Accuracy Range:**
Typical accuracy ranges for Class 2 estimates are -5% to -10% on the low side, and +5% to +20% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances.

**Effort to Prepare (for US$20MM project):**
Typically, no little as 300 hours or less to perhaps more than 3,000 hours, depending on the project and the estimating methodology used. Bid estimates typically require more effort than estimates used for funding or control purposes.

**ANSI Standard Reference Z94.2 1989 Name:**
Definitive estimate (typically 5% to +15%).

**Alternate Estimate Names, Terms, Expressions:**
Detailed control, forced detail, execution phase, master control, engineering, bid, tender, change order estimate.
### Class 3 Estimate

**Description:**
Class 3 estimates are generally prepared to form the basis for budget authorization, appropriation, and/or funding. As such, they typically form the initial control estimate against which all actual costs and resources will be monitored. Typically, engineering is from 10% to 40% complete, and would comprise at a minimum the following: process flow diagrams, utility flow diagrams, preliminary piping and instrument diagrams, plot plan, developed layout drawings, and essentially complete engineered process and utility equipment lists.

**Level of Project Definition Required:**
10% to 40% of full project definition

**End Usage:**
Class 3 estimates are typically prepared to support full project funding requests, and become the first of the project phase “control estimates” against which all actual costs and resources will be monitored for variations to the budget. They are used as the project budget until replaced by more detailed estimates. In many owner organizations, a Class 3 estimate may be the last estimate required and could well form the only basis for cost/schedule control.

**Estimating Methods Used:**
Class 3 estimates usually involve more deterministic estimating methods than stochastic methods. They usually involve a high degree of unit cost items, although these may be at an assembly level of detail rather than individual components. Factoring and other stochastic methods may be used to estimate less-significant areas of the project.

**Expected Accuracy Range:**
Typical accuracy ranges for Class 3 estimates are -10% to -20% on the low side, and +10% to +30% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances.

**Effort to Prepare (for US$20MM project):**
Typically, as little as 150 hours or less to perhaps more than 1,500 hours, depending on the project and the estimating methodology used.

**ANSI Standard Reference** 94.2-1989 Name:
Budget estimate (typically -15% to +30%).

**Alternate Estimate Names, Terms, Expressions, Synonyms:**
Budget, scope, sanction, semi-detailed, authorization, preliminary control, concept study, development, basic engineering, phase estimate, target estimate.

### Class 4 Estimate

**Description:**
Class 4 estimates are generally prepared based on limited information and subsequently have fairly wide accuracy ranges. They are typically used for project screening, determination of feasibility, concept evaluation, and preliminary budget approval. Typically, engineering is from 1% to 15% complete, and would comprise at a minimum the following: plant capacity, block schematics, indicated layout, process flow diagrams (PFDs) for main process systems, and preliminary engineered process and utility equipment lists.

**Level of Project Definition Required:**
1% to 15% of full project definition.

**End Usage:**
Class 4 estimates are prepared for a number of purposes, such as but not limited to, detailed strategic planning, business development, project screening at more developed stages, alternative scheme analysis, confirmation of economic and/or technical feasibility, and preliminary budget approval or approval to proceed to next stage.

**Estimating Methods Used:**
Class 4 estimates virtually always use stochastic estimating methods such as equipment factors, labor factors, hand factors, Chilton factors, Peters-Timmerhaus factors, Guthrie factors, the Miller method, gross unit costs/ratios, and other parametric and modeling technique.

**Expected Accuracy Range:**
Typical accuracy ranges for Class 4 estimates are -15% to -30% on the low side, and +20% to +50% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances.

**Effort to Prepare (for US$20MM project):**
Typically, as little as 20 hours or less to perhaps more than 250 hours, depending on the project and the estimating methodology used.

**ANSI Standard Reference** 204.2-1989 Name:
Budget estimate (typically -15% to +30%).

**Alternate Estimate Names, Terms, Expressions, Synonyms:**
Screening, top-down, feasibility, authorization, tactored, pre-design, pre-study.
Figure 6
Comparison of classification practice
Figure 7

Estimate Input Checklist and Maturity Matrix

The maturity level is an approximation of the degree of completion of the deliverable. The degree of completion is indicated by the following letters:

1. **None** (blank): development of the deliverable has not begun.
2. **Started (S)**: work on the deliverable has begun. Development is typically limited to sketches, rough outlines, or similar levels of early completion.
3. **Preliminary (P)**: work on the deliverable is advanced. Interim, cross-functional reviews have usually been conducted. Development may be near completion except for final reviews and approvals.
4. **Complete (C)**: the deliverable has been reviewed and approved as appropriate.

### General Project Data:

<table>
<thead>
<tr>
<th>Project Scope Description</th>
<th>Class 5</th>
<th>Class 4</th>
<th>Class 3</th>
<th>Class 2</th>
<th>Class 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant Production/Facility Capacity</td>
<td>Assumed</td>
<td>Preliminary</td>
<td>Defined</td>
<td>Defined</td>
<td>Defined</td>
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<tr>
<td>Plant Location</td>
<td>General</td>
<td>Approximate</td>
<td>Specific</td>
<td>Specific</td>
<td>Specific</td>
</tr>
<tr>
<td>Soils &amp; Hydrology</td>
<td>None</td>
<td>Preliminary</td>
<td>Defined</td>
<td>Defined</td>
<td>Defined</td>
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<tr>
<td>Integrated Project Plan</td>
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<td>Preliminary</td>
<td>Defined</td>
<td>Defined</td>
<td>Defined</td>
</tr>
<tr>
<td>Project Master Schedule</td>
<td>None</td>
<td>Preliminary</td>
<td>Defined</td>
<td>Defined</td>
<td>Defined</td>
</tr>
<tr>
<td>Escalation Strategy</td>
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<td>Preliminary</td>
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<td>Defined</td>
<td>Defined</td>
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<tr>
<td>Work Breakdown Structure</td>
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<td>Preliminary</td>
<td>Defined</td>
<td>Defined</td>
<td>Defined</td>
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<tr>
<td>Project Code of Accounts</td>
<td>None</td>
<td>Preliminary</td>
<td>Defined</td>
<td>Defined</td>
<td>Defined</td>
</tr>
<tr>
<td>Contracting Strategy</td>
<td>Assumed</td>
<td>Assumed</td>
<td>Preliminary</td>
<td>Defined</td>
<td>Defined</td>
</tr>
</tbody>
</table>

### Engineering Deliverables:

<table>
<thead>
<tr>
<th>Block Flow Diagrams</th>
<th>S/P</th>
<th>P/C</th>
<th>C</th>
<th>C</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plot Plans</td>
<td>S</td>
<td>P/C</td>
<td>C</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Process Flow Diagrams (PFDs)</td>
<td>S/P</td>
<td>P/C</td>
<td>C</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Utility Flow Diagrams (UFDs)</td>
<td>S/P</td>
<td>P/C</td>
<td>C</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Piping &amp; Instrument Diagrams (P&amp;IDs)</td>
<td>S</td>
<td>P/C</td>
<td>C</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Heat &amp; Material Balances</td>
<td>S</td>
<td>P/C</td>
<td>C</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Process Equipment List</td>
<td>S/P</td>
<td>P/C</td>
<td>C</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Utility Equipment List</td>
<td>S/P</td>
<td>P/C</td>
<td>C</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Electrical One-Line Drawings</td>
<td>S/P</td>
<td>P/C</td>
<td>C</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Specifications &amp; Datasheets</td>
<td>S</td>
<td>P/C</td>
<td>C</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>General Equipment Arrangement Drawings</td>
<td>S</td>
<td>P/C</td>
<td>C</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Spare Parts Listings</td>
<td>S/P</td>
<td>P/C</td>
<td>C</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Mechanical Discipline Drawings</td>
<td>S</td>
<td>P</td>
<td>P/C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical Discipline Drawings</td>
<td>S</td>
<td>P</td>
<td>P/C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instrumentation/Control System Discipline Drawings</td>
<td>S</td>
<td>P</td>
<td>P/C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Civil/Structural/Site Discipline Drawings</td>
<td>S</td>
<td>P</td>
<td>P/C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>