

# What's in a Number?

by **Lynne Nix**

*There's no point in being exact about something if you don't even know what you're talking about.*

— John von Neumann

## THE ESTIMATING CHALLENGE

Creating realistic and credible estimates is one of the most difficult activities in managing software development projects. It is also vital for getting a project prioritized and funded. Unfortunately, projects are often justified before any real data has been captured. At this point in the life of the project, ill-defined project requirements, unidentified team members, and pressure from the executive staff and customers to get the team working on the project hamper the estimating process.

The estimating process is further complicated by the “numbers game” that gets played out within the project organization. Project managers are often asked to produce initial (a.k.a. “draft”) estimates that are overly optimistic to satisfy anxious customers, to meet an unrealistic budget and schedule constraints, or to get “pet” projects over the organization’s funding hurdle. Too often, these initial estimates get transformed into “official” project estimates. This is how the estimating “numbers game” begins:

1. The project manager is asked to make a best (optimistic) first pass at how long it will take to complete the project.

2. The sponsor declares that the project manager’s estimate is too much time and anybody else should be able to do it in less time.
3. It’s too early in the project to allow the project manager access to adequate information to produce a credible estimate, the sponsor’s number is lower and the sponsor doesn’t have to defend the estimate (he or she is, after all, the sponsor) ... and so the sponsor wins the numbers game. In this mode of operation, the sponsor will always win the numbers game.

The project and IT credibility lose in the end. This article is about breaking out of the numbers game using a process that stakeholders can understand.

## Inputs to Estimating

Project stakeholders want to be able to rely on the project estimates to predict when their work needs to be complete as well as to understand when the project results will be available for use. Before a reliable estimate can be created, a number of inputs are required:

- Project specifications
- Deliverable descriptions
- Task definitions
- Estimating assumptions
- Schedule and estimating information about past project
- Organizational estimating methods or guidelines
- Information about the project manager and team members’ level of experience

A documented software development delivery approach combined with careful analysis of business requirements and risks with clearly defined task deliverables will

help ensure realistic estimates despite project uncertainty or political pressures.

## THE TRUTH ABOUT ESTIMATING

The quality of an estimate depends on the planning horizon. Knowledge is about 100% for current events (the first two- to three-month window of time), but reduces for more distant events. Perfect planning and estimating cannot be expected to occur at the start of a project. Estimating effort will be ongoing throughout the life of the project, but at a decreasing rate. In reality,

- We can only estimate based upon some preliminary specification.
- Estimates are only good for things we have done before, using people with expertise we can depend on.
- Murphy's Law is always at work.
- There is *always* a learning curve.
- The things we forget to include in the estimate are the things that cause it to be inaccurate.
- Getting better at producing estimates comes from documenting them and tracking them over time.

Development projects inevitably entail modification and revision as work progresses. Because it's impossible to anticipate all of these modifications at the time initial estimates are developed, use a "phase-limited commitment"<sup>1</sup> approach to estimating, as well as to other planning activities.

In this approach, estimates for imminent project deliverables (two to three months out on the horizon) are developed in detail, while only high-level estimates are developed for subsequent project deliverables (beyond three months). As future project deliverables become imminent, the general

estimates are redone in detail. This scheme allows the project manager to more easily adapt to project modifications, and eliminates the reworking that would take place if detailed estimates were created for the entire project too early in the development cycle. This is the most realistic way to estimate a project, although it may be more difficult to sell to upper management, who may demand commitment when too little is known.

The basics of a phase-limited commitment are as follows:

1. The customer commits to the expenditure of funds only through completion of the current phase of development.
2. The project manager must obtain customer approval to proceed to the next phase at the end of each phase.
3. The customer must review and approve deliverables associated with the current phase, as well as the proposal for the next phase of development prior to the start of the next phase.

With the completion of each phase, detailed estimates are produced for the next imminent phase and a revised high-level estimate is produced for subsequent phases. Within each phase there may be a number of formal customer review and approval points, and a final project phase review at the end of each phase. At any interim review point, the customer is able to affect, redirect, or approve the work being done. At the formal phase review, the customer has the option to approve the work being done and continue with development of the next phase, require rework to be done based on the outcome of the review, or cancel the project. In preparing for the customer review, the project manager must:

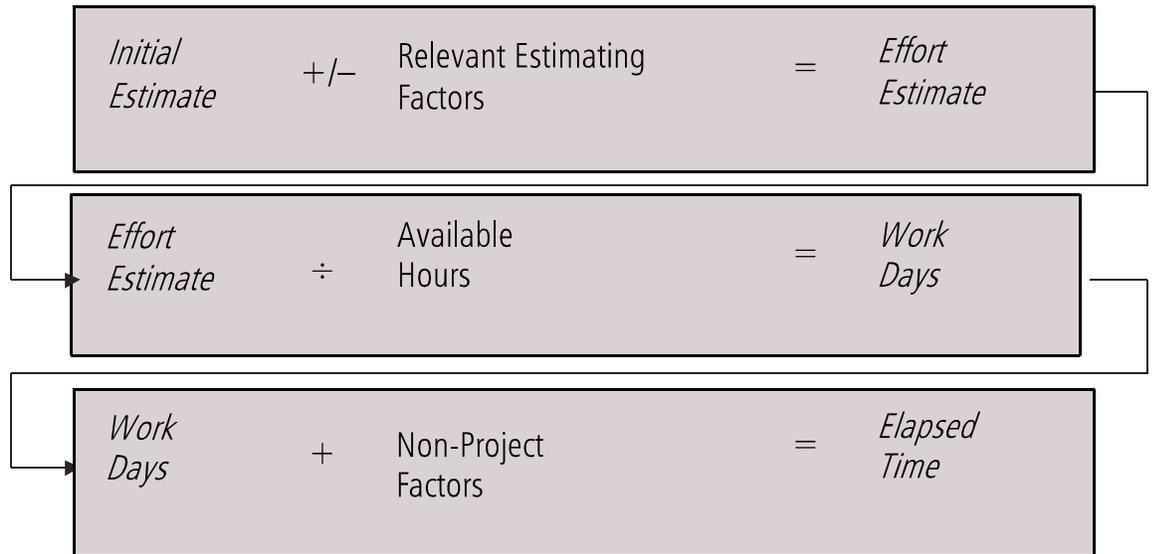


Figure 1: caption tk

- Create the detailed schedule for deliverables in the next development phase
- Present the deliverables produced from the current phase
- Request acceptance of current phase deliverables
- Request approval to proceed to the next development phase
- **Effort estimate** — the amount of uninterrupted personal time required to complete a task.
- **Work days** — the number of business days the team member will expend to accomplish the task.
- **Elapsed time** — the number of calendar days required to complete the task once non-project factors (e.g., holidays, vacations, non-project training, and other projects) have been considered.

### WHAT THE NUMBERS REPRESENT

For discussion purposes, it is important to define the terms when estimates are discussed. Let's start by reviewing *American Heritage's* definition of the word "estimate":

**es•ti•mat•ed es•ti•mat•ing es•ti•mates** 1. To calculate approximately (the amount, extent, magnitude, position, or value of something). 2. To form an opinion about; evaluate.

The following definitions provide the various types of estimates that a project team will make in relation to task assignments:

One estimate can produce three very different numbers. A team member may tell the project manager that it will take eight hours to conduct a test pass. The project manager might easily interpret this as *one work day*, when the team member really meant that it would take *eight hours of effort*; the team member has only *one hour per day* to work on this, and he or she will be on vacation for two weeks. When the project manager sees that the task took four weeks to complete instead of the expected

one day, he or she will write off the team member's estimating ability.

When estimating tasks it is easy to fall into the trap of estimating person-hour effort, and then adding people to the task until the math provides the task duration desired. Simple tasks that can be broken into many discrete steps that do not require interaction or coordination are more amenable to adding staff to decrease duration. (One example is getting everyone on the team and outside the project involved in a "bug bash" after the formal test to find any remaining bugs prior to beta testing.) The same is frequently not true of complex tasks because of the added coordination involved (sending three software developers to fix the same module will not get the job done faster).

## GETTING STARTED

Project estimation is a difficult process. The best way to estimate is to have done the project before, and based on lessons learned, estimate how long it would take to do it again. This is not usually possible, however. The next best way is to follow a repeatable approach that allows you to identify key areas and, based on past experience with similar work, estimate the approximate duration of the project.

Any project is a process of gradual refinement. It begins with a fuzzy picture of what you want to produce, and as the project progresses, the end result comes into focus. As the end result becomes clearer, so does the estimate of how much time and resources are required to complete the project. This characteristic makes any estimation method tricky. We must be willing to revise estimates as the project progresses. This process builds on the experience in the project and helps to remove schedule surprises.

Estimates are produced for each task according to the task definitions and should express the level of effort and skill involved in each task. Task estimates will be used as the basis for all scheduling and budgeting over the life of the project.

The quality of the estimate depends on the planning horizon. Knowledge is about 100% for current events, but reduces for more distant events. Perfect planning and estimating cannot be expected at the start of the project. Estimates are produced several times during the project according to phase-limited commitment. Task level estimates are produced in detail for "phase-at-hand" work and more generally for work farther out. Estimating effort will be ongoing throughout the life of the project, but at a decreasing rate.

The development of reliable estimates begins with an intensive analysis of the above elements affecting the estimating process. Take time to plan and document your estimates — you'll have to live with them. The resulting estimates may be expressed in a variety of ways — hours, days, weeks, or staff-months. They may be documented at the subtask level, as well as at the task, subphase, phase, and project level, to support future planning and project control.

The development of reliable estimates is a difficult process, not only because it requires intensive analysis and preparation, but also because it's conducted with a high degree of uncertainty about the future course of the project and about the people who will perform each project activity. Uncertainty about task performers makes estimating more difficult. Ideally, estimates take into account the personal abilities and characteristics of the person who will perform the task. Often the task performer has not been selected at the time estimates

are developed. To compensate for this, the project manager must make assumptions about the skill level required for satisfactory task performance, and estimate effort on this basis. When a staff member is later selected for a task, it is essential for team buy-in that the individual assigned to the task be given the opportunity to review the task and create his or her own estimate for the work. The project manager must review the validity of earlier estimates — by assessing the actual skill level of the performer to that skill level estimated. If there is a difference, either the estimate (and associated schedules) must be adjusted, or an individual with the assumed skill level must be found.

**Assumptions:** Throughout the planning process, the project team is making assumptions about task complexity and scope, availability of resources with appropriate skill levels, and a variety of other project-related factors. As assumptions arise during the estimation process they should be carefully documented so that they can be reviewed along with the estimates. If assumptions are later discovered to be inaccurate, then the estimates based on them can be reviewed. This can be a critical negotiating point later in the project, but it *will only work if assumptions are documented.*

### The Steps Involved in the Estimating Process

Task definitions and their estimates are the primary inputs to project schedules and budgets. Raw effort estimates will be translated into dates and dollars for the executive staff and customers, and the project manager can use them as a project progress assessment tool.

The following discussion examines the task estimation process in detail. I begin with the first step in the process — analyzing the

various factors that influence estimates, including project planning factors, levels of knowledge and experience, historical data, and organizational factors.

#### 1. Assess the Planning Factors

The factors that will impact all project planning consist of four main categories:

- Organizational factors
- Project-specific factors
- Environmental factors
- Staffing factors

#### Organizational Factors

An organization may impose constraints on a project. These constraints are considered organizational factors and include such things as:

- The number of hours in the standard work week
- The number of days in a work month (most organizations use 18-20 days/month)
- Policies regarding overtime
- Mandatory holidays
- Hiring policies
- Contingent staffing policies
- Union or government regulations by job classification

If the organization operates within an international context, it may impose additional standards or restrictions. It is always wise to validate that there are no hiring restrictions in place when you begin to assess the impact of organizational factors on your estimates.

If organizational factors place individuals on the project who lack the skill level assumed in the estimates, the estimates will have to be revised, along with any schedules that

were based on the estimates. It's important to identify organizational factors that may potentially alter estimates, and create your plans accordingly.

#### Project-Specific Factors

Project-specific factors include such things as:

- The complexity and stability of specifications
- Development guidelines or standards
- The availability of required developmental technologies and tools
- The complexity of the technologies
- Excessive functionality, code reuse, performance, or reliability
- Availability of development platforms (e.g., hardware and software)
- Integration of components delivered by different development teams or outside development companies

These factors are unique to the project and may directly impact the type and amount of work required. If the developmental technologies required in a project are not available, it's possible that work activity will be delayed awaiting their delivery. For example, if a project requires a new type of support software and that software isn't available when the project team is ready to begin system testing, all dependent task activity will halt. If user specifications require extensive validation of all system transactions, then the tasks relating to the development of validation logic will consume more time than specifications requiring little validation. Likewise if development standards require extensive documentation when a prototype is used, the documentation task will require greater

effort than if the standard requirements were minimal.

The complexity of developmental technologies may also affect task performance — some software development life cycle disciplines require that a higher percentage of time be spent on requirements definition (these methods may also result in a substantial reduction of time spent on maintenance tasks, as compared to other approaches). It's safe to assume that the more complex the set of project-specific factors, the greater the amount of effort required to complete development tasks.

#### Environment Factors

The project environment may also have an impact on the time it takes to complete task assignments, and should be considered. Environment factors include such things as:

- The physical surroundings in which tasks are performed
- The location of team members
- The level of support services available to the project

In considering the physical surroundings in which tasks are performed, a project manager should determine whether the working conditions will be noisy and crowded, or quiet and private — one set of conditions can diminish work efficiency, another enhance it.<sup>2</sup>

If team members are decentralized, team communication and interaction will require more time to ensure that tasks requiring a high degree of cooperative effort are accomplished properly.

In reviewing the level of support services available to a project, a project manager should determine whether ancillary services (such as preparing data and reproducing documents) are easily obtained, or whether

<sup>2</sup>Tom DeMarco and Tim Lister provide an excellent analysis of environmental factors in *Peopleware* (second edition, Dorset House, 1999).

vital time will be lost in turnaround delays or require team members to do this work in addition to their task assignments.

#### Staffing Factors

The final planning factors that may impact work effort estimation are staffing factors. By these we mean such things as:

- Availability of team members
- Availability of contract staff
- Internal staffing considerations
- Number of customers to be supported
- Number of project dependencies
- Number of projects to be staffed with the same resources

Availability of team members naturally has a direct bearing on task performance. Estimates assume a particular skill level for adequate completion. If people with the assumed skill level are not available for a project, each task may require proportionately more effort from the less skilled team members. Many organizations have contingent staffing policies that allow temporary staff to be hired for up to nine months at a time and require those individuals to be removed for the following three months before they can be rehired onto the project. Clearly this is for IRS employee-contractor regulations; however, it is incredibly disruptive to projects that rely on contingent staff.

Related to the availability of team members is a final staffing consideration — the internal requirement for other activities that may impair team productivity. If team members are frequently required to attend non-project meetings, training, or other activities, proportionately less time will be devoted to project work, and an additional amount of time will have to be allowed in

each task for reorienting to the work after each interruption.

Using the same set of team members on many different projects at the same time (resource fragmentation) will cause all projects to take longer than necessary due to the loss of time in starting up work from one project, winding down to start on another, and so on. This is an area where both the executive staff and customers seem to overlook the actual time lost in sharing resources between projects.

#### 2. Assess Personal and Organizational Experience

It is often the case that the project manager makes the initial estimates for project work. It is important to remember that when tasks are assigned to team members, those team members need to be given an opportunity to review and understand both the task definitions and the estimates. If there is any disagreement, the project manager and team member should work together to discuss and reconcile their differences.

After analyzing the factors that affect task performance, a project manager must next assess his or her past project experience and determine its effect on the estimating process. In doing so, a manager must consider personal experience with project job performance, with the project organization, and with the estimating process itself.

#### Personal Experience

In assessing experience with project performance, the project manager must determine his or her level of familiarity with each type of project work activity. A *low* level of familiarity will, of course, reduce a manager's ability to accurately estimate the required work effort. It's important to identify unfamiliar tasks so that additional measures can be taken to ensure credible

<sup>1</sup>I first used the "phase-limited commitment" approach to project estimation while working on projects with Ken Orr and Associates.

estimates in these areas. A *high* level of task familiarity may also reduce a manager's ability to accurately estimate the required work effort — many people unconsciously minimize the difficulty of tasks *they* perform well. The project manager needs to ask of his or her past estimating experience:

- Did you consistently underestimate or overestimate?
- Did you underestimate on those tasks with which you were most familiar, or in which you are most skilled, and overestimate in other areas?
- Did you take into account the other factors we've discussed that affect task performance?

Related to experience with project activities is experience with the *business functions* of the proposed system. It's not necessary to be a CPA to manage the development of an automated accounting system — a high degree of familiarity with the business function involved leads to better understanding and will help you estimate the amount of work effort required to automate it. More effort is required to automate a complex function than to automate a simple one, even though each project may entail the same types of development tasks.

Another feature of the business function that may affect the required amount of work effort is its *stability*. A business function that is known to be unstable — that is, one that's subject to constant modification or improvement — will require more time than a stable function (such as order entry).

#### Organizational Experience

In assessing experience with the organization, a project manager should determine whether there is a tendency in the organization to transfer team members to other

projects without warning; whether team members are likely to have additional non-project work assignments (help desk assignments, mentoring other staff, supporting existing systems); and whether team members are frequently required to participate in meetings, training, and other types of non-project activities.

Another organizational factor to consider when developing estimates is the number of *productive* hours in the work day — do team members typically take extended lunch hours, take extended breaks, or routinely leave the office early?

Yet another organizational factor is the quality of customer and developer relations. Customers and developers who have a good working relationship will accomplish more in less time than those who suffer from credibility issues from past project efforts will. It always takes a new project team time to “jell”; this situation is compounded when team members and customers bring baggage from past projects with them. Each of these factors must be taken into account when developing estimates for work effort, since each may extend the actual time required to complete a task.

If your past performance as an estimator was less than optimum, or if you have no experience in this area, you'll see that there are estimating techniques that can improve your chances of success. Your use of these techniques will be significantly better if you first assess your experience to identify and compensate for areas where your experience is weak.

#### 3. Assess Historical Data and Available Methods

The last area a project manager should investigate prior to producing an estimate concerns the availability of historical project

data and the organization's estimating methods.

By *historical project data*, we mean documentation about the development of other information systems. If this documentation is available and you can establish its relevance to your project, you may be able to use historical data about past performance to estimate the work effort for the current project. Historical data may also be used selectively to devise estimates for standard tasks that occur in all development projects.

A technique that may be used in the absence of historical project data or the organization's estimating guidelines is participative estimating. The participative technique relies on team members with relevant experience to produce an estimate. With this approach, each person estimates using his or her experience and validates his or her estimates with other experienced team members. Estimates using this approach tend to be more accurate and defensible (there's always someone who thinks the work should take less time than you do) than those produced by one person. Its many advantages include:

- Team members' increased familiarity with project requirements
- Enhanced validity of the estimate
- Higher team member commitment, since the team members were consulted and had the opportunity to influence the estimates

The disadvantage to participative estimating is that it may involve people with differing understanding of the work and apply different estimating factors. To make it more reliable, the project manager can outline a set of standard estimating assumptions and guidelines for the team to follow.

#### 4. Review Estimating Methods

By the organization's *estimating methods* we mean tools and guidelines for predicting effort and duration. In the absence of a standard method, your company should at least provide guidelines for preparing and presenting estimates. These guidelines may stipulate that estimates should include the work customers will perform on the project team, or they may require that estimates reflect *only* the efforts of the development staff involved in the project. They may require that estimates be expressed in a standard unit of measure such as days, weeks, or staff-months. They may ask that you estimate support services efforts separately. Each of these requirements should be investigated to prevent needless reworking of estimate formats later in the project.

#### 5. Document Estimates and Assumptions on Which Estimates Are Based

Having evaluated all of the elements that impact the preparation of estimates, it's critical to document these elements in a list of assumptions. This list of assumptions should be used along with task/deliverable information to derive work effort estimates that reflect task performance under actual conditions. Having a documented list of estimating assumptions will also allow you to review the estimates and readjust them should any of the assumptions prove to be false later in the project.

### FINAL THOUGHTS ON THE ESTIMATING PROCESS

#### Avoid SWAG Estimates

At a minimum, any estimate should be based on a basic understanding of the business functions that are to be supported. Take the time to research the work, you'll have to live with your estimate.

### Use Estimates Based on Past Experience

Use past experience (your own and measurements from other projects) to determine both effort and duration estimates. It is often a mistake to assume that this project will go much faster than the last. While it is true that learning will take place and improvements upon past performance will be made, each project will differ significantly.

### Involve the Whole Project Team

The team as a whole will be involved in creating the product, and needs an opportunity to contribute and buy in to the original estimates. Ask each team member to estimate parts of the project and then compare estimates and resolve differences. Reach team consensus on the high and low range of the estimates.

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