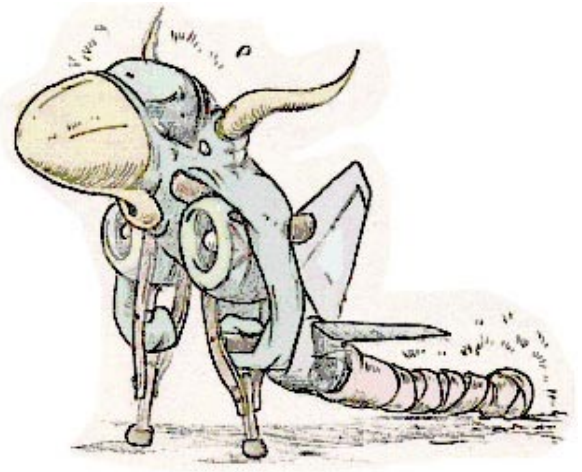
Naval Air Systems Command

Aging Aircraft

Integrated Product Team



Neandertal's Guide *to* Cost Estimating

NAVAL AVIATION SYSTEMS TEAM

guess: ***a conjecture based on little or no evidence***

es-ti-mate: ***a guess made by an expert***

About the title...

Let there be no doubt concerning the authors', and editor's, views regarding non cost estimators. The title of this desk top reference merely refers to the ease (hopefully!) with which it may be used by those unfamiliar with the intricacies of cost estimating.

Also -- In many older books, **Neandertal** is spelled with a "thal" ending (Neanderthal). This is the Old German spelling that was replaced in the early 20th century. This antiquated usage persists in some English publications, however, and also appears in the scientific designation (Homo sapiens neanderthalensis).

Specifically, the name "Neandertal Man" was given to this early Human species due to the first recorded find of remains occured in a limestone cave deposit in the small Neander River Valley near Düsseldorf in 1856. "Neander Valley" auf Deutsch, is "Neander Tal." Hence Neander**tal**, not Neander**thal**.

Contents

...A roadmap to the stars!

At the end of each chapter, you will find a line drawing of an aircraft from Naval Aviation's past. Can you identify them all? See the back cover for answers.

-- SUDDEN DEATH WARNING --

So now that you've read this far and we've exceeded your attention span, you want to jump right into the quagmire and start estimating -- Great! Here's what you'll need: Two No. 2 pencils; calculator or abacus; one large eraser; and a copy of your resume for your ensuing job search! Those of you who read through to Chapter 6 will be rewarded with laurels, accolades and a decent cost estimate.

Chapter 1

'A horse that can count to ten is a remarkable horse, not a remarkable mathematician.'
-- Samuel Johnson

Cost Estimation

...For the rest of us

You don't need a PhD in cost analysis to develop a reasonable preliminary cost estimate -- Anyone can do it using a few simple, but important steps.

Neandertal Man, or *Homo Neandertalensis*, got a bad rap when first discovered in the middle of the 19th Century. With his sloped and receding brow, heavy stature and square jaw, early anthropologists erroneously ascribed to him a brutish and primitive nature. Latter-day scientists now know him to have used language, tools and ritual in his own highly developed (well, for the middle Paleolithic era anyway) culture.

Anthropologists don't know why the Neandertal passed from the world scene approximately 20,000 years ago -- perhaps his tools weren't quite good enough, or he didn't use them correctly. Perhaps the costs of living in the last ice age were just too great.

Don't feel like a Neandertal!

Likewise, today we in Naval Aviation experience high costs of supporting aging systems and platforms at the end (hopefully) of a budgetary ice age. Unlike Neandertal Man, however, our tool box includes cost models for developing new technology to lower our total ownership costs. But using them can make a lot of engineers or logisticians *feel* like a Neandertal.

We've created this guide for the purpose of helping you, the engineer or logistician, develop a basic, fairly accurate and credible cost estimate in support of a cost reduction initiative.

We won't make you an expert cost analyst. Rather, we are attempting to take some of the ambiguity out of cost estimating and provide a systematic and uniform approach. Our goal is to help you, during the one or two times a year you are called upon to provide a cost estimate, develop a rough order of magnitude estimate of sufficient quality to make a go/no-go decision.

In the remainder of this guidebook, we will attempt to provide the basics on the following topics:

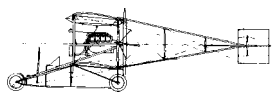
- **Common types of cost reduction initiatives**
- **Common approaches to costing**
- **Basic cost analysis techniques and methods**
- **Cost information sources**
- **Incorporating escalation and inflation**
- **Crosschecks**
- **Business case analysis of your results**

We will also identify the major pitfalls that can lead to inaccurate results in developing preliminary cost estimates. These major pitfalls will be identified with a **Sudden Death** warning.

While there are many cost analysis guidebooks and manuals around, we would especially like to note the sources listed in the bibliography as additional sources of information.

Using this guide

As previously stated, we are not out to make you an expert cost estimator -- but we will get you through developing a rough order of magnitude estimate. Please control your temptation to jump to the actual "how to" section and plug in numbers -- read through the entire guide *before* starting your actual estimate. It will save you time, effort and grief in the long term.



Chapter 2

'Predictions are always difficult -- especially when they're about the future.'

-- Niels Bohr

The Cost Estimate

...definition, challenges and types

Cost estimating is an art! And like painting or playing a pipe organ, the more you do it, the better you get at it. Instead of applying brush to canvass or fingers to keys, though, with this art form you make a *guess* – a calculated one to be sure, but a guess nonetheless.

The calculated guess of estimating cost is:

Approximating the probable worth or cost of an activity based on information available at the time.

The actual cost is known only at the completion of the project. Therefore, the size of the estimate error tends to decrease as the project progresses.

There's always a catch

Three common challenges make accurate cost estimating difficult, if not darn near impossible:

1. *Project Definition*

Defining, or scoping, your project is difficult early on. If you knew exactly what it was you needed to do, and how to do it, you wouldn't need to do a cost estimate, right? Nevertheless, better definitions up front will yield better results in the end.

2. *Identifying Appropriate Performance Schedules*

Defining an appropriate execution timeframe schedule is critical to the cost estimating process. In particular, for most new initiatives Return on Investment (ROI) remains the metric used to measure both "investment goodness" and eventual execution success. Having a well thought out schedule that provides the necessary time for execution (including stuff that happens) and implementation is critical for accurate estimating.

3. *Elusive Data*

As with any project, getting the data you need can be time consuming -- *if you can even get it at all!* And once you do get it, can you understand it? Does it make sense? All too often, the data you need up front will be unavailable, ambiguous or hard to get.

4. *Omitted/Incorrect Cost Elements*

There are many cost elements (we will discuss these later) in the typical estimate and omitting any of them, or using the wrong ones, will degrade your accuracy. The better you do at using the all the right ones will vastly improve the accuracy of your estimate. How do you know? Carefully follow the systematic approach in this guide and you will eliminate many of the "careless" mistakes -- generally errors of omission and using incorrect cost elements.

Knowing these challenges exist and anticipating them before you even begin your estimate will vastly improve the quality of your work.

Estimate types

Cost estimating techniques come in two basic flavors. The first is **"Top Down"** or *parametric estimating*. The second is **"Bottoms Up"** or *industrial engineering estimating*.

Each estimate technique has pros and cons.

Top Down estimating is useful and most suitable in the early stages of system development when information is not readily available.

An example of parametric estimating would be using a cost per pound as a Cost Estimating Relationship (CER) and multiplying it by the weight of a proposed new aircraft to get the production cost. The drawback is that the estimate technique relies heavily on the CER, which may or may not be accurate or even applied correctly.

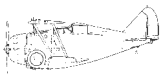
Estimating by analogy is often an excellent choice for ROM estimates. Using this approach costs for a known item is used as a baseline for the new estimate. Then using cost drivers like complexity, differences in material composition, schedule, reliability and any other factors based on what is known for the new item a soundly based estimate can be developed.

Bottoms Up estimating uses a building block approach that works better when more is known about the system to be estimated.

An example of bottoms up estimating would be using a catalog to get the price for COTS hardware for an aircraft and then adding the nonrecurring labor as estimated by all of the various competencies in the organization that will be involved in the upgrade. The drawback of this technique is that a lot of information is needed, much of which is not available during the early stages of a program.

Summary

Just as there are many types of platforms and programs needing estimates, so is there a plethora of methods and elements that comprise a solid cost estimate. Knowing the challenges and the basic approaches *before* you jump in will help.



Chapter 3

'Not everything that counts can be counted, and not everything that can be counted counts.'
-- Albert Einstein

Estimating Methodology

... ain't rocket science

With the preliminaries under our belt, we may proceed to the actual cost estimate itself. This is not difficult, but you do have to take it one step at a time. You have decided which approach you are going to take (Top Down or Bottoms Up, remember?) and you have a pretty good handle on the challenge ahead, right? Well stop right there! Before charging up San Juan Heights with the Rough Riders, take awhile to read through this entire chapter before breaking out your #2 Lead Pencil and trusty calculator.

From whence we came...

Although the cost estimating methodology presented in this guide borrows heavily from the AIR 4.2 Technical Process Universe, we will differ slightly in order to simplify the process. After all, we're looking for a reasonable rough order of magnitude estimate, not the final that will be submitted to OPNAV for APN funding.What follows is an orderly, yet in-depth, step-by-step outline that will build a basic estimate.

Remember -- You will probably have to modify some steps for various reasons, including satisfying funding source criteria.

Cost Estimating Process

Here is a brief overview of the basic cost estimating process used by the pros in AIR 4.2. We've even asked some celebrity cost estimators to explain each of the steps in depth following the outline.

Note: ***This is a strawman! You will need to modify this basic outline as required to fit your specific application.***

1. Do not pass go … *yet!*

Before you spend a lot of time (and money) putting together a cost estimate for a nifty initiative, you'd better ask yourself the most important question -- *Would your initiative actually help the Fleet?*

2. Gather the Facts

Gather all the known facts pertaining to the issue at hand. Try to answer as completely, and succinctly, as possible the 5 W's and the H (Who, What, When, Where, Why and How).

3. Review tasker

With facts in hand, review the original tasker/guidance thoroughly. Which funding source are you targeting and is this initiate appropriate for that source?

4. Draft an executive summary

With facts and appropriateness settled, draft an executive summary that scopes the problem, and the proposed solution, as precisely, succinctly and accurately as you can at this early stage.

5. Get Customer Buy in

Take your executive summary that you so expertly and astutely drafted in the previous step and take it to your "customers," including your resource sponsor, for concurrence. Don't waste precious time – get your buy in ***up front***.

6. Develop a WBS

Having scoped the problem, and gotten support from your customers and resource sponsors, identify the impacted cost elements of your proposed project. We will discuss specifics later.

7. Stop for a Sanity Check

Take the comprehensive list from the previous step and give it a Systems Engineering 'Sanity Check.' Is it realistic? If so, use it to lay out tasks and to develop a Work Breakdown Schedule.

8. Fill in the blanks

Fill in the blanks of costs in the WBS and ***estimate the cost!***

Remember – You will need to do two different ledgers – one for the "As Is" cost (or baseline – if you were to do nothing but maintain the status quo) and the other for the "To Be" cost (the cost of implementing your new idea – be sure to phase in savings, as well as implementation and investment costs).

9. Review your results

Remember the purpose of this estimate – to give you, the non-cost estimator, a rough order of magnitude as to whether or not a particular idea or project was worth further study.

10. Make your go/no-go decision

Interpret your results and make the determination to continue or not. Do you proceed with the funding request/project/actual cost estimate? Your ROM results will help you decide.

From here…

The rest of this manual will flesh out this outline and walk you through the ROM cost estimate. Please read through the entire process before jumping into the process!

Step 1 -- Don't pass go ... yet!

Mr. Potatohead

No Science Fair Projects

The beginning is the best time to ask yourself if your great idea will truly help the Fleet. Or is it just another piece of "Mr. Potatohead Engineering?"

All too often, what we think is a great idea for the Fleet turns out to be just another Science Fair Project -- a really killer display of our technological prowess that just has no real application out in the "Real World."

Goodbye, Mr. Potatohead

How does this happen? How come some really great ideas pass all the way through the cost estimate process and into execution before someone finally realizes that it has no practical application for the customer? Because what passes for Systems Engineering actually is just randomly assembling a Mr. Potatohead -- he needs a mouth, not three arms.

Do your homework and take a hard look at your idea. Ask yourself a fundamental question: ***Does it answer a Fleet need?***

If it doesn't fill a need in the Fleet, then you probably won't get funding for it anyway -- so why waste your time?

-- SUDDEN DEATH WARNING --

So you have a great idea... *Does it fill a Fleet need?* If not, you're wasting time and effort if you proceed. DO NOT PASS GO, DO NOT COLLECT FUNDING

Step 2 -- Gather the Facts

Just the facts, Ma'am

As with any investigation, you must assemble all the pertinent facts.

Sgt. Joe Friday

The problem statement is the most important part of the estimate. It guides the whole shootin' match. So let's get one thing straight -- like Sgt. Friday tracking down yet another dope-addled, runaway teenager, you must gumshoe all the facts you can *before* you even *start* drafting a problem statement.

The ole Inverted Pyramid Scheme

Confronting a blank slate of facts is intimidating! So start easy. One way to get started is with the classic 5 W's and the H. Although yours may vary, here are the usual suspects:

Who Usually your program, team or IPT. Other 'whos' could be your customers, a particular vendor or all Fleet maintainers, for example.

What The new tool, part, process or hire whose cost you will be estimating. Also, the need being addressed.

When A start/end date, time frame, or ?

Where Location (if relevant), either of the specific part, or of the effort ("In house" for example)

Why Perhaps the most important -- the compelling justification for your good idea or project.

How The means by which you will implement, produce, or otherwise bring your idea to fruition.

Remember to keep them* BRIEF *and* SUCCINCT *... for now

Step 3 -- Review the Tasker

Hold the phone, Robin!

Even Gotham's caped crusader waited for instructions from the mayor before charging off to fight evil with the ole Wham! Sock! Pow!

Batman

So, fellow cost fighter, you have the facts. Is the situation well in hand? Time to leap into the Batmobile and charge off into the cost-estimating sunset? Not so fast.

Avoid a Wholly Wasted Effort, Batman!!

With your facts in hand, and before you proceed, this is an excellent time to **review your tasker carefully**. Do the facts lend themselves to the funding source you're going after? From just a cursory look at the plain facts, do you still even have a case? If no to either one, you may as well quit here before you waste any more time and effort.

There is a veritable plethora of funding sources you can use to fund a good project -- OSIPs to SBIRs to name just a couple in the alphabet soup. You must ensure at this step that your facts **lend themselves to the funding request format** you will be pursuing. Also helpful is making sure the facts are even **appropriate for the type of funding you need**. For example, if your facts support an upgrade to an existing platform, you can't target R&D or O&M, N funding.

You should also look at success rates of prior attempts to gain funding through a given source. Are there lots of projects chasing very limited fundings – or is there a real potential to obtain the funding needed?

If your facts lend themselves to the format and intent of the funding source you're targeting -- Congratulations, proceed!

Step 4 -- Draft the Executive Summary

You may fire when ready!

You've prepared by collecting and reviewing the facts. All is in order. So proceed into Manila Bay and make history!

Adm George Dewey

Admiral George Dewey didn't just show up in Manila Bay one day with the Asiatic Squadron. His successful attack on the Spaniards came about after he had reviewed his ships and strategy and found them in compliance with his orders.

Success begins with the details

With the facts sorted and the appropriateness determined, now you may draft an executive summary that not only scopes the problem, but also the proposed solution for which we are estimating the cost. A good summary will keep you focused on what is going to be estimated and eliminates tangents. It also acts as an informal agreement with the customer as to what will be included in, and excluded from, the estimate. A primary reason that the estimate costs more than expected is a changing problem statement. You must be concise and accurate.

The major element of your executive summary will be your **accurate description of the baseline** -- the "As Is." This is where you will lay out the current situation in all it's ugliness and gore and upon which you will build the rest of your analysis. How are you planning to substantiate the impacts of your initiative? What type of data, test results, engineering analysis, etc. are needed to substantiate a benefit in terms of future cost savings/avoidances? If you have no concept of how to do that or are planning to use a WAG (Wild Ass Guess), ensure that there is enough science and logic in your approach to transform that WAG into a reasonable Scientific Wild Ass Guess (SWAG).

Step 5 -- Get Customer 'Buy-In'

May the Fleet be with you

So what you have a nifty new light saber upgrade? If the Fleet doesn't want it, or your resource sponsor won't fund it, your project is headed for the Dark Side at warp speed.

Obiwan Kenobi

Once you have an expertly crafted executive summary that lays out the problem, the solution and accurately assesses the "As Is" of your project, take it to your real customer, i.e., the Fleet, for concurrence. Don't waste time or funding -- your idea or technology may be great, but there's not much point to it if the customer doesn't need it, want it or like it.

No bucks, no Buck Rodgers

Don't forget your resource sponsor! Whether at the OPNAV, PEO or PMA level, if the controller of the purse strings ain't hip to your jive ... Well, it would just stink to suddenly find yourself transported to the center of a black hole, wouldn't it? At the very least, you may come away with useful input with which to tweak your estimate.

'All the technology in the world can't help you if you stink.'

-- Bill Wasserberger

Getting customer buy-in for your executive summary/problem statement will prevent you from looking stupid through submitting a finished estimate and proposal that stinks.

Step 6 -- Develop a WBS

Begin the Beguine!

Benny and the boys are all here, you've got the facts, the executive summary, and the customer is on board -- you are ready to start breaking it down and building it up. Let's Dance!

Benny Goodman

We'll get into the swing of things and jitterbug into the down and dirty, nitty gritty world of Cost Estimating. Now you will actually begin creating your Work Breakdown Structure. The WBS is also referred to in the cost estimating world as an Estimating Breakdown Structure.

Ah, our old friend, the WBS!

When determining a cost estimating structure it is critical to envision all of the phases of your planned project and what types of costs are expected to be incurred by phase. Since most initiatives that propose benefits to the fleet in terms of increased capability, improved readiness and/or reduced cost of operations impact Operations and Support costs those elements of costs must also be identified. One excellent reference that describes not only the categories of cost impacted but also some estimating strategies is the NAVAIR Cost Department Maintenance Trade Guidebook found at URL below; http://www.navair.navy.mil/air40/air42/Overview/reference/reference.html.

The simplified cost structure provided in the table on the next page has been extracted from the guidebook. As a simple rule of thumb, all initiatives can be expected to have costs for at least

some of the elements in the table. For most initiatives you as the originator must be concerned not only with the Research and Development associated Design costs but also for costs for testing, production and installation.

ACQUISITION COST:
Design
Production
Installation
ACQUISITION ILS COST :
LSA/Maintenance Planning
Supply Support (Spares)
Support Equipment
Technical Data
Training
Facilities (Avionics) Facilities (Engines, Air Frames)
Packaging, Handling, Storage & Transport
OPERATING & SUPPORT COST:
"O" Level Maintenance Personnel
AVDLR & Contractor Depot Repair
"I" Level Maintenance Personnel
"I" Level Material
Recurring Facility Costs
Support Equipment Maintenance
Software Maintenance
Recurring Training Cost
Program Support

If the initiative requires a different support philosophy you must address the relevant logistics element costs. Finally, if there is to be a pony in this particular barn, call it Return on Investment -- you will expect some reduction on the Operating and Support phase costs.

Please note that "O" and "I" level personnel costs can be measured in terms of reduced work hours.

The other areas most likely to impacted by Cost Reduction initiatives are tied to more reliable systems and would most directly impact depot component repair costs (AVDLR) and maintenance consumables. The single most common failure of most initiatives is to ignore many of the implementation costs. In the long run, this will likely make your project unexecutable (and thus a failure) because the appropriate funding by appropriation (RDT&E, APN, WPN, O&MN) has not been identified.

-- SUDDEN DEATH WARNING --

Be sure you know, and account for, any restrictions associated with these funding sources.

***Funding is tough to get, but it's easy to lose if you're* STUPID.**

Step 7 -- Stop for a "Sanity Check"

Would you bet your life?

"He may look like an idiot and talk like an idiot but don't let that fool you. He really is an idiot."

Groucho Marx

By now, you've decided your initiative actually addresses a Fleet need, compiled an exhaustive list of all the elements of your proposed project that are going to cost money, scrubbed them against the restrictions associated with the funding source you're going after, and you developed a WBS/EBS. Time to start plugging in the numbers? **No!** This is a good time to keep yourself from actually being an idiot.

Waiter! Sanity check, please!!

Take your carefully crafted WBS that you've put so much time into and give it a good, hard systems engineering review. Even if you're not a systems engineer, give it a good going over, now that you've put it all together, and ask yourself a simple question -- ***is this doable?*** Is it realistic, given the parameters of the tasking, the restrictions of the sought-after funding sources and the resources available to you to make it work?

Or, will the WBS you've put together merely give you meaningless data? Better find out now while you can still tweak your WBS or list of cost elements.

Does it pass? No? Excellent! -- You won't look like an idiot later. Review your work to see where you strayed from the tasking. If yes, congratulations! Start planning your work schedule to make it happen.

Step 8 – Do the math

It's not a moon launch

Wernher Von Braun

You may be a rocket scientist, but that doesn't mean you have to overly complicate things. By now, the work is done. Plug and chug into your WBS using math skills you learned in the First Grade and enjoy the boost into orbit!

Okey dokey, Wernher, Here's the math part – Take your WBS and work it. With your list of cost elements in one hand, trusty ole No. 2 in the other, plug and chug those numbers! Fill in the blanks of costs in the WBS and – here's the fun part! — estimate the cost!

Cooking two sets of books...

Remember – You will need to do two different ledgers – one for the "As Is*" cost (or baseline – if you were to do nothing but maintain the status quo) and the other for the "To Be*" cost (the cost of implementing your new idea – be sure to phase in savings, as well as implementation and investment costs).

You should be able to subtract the "To Be" cost total from the "As Is" cost total and get a positive number. The bigger the number, the higher the probability you will get funding to proceed. Within reason, of course. If your number is either a negative number, or ridiculously high, recheck your math. If your outcome is clearly negative, then congratulate yourself for saving your program a lot of wasted time, effort and funding!

**** Read the next chapter on how to prepare the "To Be" estimate***

Step 9 -- Are you pumped up?

You'll be baaaaaaack

You've gotten this far, now it's time to make sure you can go the distance. Are you ready to face your program manager? Better make sure you have a robust estimate!

Arnold Schwartzenegger

Assuming you got what you were looking for in the last step, are you done? Is it time to declare victory? Not quite. Just because this rudimentary cost estimate ***indicated*** you ***might*** be onto a good idea, don't go rushing off to cut metal just yet.

Send your estimate to the gym

An *effective* cost estimate is a **robust** one. Like Arnie, a robust estimate is pumped up and ready for action. Here are some tips to make sure your estimate is as strong as it can be:

- Relevant elements need to be **scrubbed against Appendix A** (A common mistake is leaving out a major cost driver). Only then should you be bold and identify the dominant elements in the estimate.

- A robust estimate will **suggest a certain course of action**, even if that action is no action (You followed the first 8 steps, ***didn't you?***)

- Once uncertainty in the estimate has been minimized, **rank** the **alternatives** according to **expected savings**.

Identity check ...

Once your estimate comes back from the gym, it'll be rippling with shirt-tearing muscles like you wouldn't believe. But is it Mr. Universe or Mr. Potatohead? Answer thee these questions three, 'ere the other side ye see!

* Was the estimate prepared with the best possible information?

* Was the correct rationale, cost estimating techniques, and logic applied to the cost data, and is the math correct?

* Was the estimate done in good conscience, or was it done with the intent to mislead the customer to take a course of action not in the best interests of the program?

* Were correct reliability data used? A huge problem in many estimates is associated with using laboratory-type testing reliability (or even worse, specification values) as the predictor for actual fielded experience. Since component failures largely drive O&S costs it is critical that R&M projections be derated to reflect likely field experience in our hostile maintenance environments.

This simple checklist should help in providing a self-assessment to your cost estimate.

It's all in the format

If it is, now would be a good time to put your estimate numbers into the appropriate template for whichever funding source you will be pursuing (CREI, COSSI, etc).

-- SUDDEN DEATH WARNING --
Regardless of the template, ***READ*** the ***INSTRUCTIONS!*** The appendices include some information on the common pitfalls of each funding source request template.

Step 10 -- Saddle up!

Sgt. Stryker, USMC

Now the real work begins

Just where do you think you're goin'? You're not done. It's not over, yet. You may not have started this war, but you're going to finish it! It's time to…

Hit the beach!

And you thought you were done! You're only just at the end of the preliminaries! Remember, all you've done to this point is produced a rough order of magnitude estimate that tells you whether or not pursuing your particular idea or project is feasible -- nothing more. The estimate you've produced by following the steps laid out in this booklet is NOT to be used for anything beyond helping you (or your program) decide if further investigation is warranted.

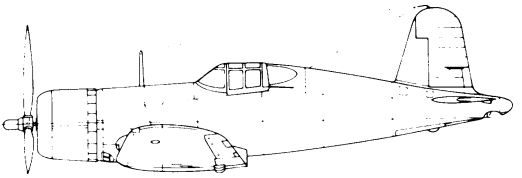
Now get busy!

If your numbers look good and it seems that your particular project is feasible, use cross checks to validate your findings. Far too many estimates fail because they yield the *desired* (by the program manager) results rather than the *most likely* results. Use as many data sources as possible, but make sure they are reliable and credible prior to delivering the estimate.

Lastly, you will probably have to present (and defend!) your estimate to your customer and management. Now is the time to advocate the results of the estimate and the decision(s) that should be made. This is also the time to answer all of the questions as to how the estimate was prepared and where the information came from. A successful defense of the estimate yields credibility. Unfortunately, the opposite is also true.

Summary

Up to this point, you've seen the basics of cost estimating, and the rudimentary steps involved in developing a rough order of magnitude cost estimate. Using the remaining chapters, as well as the specific examples and pointers in the appendices, take the basic steps and flesh them out according to your specific need.



Chapter 4

'Whether 'tis nobler in the mind to suffer the slings and arrows of outrageous fortune, Or to take arms against a sea of troubles, And by opposing end them?'

-- Hamlet Act 3, Scene 1

Preparing the "To Be"

... The heart of the matter

Unlike Hamlet, *your* program's funding stream probably couldn't be characterized as an outrageous fortune (else why would you be concerned with such plebeian endeavors as concocting cost estimates?) Thus, accurately predicting the costs of a proposed initiative will save you from a sea of troubles when it comes time to advance your initiative to the King (or your program manager, as the case may be...). How will he receive you? As Polonious the schemer, Yorick the jester or Horatio the trusted aide? It all depends on the accuracy of your "To Be" -- ***that is the question!***

Two types of cost...

Because you should already know what your "As Is" costs are (If you don't, then this is all rather pointless, isn't it?), we'll dispense with that and go right to the finer points of the "To Be" estimate.

The estimate of "To-Be" costs shows the costs for the situation that will occur when the initiative is implemented.

These costs are of two types: Recurring and non-recurring (Investment costs). **Recurring costs** are those costs associated with acquiring the actual assets to be fielded in establishing the support system. Both types of expenses represent investment (acquisition). **Non-recurring costs**, on the other hand, constitute those types of activities that are involved in the planning and development stages. Typically, these costs consist of the research and development efforts associated with defining, design engineering, prototyping and testing a new item or process. These efforts must be successfully completed in order to implement an initiative.

Estimating recurring costs

The cost elements that should be estimated for the "To-Be" *recurring* estimate are only those that will be impacted by the subject initiative. Therefore the elements selected should be the *same* as those selected for the "As-Is" estimate. Costs for elements not affected by the initiative should not be estimated.

Remember that the evaluation of initiatives is a comparative process, with the objective of determining what the likely cost savings will be. This can only be done if the estimates of baseline and initiative costs contain the same cost elements. A list with definitions of possible cost elements is contained in Chapter 6, which you should have also used in preparing the "As-Is" baseline.

Time period, schedule and phasing

Costs should be estimated for the period specified by the particular call for initiatives. If the instructions state that costs should be presented for Fiscal Years 2002 through 2011 (for example), then those are the years for which costs must be estimated.

If your initiative does not have a positive payback until after the designated period, do not submit the initiative. The reviewing board will not consider proposals that extend beyond the designated period of consideration. Remember that costs must be estimated for the same years for both the Baseline and the implemented Initiative.

Costs shown in the "To-Be" estimate must be consistent with the implementation schedule developed for the initiative. If a decrease in maintenance costs is going to result because of the installation of a more reliable avionics component, the annual "to-be" maintenance costs should reflect those maintenance costs generated by that portion of the older equipment which is still being used plus the maintenance costs of the newer avionics components as they are phased in.

The time phasing of the initiative is very critical. Potential cost savings and avoidances, the As-Is cost –the To Be cost should realistically reflect the schedules for implementation and installation.

If, for example, an improved system will not be installed before the third year of the period being evaluated, no savings due to this system should be shown before that date. Cost savings and avoidances must track with the proposed schedule for shown in the POA&M.

Savings methodology

Your initiative must show clearly **how** and **why** you expect to have cost savings and avoidances. Basically this means that your reasons for expecting these savings are reasonable and are documented, *and* that an outside reviewer can track and duplicate your results (if necessary).

Here's a few tips to remember:

- **Calculations used for estimating savings** should be explained and track with the explanations provided in the narrative. If, for example, a 15% reduction in man-hours is claimed, then the 15% reduction should be seen in the "To-Be" spreadsheet; not 14% or 16%.

- **Data should be normalized** for the appropriate Fiscal Year, expected number of aircraft, flying hours, sites, maintenance actions, etc. All data must be consistent and comparable with that provided in the "As-Is" estimate.

- **Claimed reductions in cost should be realistic.** For example, reductions in workload at the O or I level will probably not result in a reduction in billets, so reductions in billets should not be claimed.
- **All calculations should be checked for accuracy**. *Errors in fourth-grade math are among the most common errors found in initiatives.* Make sure that figures presented in the narrative, spreadsheets and templates are in agreement.

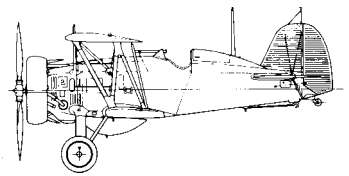
Documentation

Your assumptions for cost savings/avoidances should be supported by as much good documentation as possible. The requirements are similar as those for the "As-Is" estimate, although they usually cannot be as firmly justified, as they represent a situation that has not yet occurred. Nevertheless, you should present sufficient evidence to show that your planned savings are achievable and credible.

Sources of good documentation include:

- Experience with previous like/similar initiatives;
- Vendor/contractor quotations;
- "Bottoms-up" engineering estimates;
- Detailed studies of the situation;
- Results from similar initiatives by other services or commercial enterprises;
- Carefully considered judgement from recognized experts in the subject areas;
- Estimates based on accessible and credible data sources, whether from the Navy, DOD or industry sources.

While it is not necessary to include all details in the documentation, there should be sufficient information provided to allow the evaluator to check your sources.



Chapter 5

'The lessons folks most need to learn in life ain't fun to learn.'

-- Barney Fife

Common Mistakes

To paraphrase Gen. George S. Patton, true success doesn't come by learning from your mistakes. Real success comes from learning from the *other guy's* mistakes. Making your own mistakes, while bracing, just ain't fun as Deputy Fife so eloquently points out.

A word of warning

In the introduction and throughout this booklet, we stress the importance of providing a credible estimate. In the interest of reducing the number of errors, we have provided the following list of common errors and mistakes found in previous estimates. A word of warning! ***Check your work before you submit your estimate.*** Here's a list of the 12 most common mistakes seen in preliminary cost estimates:

1. **Errors in arithmetic** – Numbers do not add up correctly, mistakes in simple calculations.

2. **Estimates of the Total Investment required** and the Total Cost Avoidance shown on the title page of the narrative do not agree with estimates shown in the narrative and /or do not agree with estimates displayed in the spreadsheet template.

3. **Failure to use specified formats** and templates.

4. **Failure to use designated rates,** factors and dollars.

5. **Failure to identify rates**, FY dollars and other factors used in preparing the proposal.

6. **"Recycling" of proposals** without taking into account changes in formats, rates, and time period.

7. **Failure to provide a credible cost performance baseline**; sources of costs are not identified, calculation methodology not given or incorrect, projections of usage and demand do not reflect the probable future course of a program.

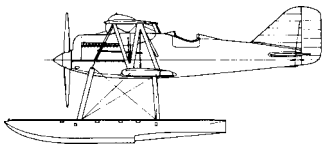
8. **Failure to provide a credible estimate** and methodology for investment costs, particularly for government efforts and Non-Recurring Engineering.

9. **Failure to provide a credible justification** for basic proposal assumptions.

10. **Failure to provide a clear explanation** of just what the initiative proposes to do and how implementing the initiative will result in a cost avoidance.

11. **Failure to adjust projected cost avoidance** to the proposed schedule shown in the narrative. An example would be taking full credit for cost avoidance in the first year an initiative is funded when the schedule shows it will take several years for the initiative to be fully implemented.

12. **Failure to provide the methodology** used for calculating cost savings or, providing it in such a way that the results cannot be replicated by the examiner.



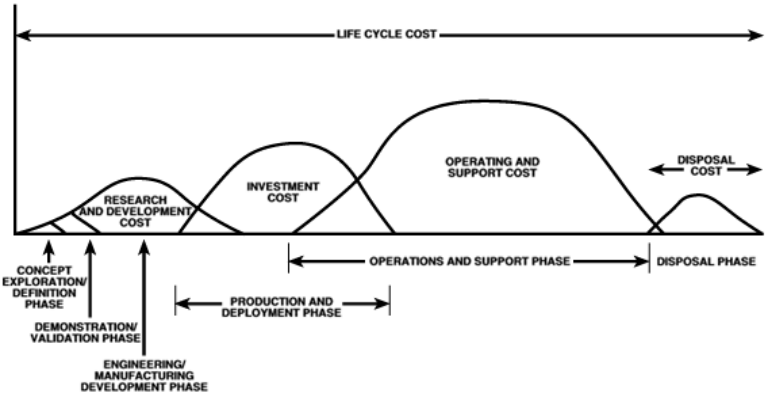
Chapter 6

Cost Elements

Earlier in this guide, we walked you through the process of assembling a WBS containing all the cost elements associated with your particular initiative. In this appendix, we'll detail what some of those costs elements actually all. Not all will apply in every case, but these are provided to give you an idea of what major cost elements typically go into a cost estimate. From this list, you can make your own.

Lifecycle Phases

To begin the process of developing a comprehensive list of cost elements for your WBS, it may help to organize them according to the typical lifecycle of an aircraft platform or component, depicted in the illustration on the next page. Following that is a discussion of each phase, and a detailed list of cost element definitions for each phase.



Research and Development Costs

Consists of costs incurred from program initiation at Concept Demonstration and Approval (Milestone I) through the Engineering and Manufacturing Development phase. Includes costs of feasibility studies; modeling; trade-off analyses; engineering design; development, fabrication, assembly, and test of prototype hardware and software; system tests and evaluation; system- specific support equipment; and documentation.

Investment Costs

Consists of costs incurred during the Production and Deployment phase (from Milestone III though completion of deployment). Encompasses costs associated with producing, procuring, and deploying the primary hardware and directly associated hardware and activities, such as system-specific support equipment, training, data, initial spares, and military construction.

Operations and Support

Includes all costs of operating, maintaining, and supporting a fielded system. Encompasses costs for personnel; consumable and repairable materials; organizational, intermediate and depot maintenance; facilities; and sustaining investment. The O&S phase overlaps with the Production and Deployment phase. O&S costs are incurred in preparation for and after a system's fielding and continue through the end of the system's useful life.

Disposal

Captures costs associated with deactivating or disposing of a military system at the end of its useful life. These costs typically represent only a small fraction of a system's lifecycle cost and are excluded from most analyses. The main exceptions (for which estimates must be provided) are disposal of nuclear waste, missile propellants, and other materials requiring detoxification or special handling.

Research and Development Cost Elements

Design and Development -- *Hardware/software cost per year*

The nonrecurring cost of hardware/software associated with the design and development of your initiative.

Source: Manufacturer, IPT

Tests -- *Engineering cost per year*

The engineering costs associated with development.

Source: Manufacturer, IPT

Tests -- *Operational cost per year*

Operational test costs associated with Navy/Marine Corps acceptance.

Source: Manufacturer, IPT

Investment Cost Elements

Production Quantity Cost -- *Not used in baseline*

The production cost associated with manufacturing items for eventual installation -- does not include spares.

Source: Manufacturer, IPT

Special Labor Costs

The labor cost to install the alternative item.

Source: IPT

Spares: Wholesale or Retail -- *Quantity/Cost*

There are two types of spares to consider when forecasting sparing levels:

Retail -- Initial spares secured at the site(s) to support operational aircraft and intermediate-level repair activities at that site.

Wholesale -- Additional spares required to fill the standard depot repair pipeline. Whereas retail spares are site driven, wholesale spares are event driven and fill the expected demand for an item during its depot repair turn around time (TAT).

Source: NAVICP; WSPD; NALDA

Logistics Support Analysis

Cost for the government and contractor to explore alternatives and to develop the maintenance concepts/requirements for the life of the item. The final outcome of this process is the maintenance plan.

Source: APML; CELSA model

Support Equipment -- *Development & Production*

The cost of all equipment required to support the operation and maintenance of the item. Only Peculiar Support Equipment cost should be included in the element.

Source: SERMIS; NAVICP; AUTOSERD; FEDLOG

Technical Data

Technical data and publications cover technical or maintenance information recorded in any form or medium. Technical data consists of written instructions, drawings, operating & maintenance manuals, specifications, inspection, test and calibration procedures, manufacturing process data, and documentation of computer programs & software.

Note: Modifications and changes to existing manuals are an acquisition cost.

Source: NAVAIR; NATSF

Training -- *Coursework/Equipment*

The processes, procedures, techniques and equipment used to train personnel to maintain the item.

Source: NTP; PMA-205; NAMTRAGRU

Facilities

Real property assets required to support the item, including conducting studies to define facilities or facility improvements, locations, space needs, utilities, environmental requirements, real estate requirements and equipment.

Source: NAVFAC; NAVAIR; OASD (A&L)

PHS&T -- *Containers*

The resources, processes, procedures, design considerations and methods to ensure that all system, equipment and support items are preserved, packaged, handled and transported properly. Reflects the initial shipment of items and the cost of procuring containers to safely transport the item.

Source: NAVICP

Other Acquisition Logistic Support Costs

Any acquisition cost that does not fit into the above ILS elements.

Operating & Support Cost Elements

Labor -- *O & I-level*

The pay and allowances of military and civilian personnel who maintain and support assigned aircraft, associated support equipment and unit-level training devices. Depending on the maintenance concept and organizational structure, this element will include maintenance personnel at the organizational level and possibly the intermediate level.

Source: VAMOSC ATMSR; NALDA

Materials -- *O & I-level*

The costs of material consumed in the operation, maintenance, and support of an aircraft system and associated support equipment at the unit level.

Source: VAMOSC ATMSR; DFAS-CL

Aviation Depot-Level Repairables

The cost of off-aircraft component repair at the depot.

Sources: VAMOSC NAMSR, LMDSS, NALDA, FEDLOG

Depot Level Maintenance

Depot maintenance includes the cost of labor, material, and overhead incurred in performing major overhauls or maintenance on aircraft, their components, and associated support equipment at centralized repair depots, contractor repair facilities, or on site by depot teams. Some depot maintenance activities occur at intervals ranging from several months to several years. As a result, the most useful method of portraying these costs is on an annual basis (e.g., cost per aircraft system per year) or an operating-hour basis.

Depot Level Maintenance -- *Labor*

The cost of military and civilian human resources supporting aircraft at the depot level. Activities can include calibration, repair, testing and replacement of parts, components or assemblies, and technical assistance.

Source: AIR 4.2 Guidance; NIFMS

Depot Level Maintenance -- *Materials*

Cost of repair parts, assemblies, subassemblies and material consumed in the depot-level maintenance and repair of the item.

Source: NIFMS

Depot Level Maintenance -- *Surcharge*

The cost of the applicable NAVICP surcharge, which changes annually.

Source: NAVICP; NAVSUP

Depot Level Maintenance -- *Recurring Transportation*

Reflects the cost to transport items to and from depot facilities to operating sites.

Source: NAVICP; Contractor proposal

Depot Level Maintenance -- *Recurring Facility*

The cost of personnel pay and allowances, material and utilities needed for the maintenance and operation of the depot repair facility.

Source: Contractor proposal

Support Equipment Maintenance

Costs associated with the maintenance of equipment needed to operate or support the item.

Source: NAVICP; NAWCAD

Software Maintenance

The cost of maintaining software needed to operate or support the item.

Source: Software Support Center

Recurring Training

The cost of instructors preparing for, including teaching materials, and teaching classes to educate maintenance personnel how to perform repairs.

Source: PMA-205; NTP; NAMTRAGRU

Program Support

All NAVAIR TEAM personnel support costs that can be attributed to the item.

Source: APML

Disposal Cost Elements

Disposal

The cost of disposing of the item at the end of its lifecycle.

Source: APML

For further reference

For a more complete reference on cost elements, please refer to the ***OSD Cost Analysis Improvement Group Operating and Support Cost-Estimating Guide***, located online at

http://www.dtic.mil/pae/

Also see the following web sites:

https://www.nalda.navy.mil/3.6.2/lmdss/

http://www.navyvamosc.com/