CHAPTER 1

"Looking Back: Reflections on Cost Estimating"

We are delighted that you have chosen to explore a vibrant career field that few people know about or understand in any significant depth: the field of cost estimating. However, before we dive into the background, terminology, statutory requirements, data sources, and the myriad quantitative methods that this textbook will introduce to help you become a more informed and capable cost estimator, I would like to start with a broader perspective – the idea of cost estimation as a profession. Two facts stand out in my 40+ years in this field, and they seem almost contradictory. First, cost estimating is *ubiquitous:* that is, it exists, formally or informally, in every organization. No idea, initiative, or conversation escapes the inevitable question: "That is a great idea, but how much will it cost?" Second, cost estimating is often invisible: despite its constant presence, it is frequently overlooked or underappreciated.

My goal in this chapter is to share personal observations from my various positions in the cost-estimating profession, highlighting the many important purposes it serves. These experiences also provide the opportunity for me to thank the leaders, mentors, colleagues, and others who have shared their skills and insights with me throughout my career and whose contributions are reflected in this book. Finally, I will discuss key developments the profession has undergone over the past 40 years and offer some thoughts on where it might be headed in the future.

In the past, nobody went to school specifically to become a cost estimator. To illustrate this point, I studied mathematics and economics for my undergraduate and graduate degrees, while my coauthor, Greg Mislick, also studied mathematics at the US Naval Academy and went on to fly helicopters for the US Marine Corps before entering the field. By different routes, we both became practitioners of operations research and specialists in answering the question, "What will it cost?" In recent years, however, graduate-level certificate and master's degree programs have emerged to hone the skills of cost estimators and establish professional standards for the field. This textbook is our attempt to pass those skills and lessons learned on to you, helping to expand the knowledge and expertise of those working in this profession.

Every organization – from a typical household to the greatest nation – relies on the disciplines and processes of cost estimation. In conversations on almost any topic, one question inevitably arises: "What does it (or what will it) cost?" It is a question

that we all ask, many times, in both our professional and personal lives. All too often, the most common response – especially from those who are reluctant to answer – is "I can't tell you exactly," as if that were helpful or satisfactory. The answer is just a dodge. We were not expecting an *exact* dollar-and-cent figure. Rather, we were looking for an *approximate* answer to help us plan for the expense while we weighed the various options for achieving our goal(s).

What kind of answer to the question "What does it cost?" is useful? I believe that the characteristics of a useful answer in our daily lives are remarkably similar to those in commercial and government applications of cost estimating, although complexity and scale may camouflage this similarity. The essential characteristics of any good cost estimate are *completeness, reasonableness, credibility*, and *analytic defensibility*.

Note that this list does not include the need for excessive *precision*. While the budgets we develop and the cost–benefit analyses we construct require specific numbers, our professional work as cost estimators does not rely on getting answers *correct to the penny*. A cost estimator should not agonize over the lack of a narrow range of possible costs. If the ranges are overly large, the user of the estimate – your sponsor, consumer, boss, or whoever requested it – may tell you they need a tighter range. In this case, you will need to seek additional data or another methodological approach in the hope of refining your estimate.

However, it may also be that a wide-ranging estimate that meets the criteria of completeness, reasonableness, credibility, and analytical defensibility is all that is required, particularly in the face of rapidly changing conditions or immature technologies. In fact, in the absence of solid data, it may be all that is possible.

This textbook is designed specifically to provide context for the cost-estimating objectives of completeness, reasonableness, credibility, and analytical defensibility. It also teaches the mathematical techniques and procedures needed to develop cost estimates and offers substantial guidance throughout that development process.

I would like to share six examples – stories that illustrate some of the lessons I have learned while holding various positions in both the corporate and government worlds. These roles have included assignments at headquarters and duty in the field, within the United States and abroad, and mostly (though not exclusively) in defense-related positions. These examples are diverse, underscoring the broad applicability of cost-estimating tools. I hope you will find them useful as you tackle programs and assumptions in your own present (or perhaps future) career in cost estimating.

EXAMPLE 1.1

Cost Estimation in Support of a Major Ship Program

As the Navy proceeded to build the inaugural (lead) ship in a new class, large cost growth began to challenge the project. I was asked to determine why this was occurring. After much analysis, I found several causes. One in particular is useful to discuss for the education of new cost estimators: a key cost-driving assumption in the original cost estimate was simply, and significantly, *incorrect*.

The original estimate had assumed that when the Navy's lead ship was being built in the shipyard, a *commercial* ship would be under construction at the same time. The two programs were expected to share the shipyard's overhead costs, relieving the Navy's ship from bearing the full burden by spreading these costs over the two ships. The estimators who produced the original cost estimate had relied on credible information and exercised the appropriate due diligence. They confirmed that the shipyard had the commercial ship on its order books and received confirmation from the Defense Contract Audit Agency (DCAA) of this order, which was satisfied that the ship would be built in accordance with the contract. It was therefore reasonable to assume that the shipyard's overhead rates would be split between the two ships. However, when the Navy ship was under construction, the commercial firm canceled its shipbuilding order for its own business reasons. Consequently, with no second ship in the yard, all overhead costs fell entirely on the Navy!

Naturally – and through no fault of the US Navy – there were significant and legitimate cost increases. They did not occur due to inexperience or naïve program management by either the government or the shipyard. Thus, the first lesson learned in this example is that *assumptions always drive cost*. The second is that *assumptions can be fragile*: what is true at one point may not hold later. This was indeed the case here. The third lesson learned is that the one constant you can always rely on is change. *Change will always occur*! Even a cost estimate prepared with due diligence and reasonableness can still be wrong. After all, in this example, all the evidence pointed to the fact that there would be a second ship in the yard. In conclusion, be aware that plans and circumstances can change during the life of your program, and they most likely will. Ultimately, these changes will affect both your estimated and actual costs.

EXAMPLE 1.2

Cost Estimation in Support of a Major Missile Program

A frequent root cause of underestimation in a cost estimate (and therefore a strong invitation to a cost overrun) is the omission of a significant component of the required work. In cost estimating, we refer to such a component as a work breakdown structure (WBS) element. Whether the omission is purposeful or accidental makes no difference; as the project is executed, the labor and material costs for the missing WBS element will still accrue, the bills will still arrive, and a cost overrun will be the end result.

One example comes from a cost estimate on a missile program – an expensive new major defense weapon system we will call Program A. Experience with similar systems had taught me that a sensor would be part of this weapon system; in fact, I expected that the development of this sensor would be one of the *major* cost elements in the research and development (R&D) phase of the lifecycle estimate.

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The program office confirmed that a new sensor was indeed part of the design and integral to the weapon's successful performance. However, the program manager's R&D cost estimate *did not include the sensor*!

When I asked the PM why no sensor costs were included, he explained that a separate effort – Program B – was developing the sensor. Program A would simply do a "technology lift" from Program B, thereby avoiding any R&D sensor costs in his program. While I understood the logic, I also knew there was no guarantee that Program B would complete development on time, and I was skeptical that Program A would entirely avoid sensor-related charges. The greater risk was that any delay in Program B would also delay Program A, thus extending our schedule timeline and causing additional costs. Consequently, I argued for contingency funds to cover this possibility. Fortunately, the program manager agreed, which proved wise when Program B was ultimately canceled! We then had to restructure Program A to incorporate the sensor development project within our own budget.

The major lesson here is that immature technology always presents the very real possibility that it may not work as planned or may be delayed – causing programs dependent on it to slip and causing costs to rise. For instance, when a program is delayed, personnel costs increase because workers must still be paid, but now over a longer period of time. A more general lesson is that it is critical to identify all technological and other risks, assess their potential cost impacts, and develop contingency estimates on the assumption that some risks will, unfortunately, materialize.

EXAMPLE 1.3

Cost Estimation in Support of a Major Ship Program

For years, the US Navy recognized the need to modernize its combat logistics fleet (CLF). However, nearly all shipbuilding appropriations at that time were being used to develop and procure surface combatant ships instead. To work around this funding problem, one clever idea suggested that a commercial shipyard build the next generation of CLF ships, with the Navy then entering into a long-term lease for each ship. This would thus allow the CLF to be funded from the operations and maintenance (O&M,N) appropriation, rather than the traditional shipbuilding account. I was asked to analyze whether this arrangement made financial sense, while others examined the legal and policy implications. My analysis was to be a "cash flow" and "net present value" (NPV) cost–benefit analysis, comparing the cost of the conventional method of procuring this ship from shipbuilding appropriations with the proposed "build-to-lease" option using O&M dollars. I also needed to include the many "what–if" (i.e., sensitivity) analyses to test how changes in assumptions and variables would affect the results.

After significant study, we found that under a wide range of reasonable circumstances, the "build-to-lease" approach made financial sense. Based on financial metrics alone, a reasonable person would have recommended this option. However, despite its apparent savings and analytical defensibility, the proposal was never presented to the Secretary of the Navy. It was judged to be "poor public policy and practice" for a variety of reasons.

The lesson learned is that while cost issues are always a major concern, they are rarely the *only* concern. Cost estimating is meant to inform and support decision-making, not to dictate it. Analysts must recognize that decision-makers may not follow the recommendations of even the most complete, reasonable, credible, and analytically defensible analysis when broader policy considerations are at stake.

EXAMPLE 1.4

Cost Estimation in Support of a Major Automated Information System (MAIS)

Often, it is important to do rough order of magnitude (ROM) cost estimates to help senior defense leaders sort through the cost implications of alternative courses of action for complicated projects. Knowing whether a program is going to cost roughly $75M or roughly $200M helps decision-makers distinguish between options that are potentially viable and those that are not.

A memorable example of this was the idea to develop an automated, defense-wide system to support civilian and military personnel and pay functions across all the military services and all components – the Active forces, the Reserve forces, and the National Guard. This was intended to be the largest enterprise resource planning program of its kind ever implemented. We were tasked to "develop an estimate of what this new MAIS would cost and to compare that cost with the cost of maintaining approximately 90 legacy personnel and pay systems which this program would replace." (Note: MAIS is now referred to as Defense Business Systems (DBS) but MAIS still applies as a legacy term in Examples 1.4 and 1.6). We were tasked long before any specific requirements – other than the broad description given in the previous sentence – had been fully defined or discussed. At this time, there was certainly no estimate of the size of this program, and size is often a critical variable for developing a credible cost estimate. We recognized that this "personnel and pay system" would be a very large software and hardware effort, and to reasonably capture the cost of the software program, we needed an estimate of its size, measured either in source lines of code or in function points. The program manager had no estimate of either.

We were trying to "bound" the problem by saying (in effect) that this effort was going to be "bigger than a breadbox and smaller than a barn," or, as we decided, "bigger than any Microsoft product, but smaller than the largest missile-defense

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project." Obviously, the estimates we developed had a wide range of outcomes. Was this range of estimates useful to the decision-makers? Absolutely.

The important lesson learned here was that at the front end of a project, when many unknowns still exist, ROM estimates with a wide range of possible cost outcomes may still be sufficient for senior decision-makers to move the decision process forward.

EXAMPLE 1.5

Cost Estimation in Support of a Major Policy Decision

A major overseas US Army command was having difficulty with retention and maintaining its force structure within the enlisted ranks. One significant part of the problem was identified as low reenlistment rates among the junior enlisted members. Based on US Army regulations at the time, a service member's family was allowed to accompany him or her overseas. The Army would pay for the overseas move and also support the family overseas with a housing allowance and base exchange privileges, but only if the service member had attained at least a minimum rank. The junior enlisted personnel who were not reenlisting at sufficient rates were precisely those who were below the required rank necessary to have their families with them overseas. As a result, their families usually remained in the United States while the service member completed the overseas tour, and retention suffered due to hardships caused by this separation. We proposed a policy to extend family support to these junior enlisted members. Our analysis examined whether the estimated costs of implementing this policy outweighed the benefits of lower recruiting and training costs due to improved retention.

The ROM estimates we provided were sufficient to convince the Army to adopt the policy, and the results did, in fact, increase enlisted retention. For cost analysts, it is highly satisfying to see crunched numbers turn into effective policy.

EXAMPLE 1.6

Cost Estimation in Support of a MAIS Program

This example involves analyzing the issue of when to insource or outsource goods and services. While this particular case is taken from the US Navy, it has broad applicability in all services and businesses. The Navy was considering outsourcing its ashore (i.e., its "non-ship") information technology (IT) infrastructure and operations, including computer hardware, software, training, and help desks. Even before the Request for Proposal (RFP) was developed or published, the Navy

required a cost–benefit analysis to address the important issue of the Return on Investment (ROI) of such an enterprise.

ROI is simply a fraction. The numerator is the savings estimated from the proposed outsourced system compared to the existing (or status quo) system, while the denominator is the estimated cost of the investment required to transition and maintain the proposed outsourced system. The challenge in this analysis was that we had little data to estimate either the numerator or the denominator! The Navy did not know the costs of either the infrastructure or operations of the existing system nor did it have any insight into which vendors might bid on such a comprehensive outsourced effort – or what it would cost to capitalize and operate.

Given those significant restrictions, we still made reasonable assumptions to characterize the unknowns and developed cost estimates from these assumptions. We then conducted extensive sensitivity analyses to understand the relationship between ROI and different values of key independent variables. We identified a critical variable in these computations, which was the fraction of best commercial practices the Navy would likely achieve if it transitioned from the existing insourced option to the proposed outsourced option. For example, if the Navy harvested only a small fraction of the benefits of the commercial best practices (say, 0–20%), the desired savings would not be achieved, and the ROI would be negative and unattractive. On the other hand, if the Navy captured a larger fraction of those benefits (say 80–95%), then the savings would be realized, and the ROI would be positive and attractive.

Therefore, we developed a two-dimensional graph for senior decision-makers. The horizontal axis showed the "percentage of best practices achieved," and the vertical axis showed the "ROI of investing in the new system." This graph compressed a great number of assumptions, methods, and analyses of the costs and benefits into a single visualization tool. Of course, there is a corresponding loss of analytical nuance and texture in this simplification. Nevertheless, it was precisely the simplicity and transparency of this tool that permitted very senior decision-makers to make a reasoned decision, grounded in credible and defensible analysis.

The lesson learned here was that it is not necessary – in fact, it is almost *never* necessary – to say to the decision-maker that "This is the correct answer, and here is the analysis that supports it." Rather, the cost estimator should serve as a guide, helping the decision-maker navigate the decision space underlying the problem. In this way, the analysis remains in the hands of the analyst, and the decision remains in the hands of the decision-maker – both as it should be.

Hopefully, these six examples have helped you to see the difficulties that can arise during a program, as well as the lessons learned from them. At this point, I want to transition from specific examples of cost-estimating lessons to reviewing some of the changes that have occurred in the cost-estimating community over the past 40 years, along with changes that I believe are likely in the future.

It is useful to consider these changes within three dimensions: *people, processes, and data*. The following are in-depth descriptions of these three dimensions, complete with some personal observations.

People: When discussing "People," the following questions need to be considered:

- Who are the people who enter the cost-estimating profession?
- What are their academic and professional backgrounds?
- Where do they obtain their education and training in the intellectual, technical, methodological, and ethical requirements of the profession?

Forty years ago, government cost estimators entered the profession primarily with bachelor's degrees in the engineering sciences, followed by degrees in mathematics, statistics, economics, and operations research. With the exception of a master's degree program at the Air Force Institute of Technology (which was largely for young Air Force officers, captains, and below), there were no formal, degree-granting courses in cost estimating at civilian colleges, universities, or military schools, either at the undergraduate or graduate level. New entrants into the field learned their skills largely through an apprenticeship model – assigned to work on a project under the supervision of someone with experience and knowledge until they had learned enough to become the mentors themselves. To combat this lack of formal education in the cost estimation field, the Office of the Secretary of Defense Cost Analysis Improvement Group (OSD CAIG) established an annual Department of Defense Cost Analysis Symposium, called DODCAS. This forum provided a venue for exchanging information and skills across the extended Department of War (DoW) cost-estimating community and remarkably is still going strong today, though it experienced a hiatus during sequestration and other recent budget pressures. DODCAS is open not only to DoW organizations but also to contractors. (For more information, search online for "DODCAS.")

Fortunately, the landscape for education within the cost-estimating community is changing. Beginning cost estimators are now better educated, with many new entrants already holding master's degrees in the previously mentioned disciplines. Formal and informal internship programs have also been developed by organizations for their new entrants. We are entering an era in which more advanced education is now available, specifically in the cost-estimating field.

To amplify this last point on education, there are now three major repositories of cost-estimating intellectual capital, with two of them leading to certification in cost estimating and the third to a master's degree in cost estimating and analysis. These three include the following:

- The first major certification source is the *International Cost Estimating and Analysis Association* (ICEAA; https://www.iceaaonline.com/), formerly known as the "Society of Cost Estimating and Analysis" (SCEA). ICEAA has developed sophisticated training and certification programs. While these programs are used by some individuals and organizations within DoW, the primary customers are contractors and consultants who provide goods and services to the government, as well as commercial firms whose work is not oriented to government needs. Commercial firms seeking uniform standards across their enterprises have also adopted ICEAA certification as their standard. (More on this topic appears in Chapter 3.)
- The second major certification source is the *Defense Acquisition University* (DAU), which primarily supports personnel working in areas related to the

DoW's acquisition processes and the business of procuring goods and services. This includes training and certification in cost estimating. Numerous training modules are available in a wide variety of subject areas.

- While the first two sources provide certifications, the Naval Postgraduate School (NPS) developed a distance learning *Master's Degree program in Cost Estimating and Analysis*. The first cohort of 30 students began in March 2011 and graduated in March 2013, followed by a second cohort of 26 students that graduated in March 2014. To date, 14 cohorts and 271 graduates have completed the program. In addition, several hundred personnel have earned a certificate in cost estimating by completing four courses from the master's curriculum. New cohorts begin each summer for this two-year program. The program is unique in granting a master's degree specifically in cost estimating and analysis.
- Further information is available on the NPS website at https://online.nps.edu/w/379-master-of-science-in-acquisition-cost-estimating?inheritRedirect=true.

The future is always uncertain and therefore very hard to predict. Yet, in a very real way, cost estimating is about making informed forecasts. In the years ahead, I believe the profession will include a growing number of practitioners with formal training, particularly from programs such as the distance learning Master's Degree in Cost Estimating and Analysis just described. This shift comes at a critical time, as the retirement of baby boomers has already begun, creating a need for a new generation of skilled estimators.

Having discussed the people involved in the cost-estimating field, I next turn to the *Processes* that define the profession.

Processes: When discussing "processes" in cost estimating, the following key questions should be considered:

- What are the intellectual principles or "underpinnings" of the profession that permit cost estimates to be made?
- What are the processes by which cost estimates are developed, validated, and incorporated into the larger decisions that affect acquisition, budgeting, and the analysis of options?

Forty years ago, the main methodologies for developing cost estimates were cost factors, cost-estimating relationships (CERs – equations that express cost as a function of technical or performance variables), and learning curves, all of which will be explained fully in this text. These methodologies were supported by "actuals," or cost data from analogous historical programs. Risk and uncertainty in a cost estimate were typically addressed through sensitivity analysis, which examines how the baseline estimate behaves when important assumptions are varied across reasonable ranges. The results of such analyses allow the analyst to provide a more nuanced and robust cost estimate than one that merely provides a single point value. For example, rather than stating, "The baseline cost estimate for Program X is $1.2B (in FY26$)," the cost estimator might instead report, "The baseline cost estimate for Program X is $1.2B (FY26$), with a range of outcomes expected between $1.0B to $1.3B as the quantity procured is varied by ±10%."

At about the same time, the cost-estimating community was just beginning to automate the computational aspects of its work. Prior to this, it was quite normal

for estimates to be developed on large paper spreadsheets with arithmetic done manually, or for more complicated computations such as learning curves to be performed on an electromechanical calculator. The advent of the laptop-based program known as VISICALC (an early predecessor of today's ubiquitous Excel-type spreadsheets) caused quite a stir in the cost-estimating community! Its impacts far exceeded the simple savings in pencils and erasers that we no longer needed to use. More importantly, cost estimators could now perform many more sensitivity analyses within the time allotted for a study, thereby providing richer support to the decision-makers. Today, cost estimators can rapidly develop complex models in Excel or other automated tools, enabling deeper analysis within shorter timelines. Moreover, Monte Carlo simulation, once a luxury, is now a standard practice for developing probabilistic estimates, offering decision-makers a fuller understanding of risk and variability, which is critical for major programs.

As a new program wound its way through the hierarchical decision process, the associated cost estimate moved with it in a review cycle that checked for completeness in the following areas:

- WBS elements
- Credibility of the analogous program data
- Correctness in accounting for all assumptions
- Application of appropriate and accurate methodologies
- Identification of any other possible errors

Cost estimates were briefed to several levels of decision-makers, ultimately reaching the highest levels of management. This process demonstrated that cost estimates – especially for major projects – were taken seriously. At the time, the Army, Navy, and Air Force already had Service Cost Centers to perform these functions, and OSD CAIG (now OSD CAPE) reviewed the largest programs (for a history of the CAIG, see Reference [1] at the end of this chapter). These reviews were conducted under service regulations, as each branch had developed its own rules for the proper handling of cost estimates. Statutory authorities followed later, when laws were enacted mandating that cost estimates be prepared in accordance with specific standards.

In 2026, the review processes remain largely intact. Cost factors are still derived from analogous historical programs, and CERs continue to be developed using statistical regression techniques and historical data. Sensitivity analyses are still performed as well. What has changed is our ability to run Monte Carlo simulations rapidly on automated spreadsheets, allowing us to generate probability distributions for cost estimates and provide richer statistical insights for decision-makers.

Three important changes to the decision-making processes occurred to aid decision-makers. These included the following:

- The first change is that there are now statutory requirements (mandated by law and Congress) governing key phases of the cost-estimating process. One example is the requirement that all major programs (typically, those whose estimated costs exceed certain monetary thresholds) must have two cost estimates prepared for them. One is developed by the responsible program office – the Program Office

Estimate (POE) – and the other is an Independent Cost Estimate (ICE), which serves to check the completeness and reasonableness of the POE.

- The second change is that the ICE must be considered by the Secretary of Defense when making milestone decisions. Milestones are periodic reviews conducted as a program progresses through its life cycle: from conceptualization to R&D, to procurement, to O&M, and finally (if necessary) to disposal. The fate of a program – whether to be continued, restructured, or cancelled– is decided at these reviews, and the ICE is one of the key contributors to that decision. This requirement only calls for consideration of the ICE; it does not mandate adopting one estimate over another.
- The third change is that both the POE and the ICE must now include cumulative probability distributions generated by Monte Carlo simulations, as previously discussed.

The passage of the Weapon Systems Acquisition Reform Act of 2009 (WSARA 2009) heightened the visibility of the cost estimator and the cost-estimating process within the DoW. This intense focus on costs, on educating greater numbers of cost estimators, and on the processes by which costs are estimated will continue. WSARA 2009 also mandated the creation of the Director of Cost Assessment and Program Evaluation (OSD CAPE), elevating the purpose and visibility of the cost estimation field. This director position requires Senate confirmation, and the office carries broad execution and reporting responsibilities in both cost estimating and cost–benefit analysis.

Data: Last, I turn to the data used in cost estimating. Data refers to the various metrics, measurements, and parameters taken from the project for which a cost estimate is being developed. These measurements are often numerical values, but they may also be categorical variables. Examples include cost metrics, physical measurements such as size or performance descriptions, and programmatic descriptors such as quantities procured, the duration of the R&D phase, or the number of vendors awarded procurement contracts. As you will see in more depth later in this book, data derived from analogous historical programs (commonly referred to as "actuals") form the indispensable core of every professionally developed cost estimate. Thus, the identification, collection, normalization, organization, storage, and analysis of data underpin everything that we do as cost estimators.

Forty years ago, the collection of historical data was an *ad hoc*, paper-based effort. The DoW asked vendors to provide cost reports showing time-phased costs incurred on a program, allocated to the various elements in the project's WBS. Contractors were generally under little pressure to make these reports available, and as a result, they often did not provide them. The reports that *were* submitted were accumulated in a library and tended to by a very small cadre of dedicated personnel. Cost estimators frequently kept their own files of selected reports, guarding them as valuable sources of analogous actuals for future cost estimates. I often think of this stage of cost-estimating data-keeping as comparable to the medieval period in human history – before printed books became available – when hand-produced manuscripts were rare, valuable, and had very limited distribution.

Today's data resources are extraordinarily different from those of the past. Vendors now provide cost reports that are collected, normalized, subjected to error-checking routines, and stored in accessible web-based databases, with due

regard for proprietary protection and security requirements. These reports and databases are described in Chapter 4 on Data Sources. The storage and accessibility of historical data continue to expand the depth of available information and provide easy access for those with approved needs.

In closing this chapter and these reflections, I hope that these introductory remarks have provided you with an appreciation of the scope, applicability, challenges, and utility of cost estimating – and perhaps inspired you to master the material in this text and refine the diverse skills we bring to the complex question of "What will it cost?"

Chapter 2 begins this journey. It will discuss what cost estimating is; the characteristics of a good cost estimate; why we do cost estimating and its importance within the DoW and in Congress; how and when cost estimates are created and used; and the terminology of cost estimating.

REFERENCE

1. Shrull, Don. (Ed). *The Cost Analysis Improvement Group: A History*. McLean, VA. Logistics Management Institute (LMI), 1998. ISBN 0-9661916-1-7, Library of Congress Catalog Card Number 98-65004.