

## Cost Estimating

Cost estimating is the process of determining the likely cost of performing a defined scope of work at a time in the future. As with any attempt to predict the future, it is unreasonable to expect a cost estimate to be 100% correct. The estimating process should be focused on determining a reasonably accurate estimate based on defined assumptions for a reasonable expenditure of effort. The estimate should be supported by appropriate risk management strategies<sup>1</sup> and management reserves based on an appreciation of the likely levels of variability and uncertainty inherent in the estimate.

The core stages in developing a pragmatic and reasonable process for cost estimating are:

- Plan the estimating strategy based on available estimating resources and available budget for preparing the estimate.
- Determine the most appropriate approaches to develop the estimate. Select the most appropriate methodology consistent with the organisations culture and objectives.
- Consider any estimating inputs to the project delivery strategy such as assessing the cost effectiveness of alternative methodologies and strategies.
- Develop systems to ensuring the estimate covers 100% of the scope (this is nearly impossible but essential), in particular ensure potential future suppliers and subcontractors have included within their submitted price all of the scope of work you expect them to price.
- Determine the appropriate estimating technique to use (in most projects a combination of these options are used to obtain the best estimate):
  - Analogous: comparing the current project with a similar completed project and making appropriate adjustments. This is relatively quick but requires expert knowledge. Generally seen as the least accurate approach<sup>2</sup> but this depends on the degree of knowledge and expertise.
  - Parametric: using adjusted historical data to price defined elements of the project such as the cost per 'function point' in software development and the cost per 'square' (10 sq m) in domestic construction work<sup>3</sup>.
  - Bottom up (or detailed) estimating: the cost of each resource used in the project is determined and multiplied by the quantity required. This is the most expensive estimating process and the most accurate. Each cost item has to be assessed individually, labour (different classes), materials (each type separately), consumables, temporary works and overheads and rates each line item individually and multiplies the expected usage by the rate to get to the items cost. A 'detailed engineering estimate' can be as accurate as -5% to +15%.

<sup>1</sup> For more on **risk management** see: [http://www.mosaicprojects.com.au/WhitePapers/WP1047\\_Risk\\_Management.pdf](http://www.mosaicprojects.com.au/WhitePapers/WP1047_Risk_Management.pdf)

<sup>2</sup> In most situations the degree of accuracy associated with an '**analogous estimate**' is considered to be a 'Rough Order of Magnitude' (ROM) estimate with a range of -25% to +75%. However, if the nature of the work is thoroughly understood and represents 'business as usual' (ie, similar projects are repeated on a regular basis), the level of accuracy can be very much higher.

<sup>3</sup> **Parametric estimates** can occur at various levels of detail. For example a new concrete road may be estimated on a 'lane kilometre' basis which includes the costs of: set out, excavation, services, concrete supply, reinforcement supply, the placing and finishing of sub-base and the concrete wearing surface, line marking, landscaping, etc. Or, the estimate may be done at the 'unit cost' level where each of the major components are rated using loaded cost rates (ie, parametric rates) for things like the cost per cubic meter of reinforced concrete placed in the road (which includes the supply cost, the placing cost and the associated temporary works) – this is still a parametric estimate. Where this can become confusing is the cost per cubic meter of concrete could be a cost for the concrete alone (paid to the - supplier bottom up) or a cost of the concrete supplied and placed into the road (parametric cost), or the cost you agree to pay a subcontractor to manage the supply, placing and other works associated with the concrete road structure (vendor bid cost / analysis). To minimise errors, the basis of the estimate has to be clearly defined.



- Vendor bid analysis: where prices for different components of the project are obtained from the ‘market’ and compiled to generate the cost of the overall project.
- Consider a staged approach to estimating (if possible) near term work can be estimated more accurately than far-term but many projects need an overall estimate. Approaches such as ‘Rolling Wave<sup>4</sup>’ can be very useful.
- Determine the allocation of organisational overheads to the project costs and how these will be applied.
- Determine which costs are fixed (occur once only regardless of the actual project outcomes) and which are variable (change in relation to changes in the project’s work or time). Generally small savings or errors on a variable costs that occur every week will add up to a lot more than a larger one-off saving (or error) on a fixed cost. Focus most effort onto the costs that have the biggest effect overall.
- Develop or adjust estimating rates for work to be priced internally including:
  - Loaded hourly cost rates.
  - Loaded cost per unit or element (parametric estimates).
  - Balancing the allocation of costs between project overheads and loaded cost rates.
- Assess the likely levels of estimating error to develop contingencies and reserves:
  - Variability in estimated costs and rates (there will always be a level of variability).
  - Estimating errors (omissions / duplications).
  - External events and changes in the ‘market’ (eg, suppliers ceasing to trade).
  - Assess future cost movements (inflation)
- Understand the intensity of the work. Costs are minimised if the optimum crew sizes are applied to the work and it takes its ‘normal’ time to complete. High intensity work associated with a ‘crashed schedule<sup>5</sup>’ generally causes increased inefficiencies and drives up costs.
- Identify estimating and other risks and link to the project’s risk management processes. The way the estimate has been developed is of itself a risk issue<sup>6</sup>, plus there will be identified risks arising from interaction with suppliers, contractors and others.
- Link estimating to procurement to minimise risk exposure from suppliers and subcontractors.

Once the estimating process is properly planned, the actual work of developing the estimate can be undertaken with the final output the expected cost of the work and a recommended level of management reserves. The US Government Accountability Office has developed a comprehensive guide to developing credible cost estimates and then managing the budget for a project using Earned Value. The GAO *Cost Estimating and Assessment Guide* is particularly useful for major projects<sup>7</sup>.

## Cost Estimating -v- Pricing

The cost estimate is the net cost of completing the scope of work. The price charged for the work to a client should consist of the following elements:

- The estimated cost
- A reasonable level of management reserves (contingency) to cover both the expected level of variability in the cost price plus an allowance for identified risk events.

<sup>4</sup> For more on **Rolling Wave** see: [http://www.mosaicprojects.com.au/WhitePapers/WP1060\\_Rolling\\_Wave.pdf](http://www.mosaicprojects.com.au/WhitePapers/WP1060_Rolling_Wave.pdf)

<sup>5</sup> For more on **crashing schedules** see: [http://www.mosaicprojects.com.au/WhitePapers/WP1059\\_Schedule\\_Compression.pdf](http://www.mosaicprojects.com.au/WhitePapers/WP1059_Schedule_Compression.pdf)

<sup>6</sup> For more on the **effect of cognitive biases** see: [http://www.mosaicprojects.com.au/WhitePapers/WP1069\\_Bias.pdf](http://www.mosaicprojects.com.au/WhitePapers/WP1069_Bias.pdf)

<sup>7</sup> Download a copy of the **GAO Cost Guide**: [http://www.mosaicprojects.com.au/PDF/GAO\\_Cost\\_Guide.pdf](http://www.mosaicprojects.com.au/PDF/GAO_Cost_Guide.pdf)



- An amount of profit to reward the organisation for the risks involved in undertaking the work and to compensate for the use of the organisation's capital to undertake the work. This would normally exceed the amount received from a safe investment (eg, a bank deposit).

The final price is always a subjective management decision based on the defined items above, an assessment of the market and what is likely to be an acceptable price and views on the level of competition from others combined with the organisation's level of desire to 'win' the work.

The above factors are focused on a competitive estimate to 'win work' by a commercial bid or tender. If the work is internal to the organisation, the expected benefits to be realised<sup>8</sup> define an acceptable price.

## Cost Estimating & Risk Minimisation

Estimating what something will cost in the future is a risk. It is impossible to forecast what the element of work will actually cost. The estimating processes need to balance the mutually exclusive options of seeking the lowest practical cost estimate and minimising risk. Risk is reduced if the estimated values are inflated but the unnecessarily high cost estimates tend to make competitive bids too expensive to win work and internal project too expensive to undertake. Decision need to be made to balance cost and risk within the risk tolerance levels of the organisation's management. Some of the decisions that need to be made include:

- In-house resources or subcontract?
  - Direct in-house resources are subject to more control, direction and motivation but any estimating errors in the quantum of effort needed to accomplish the work are a direct cost to the project (as are supervision, quality defects, etc).
  - Subcontractors can be expected to carry the consequences of their estimating errors and perform the work for the agreed price. However, there is a loss of direct control and the need to manage contracts<sup>9</sup>. At least some of the risk is transferred to the subcontractor.
- Low price or safe suppliers and subcontractors?
  - Low bids from suppliers and subcontractors allow the overall estimate to be lower increasing your competitive advantage. The low bid may be due to a competitive advantage held by the supplier/subcontractor
  - The low bid contractor may have made an error in its estimating processes. In this circumstance the contractor may refuse to take on the work or chose to take on the work with the intention of making claims to recover its loss or delivering a lower quality product.
- Firm Fixed Price or Cost Reimbursable contracts?
  - Fixed price offers no insight into the way the contractor calculated its bid and tends to make the price changes expensive (there is no base for comparison).
  - Cost reimbursable allows insight to the pricing process but requires additional estimating to determine the cost.

The combination of options that provides the best (lowest) cost outcome within an acceptable risk parameter requires careful judgement within the organisations overall governance processes<sup>10</sup>.

Major contractors divide the work between suppliers and subcontractors – their supply chain. The art of managing the estimating process is to ensure all of the work is portioned out to trade packages and there are no duplications. The art of estimating is to ensure 100% of the work is priced; but only once! Plus the

<sup>8</sup> For more on **benefits realisation** see: [http://www.mosaicprojects.com.au/WhitePapers/WP1023\\_Benefits\\_and\\_Value.pdf](http://www.mosaicprojects.com.au/WhitePapers/WP1023_Benefits_and_Value.pdf)

<sup>9</sup> For more see **The Meaning of Risk in an Uncertain World**: [http://www.mosaicprojects.com.au/Resources\\_Papers\\_040.html](http://www.mosaicprojects.com.au/Resources_Papers_040.html)

<sup>10</sup> For more on **governance** see: [http://www.mosaicprojects.com.au/WhitePapers/WP1033\\_Governance.pdf](http://www.mosaicprojects.com.au/WhitePapers/WP1033_Governance.pdf)



accepted prices used in the estimate have been risk assessed on the likelihood of the quoted price being achieved by the supplier.

## Appropriate Levels of Detail

Adding detail to an estimate will not automatically improve accuracy. Accuracy is only improved if improved knowledge or insight is achieved. Processes such as costing individual peoples efforts against work on scheduled activities can only add value if information being used is based on new and enhanced information preferably gathered from the person actually involved in the work (or from knowledge of the specific person). This type of estimating is appropriate for short term work but is pointless for tasks scheduled months in the future where the precise scope of work is not known and the people who will be doing the work are not defined<sup>11</sup>.

Adding unnecessary detail increases costs, increases the workload, reduces visibility and reduces flexibility. Superficial detail will also change expectations of more senior managers who may believe the information is valid and therefore believe it is safe to reduce contingencies.

## Guideline for Creating a Good Estimate

Estimators forecast the future, attempting to predict the time and money required to produce a product or service. Predicting the future is never an easy task, and becomes increasingly difficult the more unique the project. However, knowing and applying these golden rules of estimating will provide greater opportunity for a successful forecast:

**Find the Right Estimator.** Estimators familiar with the work and estimating methods are key. There are many estimating techniques including: phased, top-down, analogous, parametric, and bottom-up. Regardless of the estimating method, the person making the estimate should have an understanding of the work to be done, and have a proper understanding of the techniques and goals of estimating. He or she needs to understand that the goal is to predict the most likely outcome.

**Estimate Based on Experience.** All projects are unique, but they often have similarities with other historical projects. Data from past projects can be helpful in estimating future ones - past performance data improves the accuracy of any of the discussed estimating techniques. Formal data is best, if this is unavailable people's personal experiences and recollections are valid, but need confirmation.

**Avoid Negotiating Estimates.** The tendency of management is to request estimate changes to reduce schedule and budget this should be resisted by demonstrating that the estimate was created from project specifications and represents a realistic balance of cost, schedule, and risk. Also, demonstrate that the estimate is linked to product specifications and the work breakdown structure. Further, highlight that the only way to reduce an accurate estimate is by changing the product scope or worker productivity.

## Linking Cost Estimates with the Schedule

Apart from very small short term projects (3 to 6 months and under \$200,000) attempting to directly integrate the cost estimating process with the scheduling process in fraught with difficulty. Even on these smaller projects, direct linking is not really feasible unless the primary source of all costs is staff directly employed on the work.

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<sup>11</sup> For more on *estimating detail* see: [http://www.mosaicprojects.com.au/WhitePapers/WP1052\\_Time\\_Estimating.pdf](http://www.mosaicprojects.com.au/WhitePapers/WP1052_Time_Estimating.pdf)

Most normal projects require a degree of integration between cost and schedule. This is usually achieved by developing a WBS and integrating time, cost, scope, risk and quality at either the Work Package level or the Control Account level<sup>12</sup>.

## Dealing with objections

It is not uncommon in internal projects and negotiations, that your carefully prepared project estimates have to be justified or defended if the client or sponsor thinks the numbers are too high. If you have done the estimating properly, reducing the price (or time) in the face of an objection simply creates a bigger problem later when the project overruns its (reduced) costs or time!

Information is the key to validating your work. You should be able to defend the estimate by demonstrating:

- Your understanding of the work
- The estimating technique(s) you used
- Your estimate of the effort hours, duration and cost
- The detailed estimating information in case the sponsor would like to review
- Your estimating assumptions
- The level of uncertainty as reflected in the estimating range

This level of information gives you the facts to respond to the challenge, and it will stop many challenges because people will have difficulty disputing your facts. The keys to this part of discussion are your credibility<sup>13</sup> and the quality of the information you have presented.

Once the credibility of your estimate is accepted based on your estimating rigor, the discussion can then proceed to alternatives if the sponsor still thinks the numbers are too high, or cannot afford the solution at that cost, there are a few alternative options:

- Determine if the client has any additional information that would allow you to revise your assumptions and perhaps revise the estimate. For instance, if a critical end-date now has some flexibility, perhaps the estimate can be revised based on this new information.
- Determine whether high-level requirements and functionality can be scaled back. In many cases, the original set of features and functions is more of a wish list. After seeing a price tag, it is very possible that the client can live without certain features.
- If you included a high contingency to reflect a high estimating risk, ask the client for more time to gather more detail for the estimate. This may result in there being less uncertainty and risk, and allow you to reflect this as a smaller contingency.

No estimate is perfect, what sensible sponsors and clients are seeking is reassurance you have done the best job possible in the circumstances and the costs are realistic. This requires them to believe you are skilled and credible and our estimating processes were rigorous and effective. .

## Managing the Estimate – Lessons Learned

Estimating normally precedes the start of a project or is completed in the early concept and planning phases. Whilst the estimate may go through several iterations as the final scope of the project is firmed up the normal expectation is the estimate should be converted to the cost baseline before the main ‘execution phase’ begins.

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<sup>12</sup> For more on the **WBS** see: [http://www.mosaicprojects.com.au/WhitePapers/WP1011\\_WBS.pdf](http://www.mosaicprojects.com.au/WhitePapers/WP1011_WBS.pdf)

<sup>13</sup> For more on **credibility** see: <http://mosaicprojects.wordpress.com/2013/04/27/credibility/>



The cost baseline provides one of the key foundations for the on-going management of the project work. The cause of any variance from the baseline should be identified and options developed to lock in gains and mitigate losses. This is the domain of project controls, cost engineering, Earned Value Management and project administration.

Estimating processes are used to price variations and occasionally to re-estimate the project if the original cost baseline is found to be invalid. However, numerous surveys have shown in most circumstances, re-estimating the project costs to complete is less accurate than applying Earned Value calculations. The exception is where major changes in the structure of the project team and/or management have occurred.

On the completion of the project (and occasionally during the execution of the project), it is important to undertake an effective 'lessons learned'<sup>14</sup> study to determine the voracity of the estimating process and identify areas for improvement. A major advantage of retained organisational experience is the capability to accurately price work in a particular domain and understand and manage the associated risks.

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<sup>14</sup> For more on **lessons learned** see: [http://www.mosaicprojects.com.au/WhitePapers/WP1004\\_Lessons\\_Learned.pdf](http://www.mosaicprojects.com.au/WhitePapers/WP1004_Lessons_Learned.pdf)

