FACTS: Factors, Analogies, CERs & Tools/ Studies for Government Acquisitions

Ruth Dorr
Daniel Harper

ABSTRACT—

Government agencies are attempting to maximize the use of their increasingly limited funds. Accurate and credible cost and schedule estimates have always been a challenge, yet they are becoming more important than ever given our country's debt crisis and current political environment.

In addition to needing credible cost and schedule estimates, federal agencies have experienced a growing demand for rapid turnaround of these estimates. This need is increasing as the pressure to rapidly deploy systems mounts. The push for agile software development compounds this problem.

A critical component in cost estimating is the data collection of costs for the various elements within the estimate. FACTS is a project to establish a knowledge management environment in order to assemble various useful Factors, Analogies, CER's (Cost Estimating Relationships) & Tools/Studies-"facts" that exist not just within one agency or organizations, but across the cost community. The goal is not just for one or two people to collect data and create a database, but to instantiate a culture of sharing and collaboration within the cost community at large.

Table of Contents

List of Tables

INTRODUCTION

The current state of the US budget and the fiscal climate requires programs to be increasingly conscious of their costs. Sequestration, the Fiscal Cliff, and the sluggish economy in general are impacting the funds available to programs. Programs are under much closer scrutiny with their spending and budget requests. Now, more than ever, programs need reliable and defensible cost estimates to justify the acquisitions needed to support their missions.

Further, the constantly changing landscape of what Congress desires to implement and will fund creates a need to be able to provide reasonable cost estimates within a rapid turnaround time. More and more frequently cost estimators are being challenged to provide an initial cost estimate in a compressed period of time. The abbreviated period of time significantly constrains the resources cost estimators can devote to data collection and quality assurance.

Additionally, due to budget cuts, some positions within agencies are going unfilled concurrently with tightening training budgets. There is a growing concern that institutional knowledge is being lost as greater numbers of the more senior and experienced cost estimators retire and leave the workforce. The new generation of cost estimators will be required to do more without the benefit of senior cost estimators as mentors or formal training in cost estimating techniques.

One way to mitigate some of these problems is to find a way to bring together in one place many resources from a large number of cost estimators. In this way more components of a high quality cost estimate are available to a larger group of cost estimators. FACTS is a collaborative initiative to bring together the government acquisition cost community to facilitate information sharing and improve the cost estimating process.

WHAT ARE THE FACTS

The FACTS referred to here are Factors, Analogies, Cost Estimating Relationships and Tools/ Studies used for government acquisitions. These are the building blocks of a high quality cost estimate. Access to these FACTS is critical to the cost estimating process.

Factors

A factor allows the estimator to approximate the cost of one element based on a multiplier applied to another element. Factors are often expressed as percentages since they are based on a multiplier of one cost to another. Factors provide a method of estimating cost based on widely accepted, general characteristics of a particular type of cost element.

Factors can include ratios, rules of thumb, and percentages. Unlike analogies, factors are not unique to any one program so they can be used on many, similar types of programs. Simple factors are good for general use when a more complex cost estimating relationship (CER) specific to the project under study has not been developed or is not readily available.

While factors are versatile and contribute to a defensible cost estimate, they need to be accessible in order to be used. When a cost estimator has access to a number of factors, the

factor most appropriate to the particular situation can be selected. A central repository of factors would greatly facilitate the creation of a defensible, rapidly generated cost estimate.

Analogies

Analogies can refer to entire systems or just some elements of systems. The premise behind using analogies when building a cost estimate is that most systems are comprised of components that have been used before in some context. Since it is likely that other agencies have implemented similar functionality in the recent past the cost estimator may be able to find an analogous system for cost comparison. The GAO Cost Guide refers to using analogous systems as an acceptable basis for cost estimates particularly for the early stages of a project where relatively little is known of its principal cost-driving characteristics and design

Analogies are most useful to cost estimators when building an estimate in a rapid time frame in the beginning phases of a program. Analogies, when used as a single data point, require context. However, a collection of analogies can be used as a historical database when building cost estimates. Analogies can be aggregated and statistically analyzed to build CERs and to facilitate parametric cost estimates. They can also be readily captured in a spreadsheet or database such as the one below:

Table 1 Operational Testing Agent Analogy

System or Element	Agency	Value	Unit	Year of Data	Definition & Comments	Source	Sensitivity
Operational Testing Agent	DHS	$1.8 M	TY$M	FY12	This includes test consulting services provided by the U.S. Navy Space and Naval Warfare Systems Command (SPAWAR) in support of testing. The OTA provides a number of personnel to monitor and observe testing activities and contribute suggestions drawing from the SPAWAR knowledge data base.	According to the GAO Nov 2011 Report on the DHS Transformation program, "Cost of an operational testing agent, who would be responsible for planning, conducting and reporting independent OT&E for Release A, was not included in the acquisition planning process. USCIS officials from TPO and OIT agreed that an OTA appeared to be a duplicative effort because TPO had already planned to conduct independent testing. However, DHS denied TPO's request for a waiver of the OTA. As a result, USCIS contracted with an independent OTA by Oct 2010, and as of June 2011, TPO has awarded approximately $1.8M towards this contract."	Public

Analogies are applicable both to an entire program and to a "sub-element" of a program. An example of a "sub-element" analogy might be the cost of an Operational Testing Agent. For example, a particular program requires an Operational Testing Agent (OTA). The cost estimator may know of a GAO report on another program within the same agency that spent $1.8M to conduct OTA testing. The cost estimator would then be able to use that figure as an analogy for the cost estimate. With a larger data base of analogies involving many sub-elements, one could theoretically build a system using relevant sub-element analogies that could be highly representative of the system being costed. However, as useful as an analogous program can be when creating a cost estimate, it can be a daunting task for the cost estimator to search for analogous systems on which to base an estimate.

The use of analogies is not without risks. Since an analogy does not necessarily catalogue cost drivers within the program, it can be risky to simply refer to one analogous program when preparing an estimate. The larger the collection of analogous programs available to the cost estimator, the more reliable and defendable the resulting cost estimate will be.

Cost Estimating Relationships (CERs)

CERs are a more advanced type of factor. CERs are generally more rigorous and more statistically sound than factors, having been analyzed through techniques such as regression analysis. In addition, CERs are typically based on larger, historical data sets composed of many similar or analogous programs.

CERs are useful for sensitivity analysis and design tradeoffs, as their input parameters can be manipulated easily. CERs can also be calibrated to a particular program to correct an analogy or make it more applicable to the current project. CERs can be used at any point during a project life cycle but are typically most useful during the earlier phases such as design and build. While CERs are very useful to cost estimators, they are less readily available than factors because they take longer to develop.

Tools/ Studies

Tools and Studies comprise the remaining elements of FACTS. Tools and Studies often contain multiple factors or CERs, but provide much more context than a CER or factor alone. Tools and Studies must be well understood in order to be used properly. "Studies" can include papers outlining new research in emerging technologies, such as cloud computing or business intelligence. They often are comprised of hundreds of pages which require in-depth analysis and digestion of the material. Tools and Studies furnish the supporting background to the formulas and factors, and may at times be difficult to extract into a database. However placing them on a shared site, particularly one with tagable search terms, allows them to be used effectively. One of the side benefits would be that these tools and studies would provide credible rationale for documenting the Bases of Estimate required by the GAO Guidebook.

An example of a useful Tool that one might post would be the Naval Center for Cost Analysis' (NCCA) Inflation Calculator, an Excel-based tool enhanced by macros and GUI menus for converting constant-year dollars to inflated dollars and vice versa across all the dozens of DoD and branch appropriations. This tool is quite mature, is updated annually, and is a great example of something that can be shared and leveraged for work at an agency with less cost maturity. Often times in such agencies standard inflation indices are not provided and each project typically uses its own tools, or in some cases, a simple 2-3% annual factor.

One example of a study is the Software Development Cost Estimating Guidebook. At more than 200+ pages, this tome is not easily codified in spreadsheet form alone. The manual touches on numerous factors impacting cost, including the impact of physical space for development teams, team experience, etc.

WHY IS IT IMPORTANT TO GATHER THE FACTS?

Government agencies use cost estimates in many ways. A cost estimate is a key component in the resource allocation process of the agency and ultimately serves as the basis for budget

requests made to Congress. The cost estimate is also used to measure the progress of a program that is underway. Thus, a reliable cost estimate contributes to better resource allocation throughout the life of a project, and (by extension) across the government.

The Government Accountability Office (GAO) has issued many reports in the past few months which discuss the need for improved cost estimates across the government. One report, (GAO-12-629), reviewed the cost estimates of major IT programs across the government. The report clearly highlights the need for a better way to collect and store cost related historical data. GAO found that out of eight agencies reviewed, only one agency had a process currently in place to collect and store cost related data effectively. The other seven agencies did not have a process in place to gather this information and use it effectively across the agency. These seven agencies are severely hampering their ability to produce the high quality cost estimates needed to make reasoned decisions about the allocation of resources that are growing ever scarcer.

HOW DO I GET THE FACTS?

The need for FACTS is clear. Yet gathering the FACTS remains a challenge. The GAO Cost Estimating and Assessment Guide reveals that after 40 years, the process of gathering historical cost information to use in formulating new cost estimates persists as a problem. In order to solve this problem many questions need to be answered. How can the FACTS be efficiently captured? Where is a central repository of the traditional spreadsheets, databases and other cost estimating artifacts that have been captured? How can the knowledge of the cost estimating community be leveraged effectively? Some of the answer lies in the traditional methods of knowledge sharing: Communities of Interest; newsletters; listservs; and events such as technical symposiums. However, history indicates that this is not enough. What is the paradigm shift needed to break the impasse? One answer to this on-going problem lies in utilizing the many tools capitalizing on social networking capabilities and adapting them to a business environment.

Gathering the FACTS

In the cost community, it is often a huge challenge to share information or find useful cost data within the cost estimators' own organization, much less outside of their own agency or company. Many experienced estimators will have a store of data from programs they themselves have worked on but still need to rely on a personal network of other cost estimators to look for other supporting information when needed. Newer cost estimators do not have the benefit of either personally gathered legacy or a large personal network of other cost estimators to leverage. In the GAO Cost Estimating and Assessment Guide, GAO observes that gathering and maintaining historical data is a challenge for cost estimators. The GAO notes that often times the realities of the current cost estimating environment, including compressed schedules and shifting policies, impede the collection of historical cost data. In addition, the GAO points out the difficulty cost estimators have in accessing many of the components of a solid cost estimate, such as analogous systems and CERs.

When individual cost estimators develop a cost estimates they gather the FACTS for a particular estimate. Cost estimating best practices require the estimator to not only gather the information but to store it for future reference as well. Frequently, this background information is captured in a file or a location on a computer that is specific to a particular estimator. This practice facilitates the justification and replication of that particular estimate but does not necessarily improve the research and development process for the next estimate. Sometimes the cost estimator who developed the original estimate will develop a similar estimate a few years later, and will remember (or find via a search of their hard drive) where the background information is stored. Sometimes the estimator will have her own network to tap into for background data. Frequently, however, each cost estimator must begin the research process anew for each estimate. This point is where the challenge truly begins.

Sharing the FACTS

The next step in the process is to share the FACTS. While many of these artifacts exist on the hard drive of an individual cost estimator or perhaps even in the repository of a single that department, they are often inaccessible to other cost estimators. The challenge is to gather all of these costing artifacts into one place so that many cost estimators can access them.

Not only should information be shared among cost estimators in one group, it should be shared with cost estimators across agencies. Many cost elements are similar across agencies. For example, a phone center for DoD will have primary characteristics that are the same as one for IRS, VA or CMS. Cost data from all of these can and should be used as a basis for a new phone center cost estimate regardless of the agency involved. Since much of the cost data is applicable across government agencies, an interagency collaboration to share historical cost data would be useful. This joint effort would help to alleviate some of the problems the agencies have encountered regarding the lack of access to historical cost data.

It should be noted that care does need to be taken when sharing data, particularly with cost information. Some cost information is sensitive or company confidential. This type of information should not be included in a sharing site with a large audience. Fortunately there is a large amount of cost information that is useful to the cost community which can be more publicly accessible. The goal is to gather and allow access to the later type of shareable information. By using a sharing network many cost estimators can access and contribute to the cost estimating knowledge base.

Some companies and programs have internal sharing sites where anyone within the company can access this type of information. One common example of this is SharePoint. Unfortunately, these sharing sites tend to be restricted to one group or another. Frequently one project area has access while others will not. As a result, the artifacts and lessons learned from one cost

estimate cannot be readily accessed by another cost estimating organization. Even though it is a CMMI and GAO best practice to have a commonly accessible method to share this type of information, it is not leveraged to the maximum effectiveness in most cases. Frequently the capability to share data on a network does not really exist. Even when a method of common access does exist, it is not updated frequently. The evidence indicates that if a site is not actively updated then participation will decline, and the utility of the knowledge management activities will diminish.

There are currently some sharing networks that are partly open to the cost community at large. One such type is the Defense Acquisition University Knowledge Sharing Portal (http://www.dau.mil/images/Pages/Knowledge_Sharing.aspx). The initial membership is free but registration is a bit cumbersome, requiring a biography and 10 minutes or so to fill out the on-line request form. In addition membership is restricted to members of the Department of Defense (DoD), Government, or those supporting the Defense Industry. The site contains a lot of administrator-posted content such as DoD Directives on all aspects of Acquisition, but there does not appear to be a lot of user-generated content. It is a useful resource, though heavily DoD-centric and much more "top-down" than the "web 2.0" approach recommended by Knowledge Management (KM) practitioners.

Many companies are currently experimenting with social networking tools for the enterprise. According to research conducted by Gartner, 50% of business enterprises will have incorporated some sort of social networking tool by 2012. There are many examples of how social media style of knowledge sharing is making its way into the work place. IBM has created the Beehive research project. Booz Allen Hamilton has an internally accessible prototype that they use known as "Hello" for Hello.bah.com. At MITRE a research prototype tool called Handshake has been adopted, has the added capability of allowing external participation. Other industries are currently using similar social networking tools. Medpedia is a medical wikis that allows information sharing between physicians and researchers in the medical community.

The Next Generation of Data Sharing

Texting, Twitter and Facebook have changed how people interact in their daily lives. Cost estimators can incorporate these changes into the way they do business to improve the cost estimating field as well. Many of the business enterprise social networking sites incorporate these ideas. A Web 2.0, or "bottoms-up" tool such as the Handshake Group, has many advantages over a traditional "top-down" knowledge sharing tool like SharePoint. In the case of Handshake, the interface is much simpler and provides 90% of SharePoint's functionality with minimal training. Based on Elgg®, a free and open source platform, Handshake is a good example of how organizations can leverage some of the benefits of social networking tools by using the flexibility of open source software to tailor the tool to meet specific business requirements.

The Handshake tool serves as a user friendly "SharePoint lite" allowing for collaboration and file sharing (including metadata tagging) without the need for a SharePoint administrator. If an individual can find a video on or upload one to YouTube, they can do so on Handshake or similar tool. This type of tool has a number of characteristics that facilitate effective, dynamic knowledge sharing:

- Easily incorporates external participants, sponsors and partners while retaining the ability to have sections accessible only to internal participants.
- Allows users to interact with a variety of SMEs
- Preserves e-mail dialogue for future members (versus sitting in individual e-mail inboxes, inaccessible to new employees)
- Has a simple Calendar feature to depict events of common interest to users
- Integrates with Outlook e-mail for those with firewall issues
- Allows users to provide value-adding "color commentary" to posted artifacts. For example, one contributor might post an artifact discussing Software Cost Estimating Relationships. Another contributor might then post a comment about the usefulness or limitations of that particular artifact. In this way a dialogue is encourage not just on a particular question but on the cost estimating FACTS in general.
- Allows users to provide feedback on artifacts via comments or simply by using a "like" function.
- Captures group metrics about the site including the total number of items submitted by time period and information on the number of discussions, files posted, and blog posts.

Awareness and Outreach

A social networking site is only as good as the network of members supporting it. A program of outreach and awareness is critical to the continued success of collaborative, knowledge sharing. Organizations must find ways to reach out and connect to other cost estimating groups.

Internally, at MITRE, the Cost FACTS Handshake site has been promoted organically via the tools "champions," through their personal signature blocks providing the site link, lunchtime presentations, and internal networks. The site was unveiled via an internal Cost Group newsletter in June, as well as an internal brief to approximately 50 attendees. It is being actively promoted to external cost estimators as well. The intention is that an extensive network of cost estimators will participate in knowledge sharing. Whether one cost estimator participates every week or a hundred estimators participate only once, the collaboration will benefit all participants.

Artifacts and discussions need to be posted regularly; at least weekly works well. By keeping the site current and dynamic, users are encouraged to visit frequently to keep up with the latest information. Recognizing that people are not going to give up e-mail anytime soon, the tool can be used to notify users via e-mail of new artifacts and discussion, and even allow users

to contribute via e-mail without having to use a web browser. Therefore participants can also contribute via mobile platforms such as iPhones or Blackberries.

This type of outreach and awareness strategy is critical to the success of a knowledge sharing site. Unless people know that the site exists, they will not participate. Unless they can see that the site contains a dynamic exchange of information, they will not participate actively. Once people realize the type of valuable information contained in the site they will continue to utilize it. The collaborative nature of the environment will encourage them to contribute, thus creating a perpetuating cycle.

CONCLUSION

In order to meet the current needs of the cost estimating community, companies and agencies need to find a way to leverage the existing knowledge base more efficiently. The need for this resource multiplier becomes more apparent every year as new challenges are presented to the cost estimating community. There are many ways to meet this need. The majority of solutions lie within reinforcing the connections between individual cost estimators to create a whole cost estimating community that is greater than the sum of its individual estimators.

The most important element of information sharing, regardless of the platform used, is that it be accessible and inviting to a larger group in the community. Even if this is only implemented within one company or agency, rather than throughout the entire government acquisition cost community, significant benefits can be realized. However, the greater the network, the greater the value able to be realized ("Network Effect").

Social media tools represent an opportunity for the cost estimating community to work across the traditional boundaries of agency or organization to resolve the persistent, fundamental problem of how to efficiently capture historical cost data. These tools have the advantage of flexibility and ease of access to a larger community. An additional benefit is that the new generation of cost estimators, raised on Facebook and Twitter, will be well-versed in information sharing before they develop their first estimate, and can leverage the knowledge of a dwindling body of experienced cost estimators more effectively.

The job of cost estimators will not become easier in the near term. The terms 'sequestration', 'continuing resolution', and 'budget cuts' have become all too familiar. In all probability the job of cost estimators will become more challenging. The more tools and support that can be generated within the cost community at large, the more efficiently defendable, quality cost estimates can be developed. Expanding the network of cost estimators, increasing their level of daily interaction and discussion within the cost estimating community, and efficiently gathering and sharing the FACTS will enhance the reach back-for both novice cost estimators working on developing their skill set as well as for experienced cost estimators looking for a way to better leverage the knowledge base of the cost estimating community. An active program within each company or organization will foster the cost estimating best practices within the company or

organization. Cross-pollination among the cost estimating groups through collaborative initiatives such as MITRE's Cost FACTS will bring together the government acquisition cost community in order to facilitate and improve the cost estimating process and information sharing.

References

1. Bloomberg Business Week, Stephen Baker, "Big Blue Embraces Social Media", May 21, 2008
2. Defense Information Security Agency (DISA), *DISA Cost Analysis Manual*, April 2011
3. Department of Energy, (DOE) Cost Estimating Guide, DOE G 413.3-21, May 9, 2011
4. Gartner Inc., "Gartner Reveals Five Social Software Predictions for 2010 and Beyond", February 2, 2010
5. Government Accountability Office (GAO), *21st Century Challenges: Reexamining the Base of the Federal Government*, GAO-05-325SP, Washington, D.C., February 2005.
6. Government Accountability Office (GAO), *GAO Cost Estimating and Assessment Guide: Best Practices for Developing and managing Capital Cost Programs*, GAO-09-3SP, Washington, DC, March 2009
7. Government Accountability Office (GAO), Information Technology Cost Estimation: Agencies Need to Address Significant Weaknesses in Policies and Practices, GAO-12-629, Washington, DC, July 2012
8. International Cost Estimating and Analysis Association (ICEEA), Cost Estimating Body of Knowledge (CEBoK), Vienna, VA, 2009
9. Software Technology Support Center Cost Analysis Group, *Software Development Cost Estimating Guidebook,* October 2010.

Ruth Dorr
MITRE Corporation
costfacts@mitre.org

Daniel Harper
MITRE Corporation
costfacts@mitre.org