

**Testimony for the House Committee on Armed Services
- Panel on Defense Acquisition Reform –
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Statement of Dr. Daniel A. Nussbaum, Naval Postgraduate School

Chairman Roberts, distinguished members of the panel, I would like to thank you for this opportunity to discuss my thoughts on how to improve the acquisition and cost estimating processes in the Department of Defense. These ideas are mine and do not necessarily reflect the views of the Navy or the DoD.

I am Daniel A. Nussbaum, a member of the faculty at the Naval Postgraduate School, Graduate School of Operational & Information Sciences, in Monterey, California. I've spent the last thirty years mainly doing and more recently teaching and researching in the defense acquisition management system, with a focus on cost estimating. I was a previous Director of the Naval Center for Cost Analysis and past President of the Society of Cost Estimating and Analysis. In my current capacity, I educate mid-career military officers and Department of Defense civilians, as well as graduate students from many allied nations, in cost estimating, and I conduct research in cost estimating and the return on investment that the insertions of technologies offer.

All my experiences in cost estimating confirm that three things are necessary for sound cost estimating. They are 1) Acceptance of the underlying uncertainties in

predicting the future, 2) Accurate and plentiful historical data, and 3) Professionally trained and certified personnel.

First I want to discuss Uncertainty

There is uncertainty in all estimates, and this uncertainty is intrinsic to the professional practices in the Cost estimating profession. Uncertainty derives from several sources, with a major one being that we are usually designing (or building or operating) something that is substantively different from what we did before. The difference may be in the product itself (e.g., the technologies used in the system), or in the economic conditions (e.g., labor rates, or overhead rates, or material costs), or in the programmatic environment (e.g., how many we buy at a time or in total, and the manufacturing processes and technologies used).

An estimate reflects our knowledge at a point in time, when we "freeze the problem" and base the costs on the configuration and programmatic as they are understood at that moment. From that baseline, many things can change that can also change the cost estimate, including:

- Changes in labor rates, overhead rates, or schedule.
- Changes, including enhancements, to capability or quantity. While these can be controlled by mechanisms such as the Configuration Control Board (CCB) initiative. The CCB is not intended to tie the hands of the customer who may very well need these changes. For example, we would not peremptorily reject enhanced Intelligence, Surveillance and Reconnaissance (ISR) capabilities to

Global Hawk, to support the kinds of missions we're engaged in now, solely for reasons of increased cost.

- There are cost changes internal to the program when a particular technical solution to a problem does not work as planned, and an alternative technical solution becomes necessary. For example, aluminum may have been assumed to be the right material for some portion of an aircraft structure, with man-hours per pound of aluminum used as the basis of estimate. If subsequent testing or analysis shows aluminum to be inadequate, some redesign will almost surely be necessary. Redesign takes time and engineering labor) to accommodate the use of alternative materials. And, alternative materials, like titanium, cost more for materials as well as for fabrication.

Second, let us look at the impact of Historical Data

A hallmark, and necessary characteristic, of a sound cost estimate is that it is based on historical program performance (what we call “actuals”) from similar or related on-going or past programs.

While the historical record is necessary, it is not sufficient, because we must take into account those processes and technologies that came into being after the dates of the historical data.

Historical data is variable. Not every aircraft costs the same as every other aircraft. Not every ship costs the same as every other ship. This variability is at the root of the “less-than-perfect fit” that characterizes our cost estimating models. The

measurement of these “less-than-perfect fits” is accomplished through statistical constructs like “standard error of the estimate” and “confidence intervals”.

The general point is that we assume that the patterns of the past will repeat in the future. These patterns are almost always statistically grounded patterns, modeled with the powerful and subtle techniques known collectively as “regression”. Further, we know of no alternative approach to using the past as a guide to the future, if we want a scientific (i.e., reproducible and auditable) approach.

Grounding cost estimates in historical program performance suggests that the cost estimating profession subscribes to the idea that “the Past is Prologue”. That is correct. To the charge that such an approach is deficient in that it presumes that all the experiences of the past – the good and the bad – will be repeated, we in the Cost Estimating community answer that the future will not replicate the old mis-forecasts and inaccurate assumptions; rather, the future will bring with it its own, new, mis-forecasts and inaccurate assumptions. Of course, the same is true of the successes and correct assumptions of the past. That is, the historical successes and correct assumptions will not be exactly replicated; rather, new successes and correct assumptions will be achieved.

By bringing statistics and probability into the arena, we accomplish two things: we can take advantage of the full power of these powerful, subtle, mathematical disciplines; and simultaneously, we have introduced the language, the methods, and the results of these mathematical disciplines into what are invariably public discussions. In this sense, we are like meteorologists, usually right in general and occasionally not right

in particular. It is a continuing challenge for the professional cost estimator to provide a clear explanation of the basis of a cost estimate to those who use those cost estimates.

And thirdly, we need to talk about the key role of Professionally Trained and Certified Personnel.

Not all estimating is done by government employees. There are three cost estimating sub-communities: government in house estimators; employees of the large vendors who also design, develop and build what we buy (e.g., Boeing, Northrup Grumman, Lockheed Martin); and support contractors (or, consultants) that specialize in (or have divisions that specialize in) supporting the cost estimating needs of the government. Surely, we need to increase the capacity and quality, that is, the numbers and training, of the government estimators, but so do we need to enhance the professionalism of the other two communities.

Currently, there are no undergraduate curricula in cost estimating. The undergraduate classes that are closest to cost estimating are those in financial economics, which introduce the concept of net present value, but do not address the source or basis of the underlying cost estimates.

There are four educational institutions that I am aware of that teach at least one course in cost estimating. These are

- The Naval Postgraduate School (NPS, <http://www.nps.edu/>), located in Monterey, California, where I currently teach and do research in cost estimation.

- The Air Force Institute of Technology (AFIT, <http://www.afit.edu/>), located on Wright Patterson Air Force Base, in Ohio.
- The Defense Acquisition University (DAU, <http://www.dau.mil/>), located in diverse locations, with the DAU Capital campus on Ft. Belvoir, in Virginia.
- Massachusetts Institute of Technology (MIT, <http://web.mit.edu/>) in Cambridge, MA., which offers one elective course in cost estimating within its engineering curriculum.

DAU provides instruction that is required for certification in cost estimating, in the Business, Cost Estimating and Financial Management (BCEFM) Career Field, under the Defense Acquisition Workforce Improvement Act (DAWIA). The recent separation of the BCEFM career field into two separate CE and BFM tracks is a very welcome development (cf <https://acc.dau.mil/CommunityBrowser.aspx?id=277653&lang=en-US> for background) and should be supported. DAU is industriously tailoring its Cost Estimating courses to accommodate the separate CE track, and this too is a good evolution which should be supported. DAU support is largely limited to military and DoD employees.

The Society of Cost Estimating and Analysis (SCEA, <http://www.sceaonline.net/>) membership includes approximately one-third of all cost estimators supporting DoD. SCEA is a central and indispensable player in the training, initial certification and periodic recertification of cost estimators. Specifically, SCEA has collected a body of cost estimating knowledge that it provides to members of the Cost Estimating community, provides training in cost estimating, has developed and offers an

examination and experienced-based certification program that “...*promotes competency recognition based on preparation, assessment, and sustainment... it provides a professional credential that sets the standard for the entire costing estimating and analysis community. It provides the foundation for professional cost careers and offers employers and individuals a means of distinguishing and achieving excellence. Ultimately, certification offers a stamp of approval of an individual's mastery of the basic and intermediate cost knowledge and consequently strengthens the individual's and their organization's ability to produce quality cost estimates and analyses*”.

Speaking from my experiences at the Naval Center for Cost Analysis, I can say that the best way to find, recruit, train, develop, and retain the next generation of cost estimating leaders is to have and support a robust Cost Estimating Intern Program. Look at the current leadership of Navy cost estimating, and you will be amazed at the number who began their careers in a Cost Estimating Intern Program.

A Cost Estimating Intern Program combines classroom training with on-the-job experience and enables DoD to cultivate skilled estimators with hands-on experience in the state-of-the-art technologies of defense weapons, platforms and support systems, the DoD planning-programming-budgeting-execution process, as well as the quantitative skills of cost estimation.

I appreciate very much what this committee seeks to accomplish, Mr. Chairman. This concludes my prepared statement.

For further information about this statement, please contact:

Daniel A. Nussbaum
Graduate School of Business and Public Policy
Department of Operations Research
Naval Postgraduate School
1411 Cunningham Road, GL 242
Monterey, CA 93943
831-656-2387
dnussbaum@nps.edu