Q. What exactly is an estimate?
According to the Project Management Institute's *A Guide to the Project Management Body of Knowledge*, a project estimate is an "informed assessment of the likely project cost or duration" (emphasis added). *Informed* means that you have an identified basis for the estimate. *Likely* focuses on the inherent uncertainty of the estimate: every estimate is but one of many possible outcomes.

Q. What should I use as the basis for my estimates?
The first step is to define the project scope. In the absence of a defined scope, you should not estimate anything other than the cost of defining the scope. Similar scopes tend to have similar results, so the best predictor of future results is past performance.

Q. Where can I find historical information?
Historical information about previous projects should be available from one or more of the following sources:
- Project files. Your employer should maintain records of previous project results that are detailed enough to aid in developing estimates. If not, you must do so yourself.
- Project team knowledge. The individual members of the project team may remember previous actuals or estimates. Such recollections can be useful, but they are generally far less reliable than documented results in the official project files.
- Commercial databases. You may be fortunate enough to be involved in an application area such as construction or software development where you can purchase historical information.

Q. But if every project is unique, what good is historical information?
The product of the project is unique, but most of the activities are not. By focusing on the management similarities rather than on the technical differences, you will find that you can generate valuable insights even when the product of the project is wholly different. We have seen project managers in fields as disparate as construction and biopharmaceuticals exchange estimating insights.

Q. Even if I can find historical information, how can I pick the right number if there are "many possible outcomes"?
You should not pick just one; you should identify the full range of possible outcomes.
The Project Manager's Toolkit

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The figure below illustrates the problem with single point estimates: A and B are equally likely, but there is a far greater chance that A will be exceeded:

Q. How do I know what the distribution looks like?

It doesn't really matter. Identifying the range of possible results is the important part. In the late 1950s, the US Navy developed the Program Evaluation and Review Technique (PERT) using a beta distribution. We prefer triangular distributions because they are more precise (and easier to draw).

Q. Seems to me like developing range estimates will take a lot of time ...

It will take some time, but not a lot. We have had teams in our courses spend less than an hour to develop an estimate for a 4,000 hour project — an estimate that later proved highly accurate. A recent client spent less than a day to discover that a mission-critical, multi-million dollar new product development project was going to be eight months late. An investment of something less than $10,000 is expected to return in excess of $10,000,000. Time spent estimating is not a cost, it is cheap insurance.

Q. What do I do when management cuts my estimate in half?

The first thing you have to do is find out why they are cutting. Most such management actions are grounded in one of the following misconceptions:

• An estimate is not a price. A price is the monetary value charged for a product or service. The determination of price is a business decision that is entirely separate from the development of an estimate. The price should bear some resemblance to the estimate, but it doesn't have to. Lower prices are often appropriate to garner market share. Higher prices may be available for a product or service in short supply. Your job as project manager is to ensure that pricing and estimating are kept separate.

• An estimate is not a negotiating position. Some managers may assume that you have padded your estimate to provide negotiating room. If their assumption is true, then their cuts are appropriate in order eliminate any padding. If your estimate is an estimate (an informed assessment), you should be able to demonstrate — clearly and unequivocally — that the suggested cuts will only reduce quality.

• An estimate is not a motivational tool. Most good managers understand that a more difficult task (where the target is aggressive) can, in fact, serve to motivate the project team. But even good managers often fail to appreciate that an impossible task (where the target is so aggressive that it is clearly impossible) is a powerful demotivator.

Q. OK, so I do all this work and come up with a range estimate for each activity on my project: how do I add up all these ranges?

The easiest way, of course, is to use the Resource Estimating Worksheet included in this issue of The Project Manager's Toolkit.

Q. I tried range estimates once before, but my project management software only has room for one estimate!

Your so-called project management software is really project scheduling software. If you want a more realistic schedule, enter duration estimates rather than effort estimates into the Resource Estimating Worksheet and load the calculated mean duration for each into your software. Or better yet, find a

Continued next page
Practical ideas for full- and part-time project managers

Q. Overly optimistic? Even using the mean rather than the most likely for each of my duration estimates?

Yes. The reason is something called "convergence." When multiple network paths with a common node have similar lengths, the likely date for the node is roughly 15% later than the mean of the paths.

How Does It Do What It Does for You?

Step 1: Verify the value(s) entered.
Correct entries produce a descriptive abbreviation in the Data Checks column Type; incorrect entries produce a question mark. Correct entries are: most likely only (ML); low and high only (L-D); low, most likely, and high (UD).

Step 2: Calculate any missing values.
If low and high specified, most likely = midpoint of range. If most likely only value specified, low = half most likely and high = twice most likely.

Step 3: Verify that the calculated values represent an acceptable distribution.
An acceptable distribution will produce "OK" in the Data Checks column Status; an unacceptable one will produce "ERR." An acceptable distribution has the low value greater than zero; the low value less than or equal to the most likely; and the most likely less than or equal to the high value.

Step 4: Calculate the mean, the standard deviation, and the variance for each item.
The mean of a triangular distribution is the average of the three defining points (low + most likely + high) / 3). The standard deviation is the square root of: (((high - low) squared) + ((most likely - low) times (most likely - high)))) / 18). The variance is the square of the standard deviation.

<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
<th>Low</th>
<th>Most Likely</th>
<th>High</th>
<th>Data Checks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Type</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Status</td>
</tr>
<tr>
<td>2.2</td>
<td>Initial draft</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.2.1</td>
<td>Gather information</td>
<td>40</td>
<td>50</td>
<td>L-H</td>
<td>OK</td>
</tr>
<tr>
<td>2.2.2</td>
<td>Write sections</td>
<td>10</td>
<td>15</td>
<td>30</td>
<td>UD</td>
</tr>
<tr>
<td>2.2.3</td>
<td>Review informally</td>
<td>15</td>
<td></td>
<td></td>
<td>ML</td>
</tr>
</tbody>
</table>

2.3 Inspection cycles

| 2.3.1| Inspectors inspect        | 18  | 25          | 50   | UD          | OK          |
| 2.3.2| Prepare defects/issues list| 20  |             |      | ML          | OK          |
| 2.3.3| Resolve defects/issues    | 10  | 15          | L-H  | OK          |
| 2.3.4| Make necessary changes    | 3   | 10          | 24   | UD          | OK          |

Estimated Project Totals:

| Probability | 15% | 50% | 85% |
| Risk Level  | Scary | High | Moderate |
Step 5: Verify that there are no errors in the distributions entered.

If there are none, display “OK” next to the project totals. Note: the project total may still be in error if activities have been entered without values. Such "empty" distributions are allowed so that the activity list can include headings.

Step 6: Calculate the mean and the standard deviation for the project.

The project mean is the sum of the means of the individual distributions. The project standard deviation is the square root of the sum of the variances of the individual distributions.

Step 7: Calculate the 15% and 85% points on the project’s estimate distribution.

Summing the individual distributions results in a project distribution that is approximately normal. Published tables of "z values" can be used in conjunction with the standard deviation to produce percent likelihood of various results.

Instructions for using the Resource Estimating Worksheet

This model makes it easy to calculate an accurate estimate for a project. The model simplifies data entry by providing:

- Three different formats for entering ranges.
- A WBS template based on our P7™ Planning Guide.
- Predefined names for frequently used cell ranges.

The model uses triangular distributions for precision and does some basic error checking. However, users are responsible for verifying the accuracy and correctness of the model.

Instructions:

1. If you are not familiar with using spreadsheets, get help from someone who is. This model was developed using Excel on a Macintosh and has been used with both Excel and 1-2-3 under DOS.

2. Save a copy of this model in your own work area. DO NOT delete the instructions.

3. Enter the client and project name in the title section (usually cell A1).

4. Modify the generic Work Breakdown Structure (WBS) elements as needed. For example:
   - Rename the deliverables and activities to match those of your project.
   - Insert additional items as needed.
   - Add whole new WBS sections.

5. Go to ... “Basic_Calculations” and COPY it. Go to ... “Calculate_Variances” and PASTE it. This will copy the data checking and variance calculation logic into any rows you added in step 4. If you add more rows later (e.g., after checking the model in step 9), you MUST repeat this step or the additional rows will not be included in the project total!

6. Decide on estimate units — you may use days OR hours OR currency.

7. Enter 1, 2, or 3 values for each item. If you know:
   - Only the “Most Likely” value, enter it in that column.
   - Only the limits of the range, enter them in the columns labeled “Low” and “High.”
   - Both the limits and the most likely, enter all three numbers.

8. The model will display “ML” (for Most Likely), “L-H” (for Low-High), or “UD” (for “User Distribution”) in the column labeled “Type.” If you enter an invalid combination, the model will display “?” in that column. If your estimates are in the proper sequence (low <= most likely <= high), the model will display “OK” under “Status.” If there is a sequence error, it will display “ERR” in the “Status” column.

9. Scan the model — have you entered estimates for ALL items? Have you entered the RIGHT estimates for every item?

10. Make changes as needed and print the model when done. The “Project Total” at the end of the model will display three estimates along with the probability of meeting each.