

Streamlining IT Project Estimation and Planning

Successful project planning requires good cost estimating practices. Good cost estimating practices require that we think beyond the prediction of the cost, effort and schedule for hardware, software or systems. The cost estimator must have a tool-enabled process and a mindset that streamlines unbiased trade-offs between scope, schedule, and budget in order to provide decision makers with all the information necessary to plan and manage the development of complex systems.

So how do we achieve estimating nirvana?

First we must accept the fact that projects need to be performed and delivered under certain constraints. Further we must acknowledge that different projects operate under different sets of constraints, sometimes even within the same organization. Traditionally these constraints have been listed as scope, time and budget. They are also used to define the Project Management Triangle, with each side representing a constraint. A passing familiarity with geometry tells us that one side of the triangle cannot be changed without impact on the others. Successful project management requires that multiple views of this triangle be available to make it possible to observe how changes to one constraint ripple throughout the triangle.

Successful project planning requires the estimator to understand and be able to demonstrate the impact of project constraints on a particular project. He/she must first be able to successfully translate project requirements into measures of scope, cost (or effort), and schedule. Once this translation has occurred, this person needs to determine how closely predicted cost and schedule balance against available time and budget. In the event they don't match, the estimator needs the capability to perform trade-offs of content, time or effort, always with an eye on the entire triangle. Cost estimating is revolutionized as tools evolve to automate and aid this process at multiple levels. This paper presents a series of project management challenges and demonstrates how good estimating practices combined with the rich and flexible toolset in PRICE TruePlanning 2008 facilitates rapid and defensible decision making.

Introduction

Successful project planning requires good estimating practices. Good estimating practices require that we think beyond the prediction of cost, effort, and schedule for the systems that we build. The cost estimator must have a toolset and a mindset that facilitate unimpassioned trade-offs between

scope, schedule and budget in order to provide decision makers with all the information necessary to plan and manage the development of complex systems.

All projects need to be performed within certain constraints. Constraints relate to the scope (content and quality), cost (or effort), and schedule of the project. The Project Management Triangle provides a visual depiction of the discipline of project planning and management. Each side of the triangle represents one of these dimensions. The Project Manager's job requires understanding the geometry of the problem and maintaining a healthy respect for the triangle. The estimator should be the project manager's biggest ally in this battle with the triangle, as he is the one who understands best the relationships between scope, cost and schedule.

This paper begins with a discussion of the project management challenge of balancing needs with imposed deadlines and budgets. The next section addresses the need for trade offs and discusses some processes to facilitate successful trade-offs. Following this, several project management challenges are presented and used to demonstrate how the estimator can apply these techniques to support the planning and management of successful projects.

The Project Management Challenge

The discipline of project management is about providing the tools and techniques that enable the project team to forecast, anticipate, and organize their work to meet project constraints. These constraints are generally established at the beginning of a project but can change constantly throughout the project execution as organizational goals and priorities shift. In order to complete a project within these, sometimes shifting, constraints, the Project Manager must be able to understand the full impacts of these changes. Further he must communicate these impacts to the project stakeholders and decision makers.

Project constraints fall into three basic categorizations: scope, schedule and budget. Each side of the Project Management triangle represents one of these constraints (Figure 1). This is a tool that project managers can use to visualize these competing constraints. With this he can gain an understanding of project impacts and provide decision makers with necessary information to make good choices as these changes occur.



Figure 1: Project Management Triangle

The time constraint refers to the amount of time available to complete the project – the imposed schedule. The cost constraint refers to the budgeted amount available for the project. The scope constraint refers to the functionality that must be delivered and the level of quality required to satisfy the customer or end user's requirements. These three constraints normally compete; increases in scope mean increased time and cost; a tight time constraint could mean increased cost and reduced content; and a tight budget may require an increase in time and a decrease in scope.

Certainly, none of this is news to anyone who has taken Project Management 101 – or who has actually managed a project. In fact, there is sanity in the simplicity of these concepts. Its application however can be anything but sane. The Project Manager needs to translate scope into time and

money. In the event that there is not synergy between these three competing requirements, he must present a credible and compelling argument to the decision makers along with alternative sets of constraints that optimize the chances of a successful outcome.

Necessary Trade-Offs

First recognize that the triangle must be respected and that compromises will most likely be required. Problems arise when there is no room to wiggle on scope, schedule and budget. Most projects constrain along at least two dimensions, projects that attempt to constrain all three are likely to be unsuccessful.

There is a silver lining. Understanding the reality of the triangle is the first step. Once you put into practice a methodology that facilitates careful consideration of the entire triangle, you have an excellent foundation for making intelligent decisions. This is where the estimator becomes the project manager's best friend. The estimator understands how to translate scope into cost and schedule, how changes in scope impact other project constraints and how schedule constraints can impact cost and quality.

Scope is the quantification of features that are to be delivered. Scope is generally the most important consideration in determining what the cost and schedule for a project should be. It is not always the most influential factor in deciding what the cost and schedule will be. Initial estimates should be based on project scope as determined from the project requirements. Changes in project scope will change cost and schedule for the project and should always be accompanied by a re-evaluation of the project plan in light of the scope changes.

The project budget indicates the amount of money the organization is willing to spend on a project. Cost of the project is a function of the scope, the personnel working on the project and historical information about organizational performance on similar projects. Cost estimates should be carefully balanced against available budget to determine feasibility. If the cost estimate of the project indicates that the project will fall outside of available budget, there are several things that can be considered. Scope reduction is one option. Consideration may also be given to the use of lower cost resources. Lower cost resources are likely to impact the productivity of project execution so cost and schedule estimates need to be re-evaluated with this new information. Reuse is another area where costs can be saved. Commercial off the shelf components and reuse of existing artifacts can also be a way to cut down on the cost of the project. These decisions should also be accompanied by a re-evaluation of project costs and schedule.

The project schedule indicates the date when the organization feels the project must be completed. It is generally accepted that for a given project there is an optimal schedule that can be determined by looking at the scope, the personnel working on the project and historical organizational performance data.

Schedule can be impacted somewhat by adding additional resources but it's important to remember that additional people impact the dynamic of the project in ways that may impact costs. Overtime can be used to address short term schedule issues but tends to lose effectiveness when carried out for long periods of time.

It is important to understand that attempts to complete a project in significantly less time than predicted by mathematical models and historical data can cause significant increases in the cost of the project. It may also have a negative impact on the quality delivered. Cost increases represent the additional labor required to complete project activities in less time. They also reflect the costs of additional re-work due to tasks that have not had the proper time devoted to them.

The trend is non linear and becomes asymptotic as compression increases to the point where it becomes impossible to deliver the required amount of functionality in the given time period regardless of how many resources are employed.

Project Management Challenges

Project managers face a myriad of challenges throughout the life of a project. Certainly there is not a single area of expertise, tool or methodology that will help them face all the situations that are thrown their way. There is a subset of these challenges with solutions that are greatly eased when good estimating practices and tools are in place. These are the challenges that relate to understanding and respecting the trades that need to be made between cost (resources), schedule and scope.

Unrealistic Schedule Expectations

Most projects operate under schedule constraints. In many organizations time-to-market is the single biggest issue that drives the project team. This being said, these same organizations are not willing to accept a project that is delivered on time that does not meet customer expectations. The project manager's job is to understand customer requirements in the context of schedule pressure and communicate conflicts between scope and schedule to enable proper prioritization and manage expectations.

Consider the situation where Dan is the project manager assigned to a project that the organization feels is essential to the future success of the business – the Next Great Widget (NGW). The catch is that market research indicates that delivery before June 30, 2009 is essential to beating a comparable offering from the competitor. Having a few projects under his belt with this company, Dan recognizes that the extent and complexity of the capability being sought can never be implemented in the twelve months this schedule requires. This is especially true because of the team that has been assigned – composed of a mix of new hires and more experienced personnel.

Certainly, no one wants to be the one to tell management that it can't be done – especially on a project with high visibility and expectations. Dan is no exception. He recognizes that he needs to go to management with solutions not problems. He calls on Jane, who leads the cost estimating group for the company. After reviewing the requirements with Jane, she is able to produce an estimate of cost and schedule for the hardware, software and its integration using TruePlanning 2008. Jane's preliminary results confirm Dan's suspicion that the product, as specified is not achievable in the 12 month time frame, although the estimated cost indicates the project can be accomplished within the \$7M budget cap.

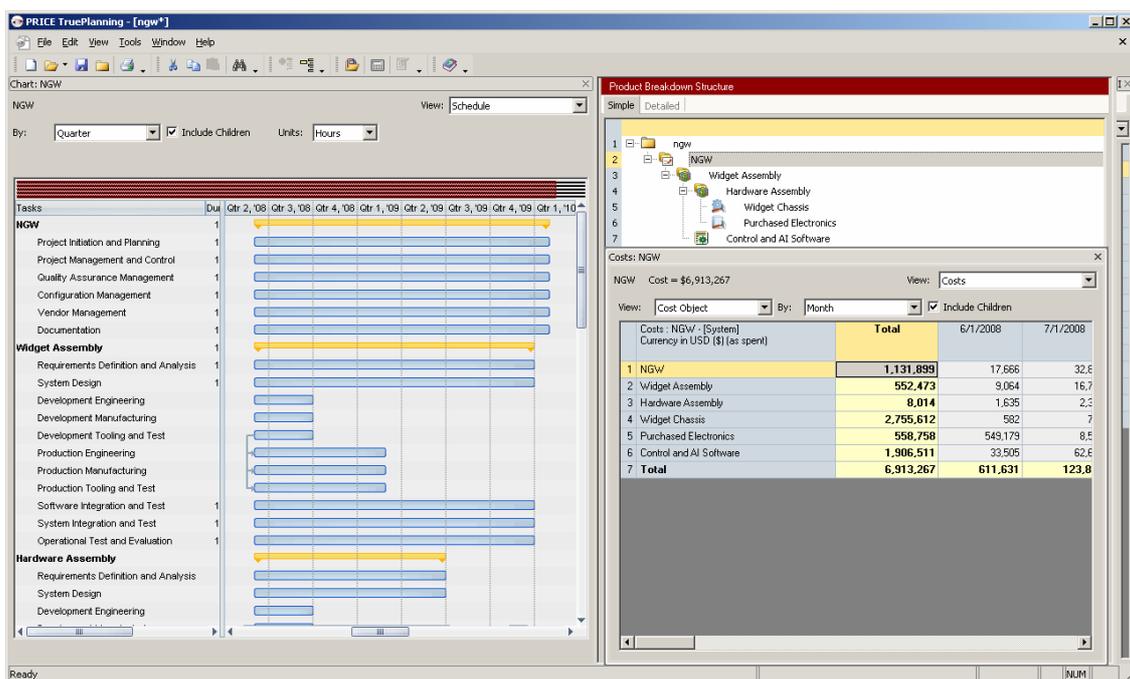


Figure 2

Figure 2 shows the preliminary estimate based on information Dan supplied to Jane about the scope, project team and historical information from previous projects. Further investigation of the calculated schedule indicates that the software development is what is driving the schedule into the fourth quarter of 2009 (Figure 3), while the development, production and integration of the hardware can all be reasonably accomplished in the mandated time frame.

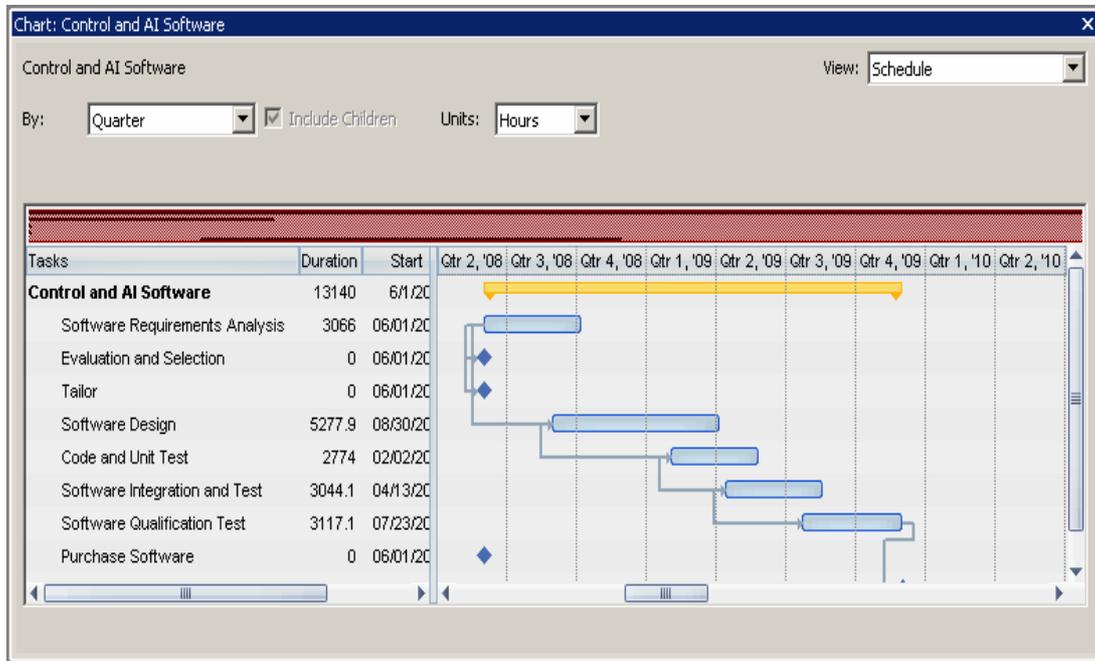


Figure 3

Dan and Jane decide to revisit the work they did for the software portion of the estimate. Constraining the schedule to have software development complete by April 2009 is possible but the estimated cost jumps from \$7M to \$8.5M (Figure 4). At first this seems like a large increase in cost but when Jane and Dan drill down they realize that this is realistic. More people will be brought on to the team earlier and the existing team will lose time at first as they bring the newcomers up to speed. Communication challenges will increase with a bigger team and the rush to get everything done on a compressed schedule will lead to requirements and design mistakes that will require rework. Jane was glad they had resisted doing this analysis in her project management software as this cost effect would never have come to light.

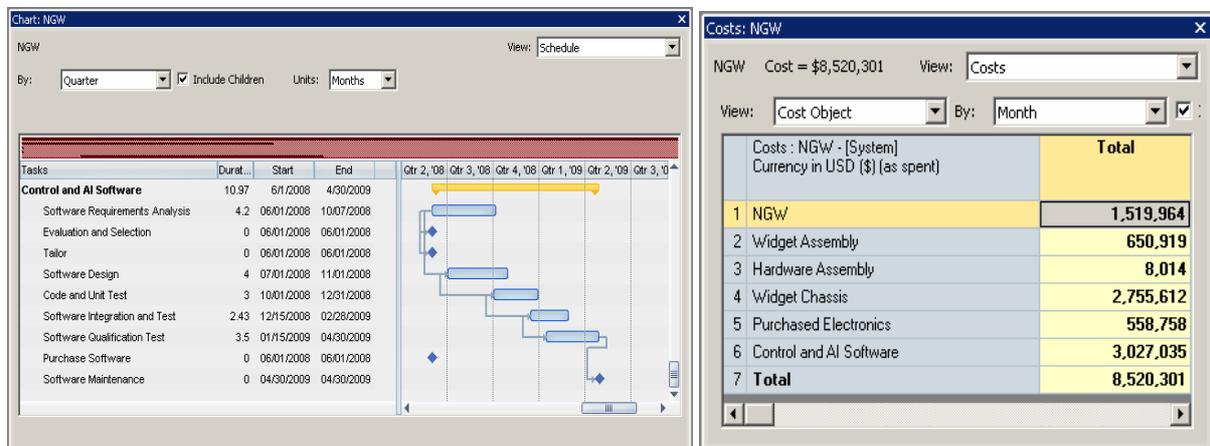


Figure 4

In an effort to consider all their options, Dan and Jane start by looking at the software development team. The team is mixed with respect to skill and experience. Dan generally likes to work with a team like that since this brings his new developers up to speed more quickly. In this case, however, he needs to consider lobbying for a more experienced team. He has Jane rerun her analysis indicating that the development team is very capable with at least five years experience with the product suite, programming language and development platform. With this change, both the cost and schedule fall into a reasonable range.

This is a good starting point, but they also need to account for the possibility that this ‘dream team’ will not be available or that there will not be enough funding available fast enough to roll this team out in time to make a difference. In order to eliminate a cycle of back and forth negotiations, Dan plans to present several options for likely project success. As part of the original estimate, he and Jane had created a software size estimate for each category of functionality based on project requirements, Jane’s historical database and validated with the Size Calculators in the TruePlanning product (Table 1). They created the following table to indicate size and complexity of the various software modules that need to be created to meet project requirements.

Functionality	New	Available	Complexity	Relative Cost
Decision Algorithms	8500	5000	High	9.25%
Learning Component	10000		High	10.34%
User Configuration		12750	Low	1.32%
Motor Control	2000	4850	Low	1.44%
Navigation and Visioning		7650	Medium	2.38%
Communication	4500	5020	High	8.39%

Table 1

As expected, when Dan takes this information to management, he is unable to get the ‘dream team’ he requires, although he is able to trade a few of the newer software engineers for more experienced ones. In addition to this, management agrees that while all of the functionality is important to this product, a scaled down version of the Communication module will be acceptable for the first version as long as the more important decision and learning components are completely finished. With this information, Dan prepares a ‘final’ initial estimate, including a risk analysis that shows the cost below the \$7M budget with a 70% confidence and a schedule analysis that shows completion within the 2nd quarter of 2009 (Figure 4). Dan gets the green light to begin the project and Jane exports the TruePlanning information into an MS Project file to help get Dan started managing the project.

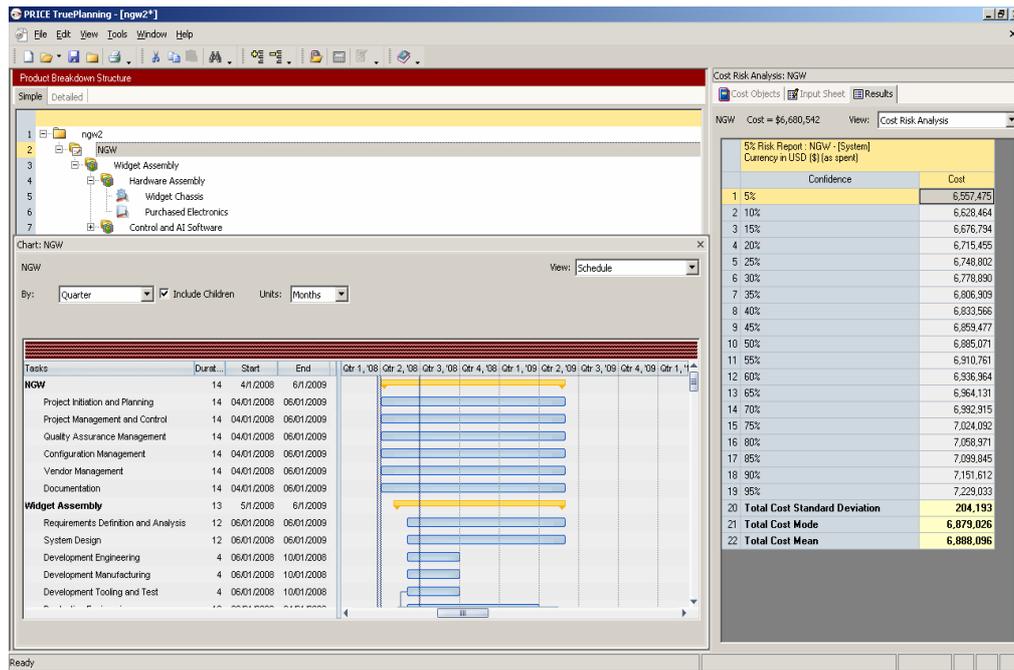


Figure 4

Scope Changes

It is very unlikely that the requirements specified in the beginning of a project relate exactly to the functionality necessary for the finished project. This is particularly problematic when technological innovation is involved. Some possibilities are hard to imagine without witness of what can be achieved. In a perfect world, project managers would be able to say no to scope changes, deferring them to future releases. This rarely happens in the real world. Project managers need the tools to help stakeholders understand the impact of scope changes on cost and schedule to support successful negotiations and informed decisions as requirements emerge or change.

The project proceeds as planned for the rest of the year. As 2009 begins, hardware is in full scale production and the critical software components are available for exposure outside of the development organization. As product management begins to spend time in the development labs reviewing capabilities, gaps in initial requirements are identified. While the decision algorithms work to specification, there are several crucial algorithms that were not considered. Review and testing of the software has made this obvious. Product management puts together a list of additional requirements – including the missing algorithms as well as a few bells and whistles that they believe will significantly improve the appeal of this offering at launch.

The list is presented to Dan who immediately thinks of the triangle. The project is operating within budget and to schedule, but with very little wiggle room. The more experienced developers had come at a higher price than Dan expected so some of the cost cushion has evaporated. Dan calls on Jane to help him work through a re-plan of the project. They update the information for the Design Algorithm module and add a module to the estimate for the UI Controls and Graphics requirements that have been added. This increases the cost to \$7.8M but more importantly it extends the schedule to November. Dan has managed the project closely to plan and was likely to finish that way without the additional requirements. With this record he is confident that he can negotiate increased costs based on requirements growth. He knows that the schedule remains the unbendable requirement. Further investigation indicates that it is the new features, not the changes to the Decision Algorithms that have stretched the schedule (See Figure 5 below).

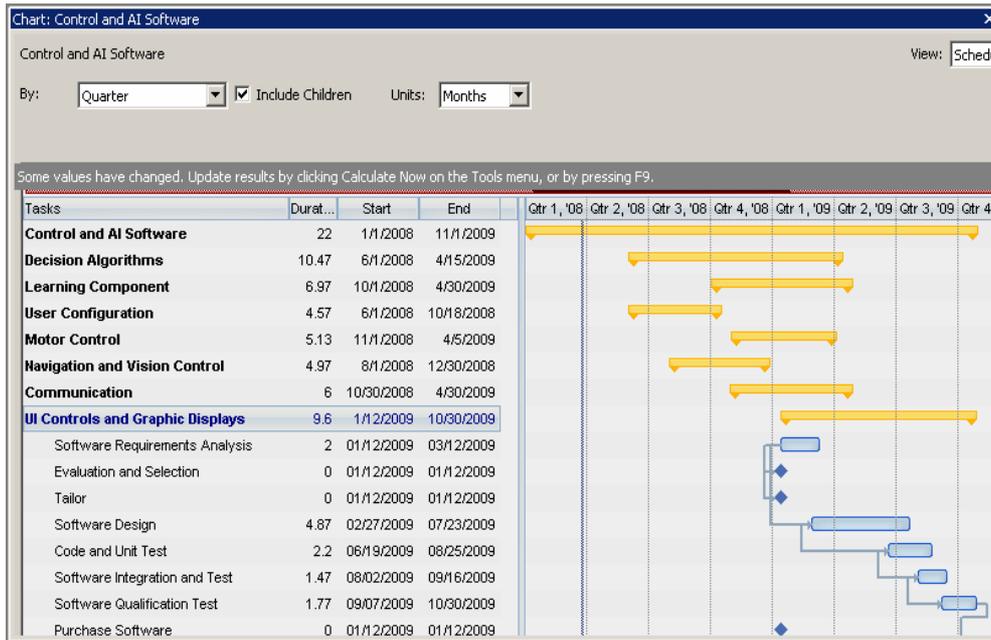


Figure 5

If he can eliminate this requirement, he can still deliver the project on time. Dan presents this information to the management team who approves the cost increase but holds fast to the necessity of adding this extra glitz to the software, while steadfastly refusing to budge on schedule. At this late stage in the project, with significant development in progress on features, it is late to negotiate functionality out of the product. Dan considers purchasing an off the shelf solution that will meet these added requirements. He and Jane perform a make buy analysis and determine that while the in house development would be slightly cheaper than purchasing off the shelf, the off the shelf solution offers the schedule relief necessary to complete the project on time (Figure 6).

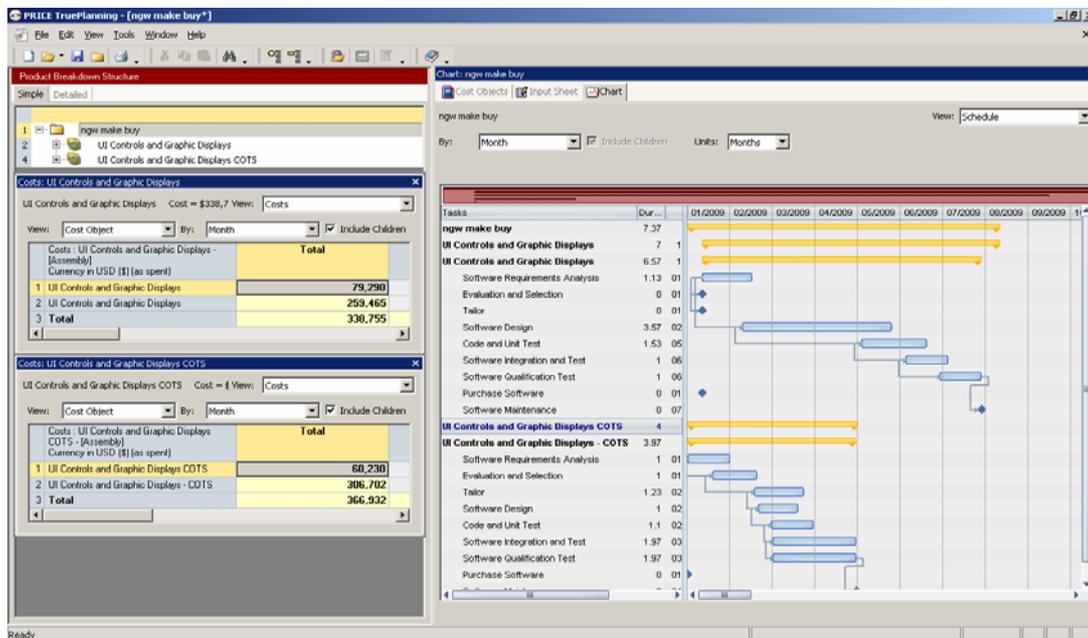


Figure 6

Dan and Jan prepare a new analysis that shows the cost and schedule impacts. They also prepare a risk report to demonstrate that the cost risk has increased due to the imposed schedule constraints and the new functionality added at this point in the project (Figure 7). The cost increases are approved and work continues on the implementation tasks.

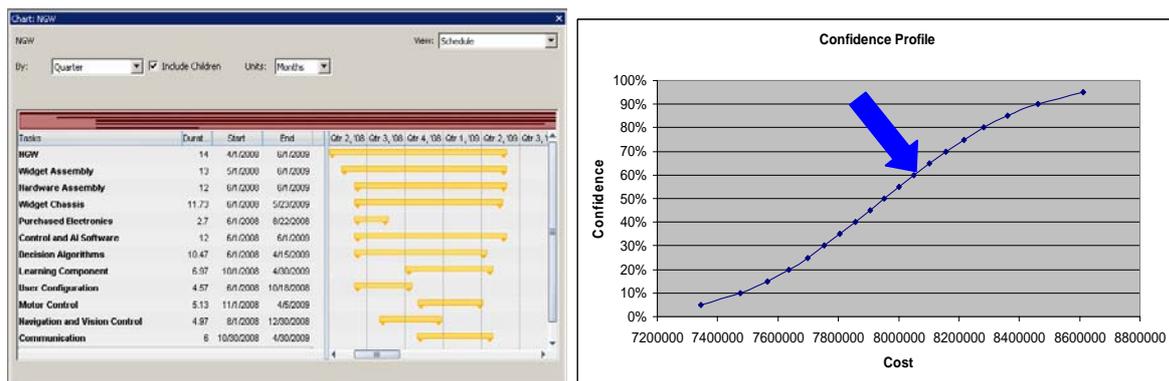


Figure 7

Resource Competition

Another common challenge faced by project managers is the competition for resources in a company with multiple projects going on at once. Organizations need to keep a big picture eye on the portfolio of projects that are occurring over time to ensure that projects don't fail because resources are pulled in too many directions. At the same time, they want to ensure that there are not long periods of time when some resources are under utilized. Individual project managers may not have this as a primary focus but someone in the organization should monitor project plans to avoid contention during important projects.

As the NGW project winds down, Dan is looking toward the future and working with product management to put together initial plans for the next release of NGW. Working with Jane again he develops a preliminary estimate for the nine month project. He prepares this plan intending to keep his original team in tact and working on this project full time. Satisfied with his initial plan, Dan proceeds to develop more detailed project plans.

Several days later Jane comes to him with a concern about his utilization of Software Engineering resources. Part of her monthly reporting includes projected utilization for the project teams in order to identify cross project contention for resources. She uses the Resource Capacity chart in TruePlanning to help facilitate this process. She has found several potential problems with resource allocation and has drilled down to determine that the Software Engineering resources were the problem (Figure 8). She explained that the blue bars indicated available capacity and the purple line indicates requirements for that resource. She had been able to flatten this curve significantly working with other project managers but she now needed Dan to rework his plan to achieve a better plan for sharing this resource.

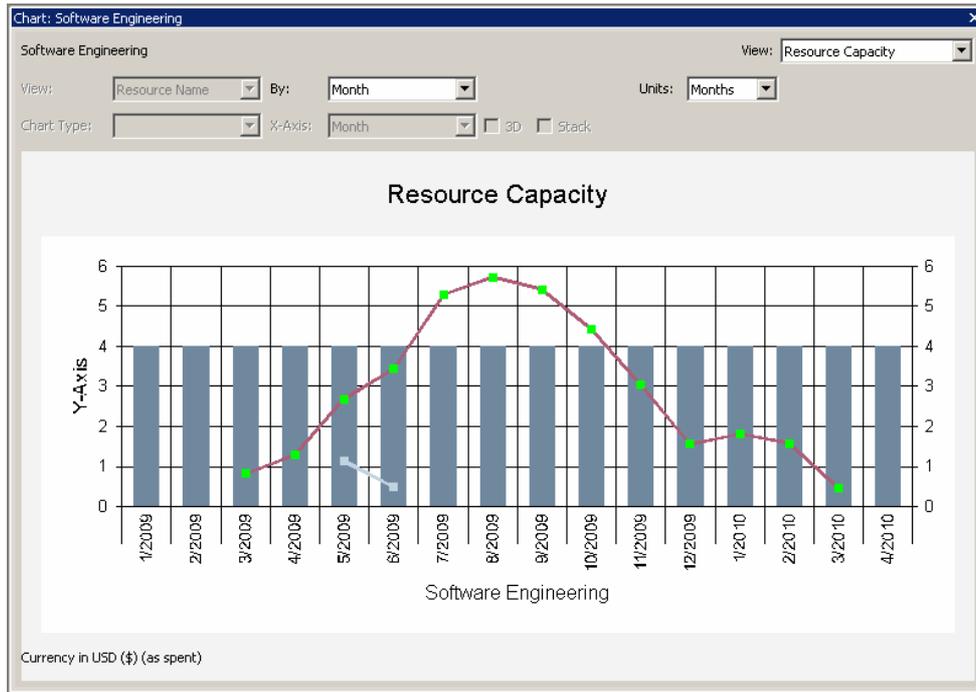


Figure 8

Reviewing the project schedule Dan found that he could delay the beginning of software development for the LGW Version 1.1 project for several months because the hardware production and assembly will be the lengthiest activity for this release. With this reduction they were able to put together a plan that would optimize the sharing of this resource across projects as well as identifying where there were opportunities to accomplish small projects in the short term (Figure 9). Dan made certain to update his cost and risk projections as he made these schedule changes to ensure that schedule constraints did not increase cost or risk in an unacceptable way.

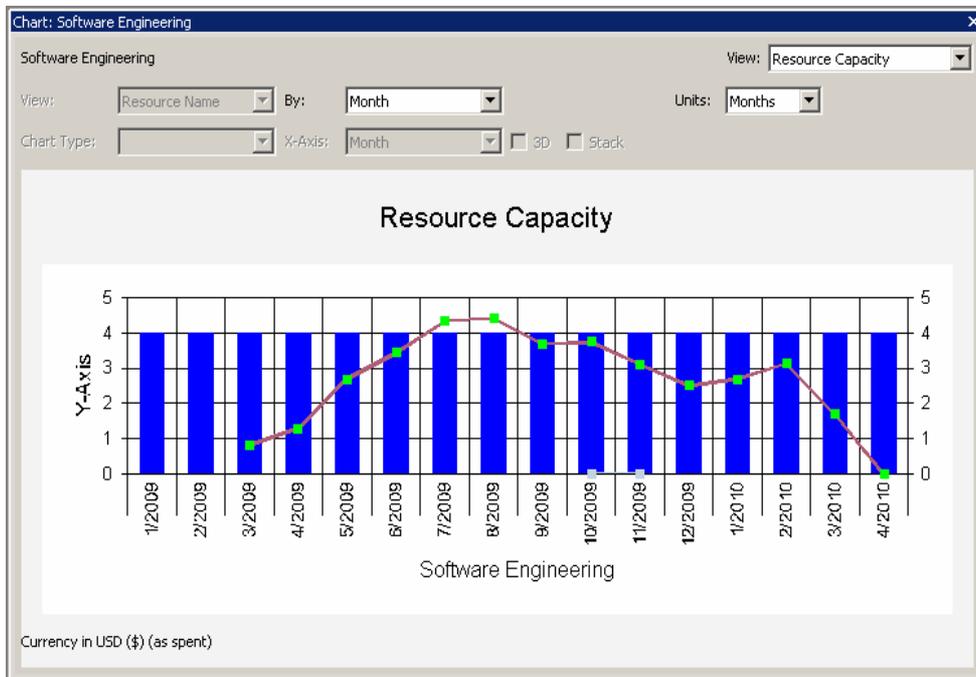


Figure 9

Conclusions

One of the many challenges that project managers face involves the balancing act required between scope, cost and schedule. Managers need to understand and respect the Project Management Triangle that shows how changes on any one dimension need to be accommodated for in one of the other dimensions. Projects that are inviolable on schedule and cost, need to be prepared to reduce scope; projects that must deliver a certain set of functionality need to be flexible on cost, schedule or both; projects with a set budget need to be willing to extend schedule and/or reduce scope.

In order to manage projects successfully, project managers need to be able to translate scope into cost and schedule and need the tools to be able to quickly and efficiently do trade-offs between these three dimensions when planning the project and during project execution. Typical project management tools help with managing changes in cost and schedule but they don't understand the interconnection between scope, schedule and cost. Without this understanding, it is possible to make change to one side of the triangle without proper consideration of how this change effects the other sides. TruePlanning 2008 is an excellent framework for performing this translation, while streamlining the analysis of project parameters across the cost and schedule continuums.

About the Author

Ms. Minkiewicz leads the Cost Research Department as Chief Scientist at PRICE Systems. In this role, she is responsible for the research and analysis necessary to keep the suite of PRICE Estimating products responsive to current cost trends. She works with industry leaders to collect and maintain cost research data and offers analyses of this data to the cost estimating community through the PRICE products.

Arlene's most recent accomplishments include the development of a catalogue of cost estimating relationships for hardware and systems projects that will be delivered to the cost estimating community as part of the TruePlanning suite.

Arlene frequently publishes articles on estimation and measurement in publications such as Software Development Magazine and Crosstalk. She speaks frequently on these topics at conference such as STC, ISPA, SCEA, IEEE Aerospace Conference, SEPG, and many others. Her 'The Real Costs of COTS-Based Software Systems' paper was recognized in 2004 by ISPA and SCEA as Best Paper in the Software Track. Her paper "A Case Study and Assessment of a COTS Upgrade for a Satellite Ground System", co-authored with Marilee Wheaton of the Aerospace Corporation, received Best Paper in Software Track in 2006 by SCEA and her paper "The Evolution of Hardware Estimating" received Best Paper in the Hardware and EVM Track at the 2007 ISPA/SCEA joint conference.

Arlene can be contacted at arlene.minkiewicz@pricesystems.com

More information on software cost estimating and the TruePlanning Suite can be found at: www.pricesystems.com

PRICE Systems World Headquarters

17000 Commerce Parkway, Mt. Laurel, NJ 08054

voice 1.856.608.7200 / fax 1.856.608.7247 / www.pricesystems.com

Please contact us at www.pricesystems.com/contact/contact.asp for more information.

PRICE Systems - Washington, D.C.

1700 N. Moore Street, Suite 1100, Arlington, VA 22209

voice: 1.703.740.0087 / fax 1.703.740.0088

PRICE Systems International

Meridian Office Park, Osborn Way, Hook

Hampshire RG27 9HY England

voice 44.1256.760012 / fax 44.1256.762122



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