

Program Acquisition Cost (PAC) Template

Horace White, Jim Cain, Raymond Garrido

Introduction

Background

The Program Acquisition Cost (PAC) template was developed by a young and upcoming cost group to bring structure and organization to developing and maintaining defendable cost models. The Naval Information Warfare Center (NIWC) Pacific cost group began in 2006 with a memorandum of agreement between Space and Naval Warfare Center (SPAWAR) headquarters and the NIWC group. The NIWC cost group began to grow although some of the earliest members of the group transferred to SPAWAR headquarters. The NIWC cost group was mostly made up of transfers from other technical codes within NIWC, private sector hires with careers not directly related to cost analyses, and Naval Acquisition Development Program (NADP) straight out of college.

Problem Statement

In the beginning of the NIWC cost group, there were as many cost models as cost analysts. New analysts had to struggle with finding a model which was easy to understand, easy to maintain, and could cover all the requirements of the program office/sponsor and the SPAWAR 1.6 cost estimate review process. In addition, many analysts spent a significant amount of time ensuring all the cost data was rolling up the WBS structure correctly and the output reports had the correct equations.

The Goals

Goal 1: More Time on Analysis / Less Time on Modeling

The NIWC Cost group decided to develop a cost model which would allow cost analysts to maximize the time spent on data gathering, data scrubbing, data analysis, and analysis implementation, and minimize the time spent on cost model construction and tedious equation updates.

Goal 2: Similar Look and Feel

The NIWC group is working capital funded. Therefore, analysts need to be able to move from one program to another and be useful as quickly as possible. The NIWC group did not want an analyst worrying about how the cost model for a particular program is constructed and how to make updates. Instead an analyst should maximize time on the program details and continuing to gather related cost data.

Goal 3: Rapid Generation

Create a template which is in essence a shell cost model. Data analysis can be transferred over, properly phased, and all the desired output sheets are immediately available.

Implementing the Plan

As the NIWC analysts began to piece together the cost model flow, the next step was to solve the first goal. What steps could be automated by VBA code? And as a result, what would need to be standardized in order for those steps to be automated? To be perfectly honest, we fumbled through this discovery for quite some time. Looking back at the numerous iterations and corresponding improvements to the PAC template makes us realize how long a seemingly simple solution takes to unfold. Figure 3 shows what is generated by the analyst and what is automated using VBA code.

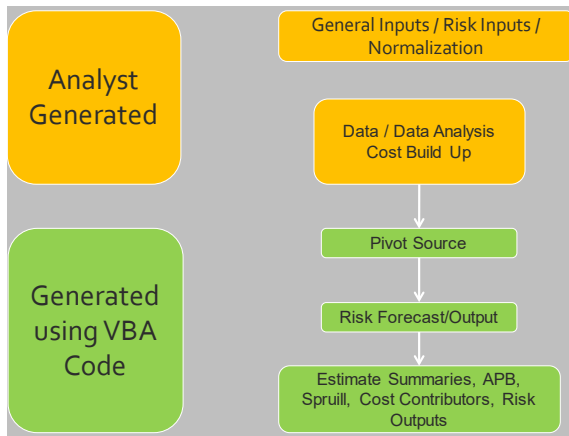


Figure 3 Cost Model Flow – Analyst Generated / VBA Code Generated

Generated using VBA Code (Automation)

Pivot Source

The Pivot Source was decidedly the first step in the automation process. The cost data already existed, just in different locations within the cost model. The VBA code could be written to thumb through the workbook looking for cost build up sheets and collects the data into one Pivot Source table (See Table 1 for an example). Each line item represents one year of cost data for one cost element. In other words, Table 1 is the Pivot Source representation of Table 2.

Year	BY \$K	TY \$K	WBS!	Description	APPN	Method	Performer	Variant	Group	Source Worksheet	WBS Level 3	WBS Level 2
2019	2,344	2,592	1.1.1	System Y Procurement	OPN	Analogy	KTR	V-2	PB Systems	Procure & Install	1.1.1 - Hardware	1.1 - Prime Mission Product
2020	2,344	2,644	1.1.1	System Y Procurement	OPN	Analogy	KTR	V-2	PB Systems	Procure & Install	1.1.1 - Hardware	1.1 - Prime Mission Product
2021	2,344	2,696	1.1.1	System Y Procurement	OPN	Analogy	KTR	V-2	PB Systems	Procure & Install	1.1.1 - Hardware	1.1 - Prime Mission Product
2022	2,344	2,750	1.1.1	System Y Procurement	OPN	Analogy	KTR	V-2	PB Systems	Procure & Install	1.1.1 - Hardware	1.1 - Prime Mission Product
2023	2,344	2,805	1.1.1	System Y Procurement	OPN	Analogy	KTR	V-2	PB Systems	Procure & Install	1.1.1 - Hardware	1.1 - Prime Mission Product
2024	2,344	2,861	1.1.1	System Y Procurement	OPN	Analogy	KTR	V-2	PB Systems	Procure & Install	1.1.1 - Hardware	1.1 - Prime Mission Product
2025	-	-	1.1.1	System Y Procurement	OPN	Analogy	KTR	V-2	PB Systems	Procure & Install	1.1.1 - Hardware	1.1 - Prime Mission Product
2019	-	-	2.4.3	System Y Install	OPN	Analogy	KTR	V-2	PB Systems	Procure & Install	2.4.3 - System Installati	2.4 - Platform/Site Activation/Installation
2020	652	735	2.4.3	System Y Install	OPN	Analogy	KTR	V-2	PB Systems	Procure & Install	2.4.3 - System Installati	2.4 - Platform/Site Activation/Installation
2021	652	750	2.4.3	System Y Install	OPN	Analogy	KTR	V-2	PB Systems	Procure & Install	2.4.3 - System Installati	2.4 - Platform/Site Activation/Installation
2022	652	765	2.4.3	System Y Install	OPN	Analogy	KTR	V-2	PB Systems	Procure & Install	2.4.3 - System Installati	2.4 - Platform/Site Activation/Installation
2023	652	780	2.4.3	System Y Install	OPN	Analogy	KTR	V-2	PB Systems	Procure & Install	2.4.3 - System Installati	2.4 - Platform/Site Activation/Installation
2024	652	796	2.4.3	System Y Install	OPN	Analogy	KTR	V-2	PB Systems	Procure & Install	2.4.3 - System Installati	2.4 - Platform/Site Activation/Installation
2025	652	812	2.4.3	System Y Install	OPN	Analogy	KTR	V-2	PB Systems	Procure & Install	2.4.3 - System Installati	2.4 - Platform/Site Activation/Installation

Table 1 Pivot Source Example

WBS!	Description	APPN	Method	Performer	Variant	Group	Total	2019	2020	2021	2022	2023	2024	2025
1.1.1	System Y Procurement	OPN	Analogy	KTR	V-2	PB Systems	\$ 14,062	\$ 2,344	\$ 2,344	\$ 2,344	\$ 2,344	\$ 2,344	\$ 2,344	\$ -
2.4.3	System Y Install	OPN	Analogy	KTR	V-2	PB Systems	\$ 3,912	\$ -	\$ 652	\$ 652	\$ 652	\$ 652	\$ 652	\$ 652
End of Table							Total	\$ 17,974	\$ 2,344	\$ 2,996	\$ 2,996	\$ 2,996	\$ 2,996	\$ 652

Table 2 Cost Build Up Example

Table 2 is the typical standard representation of a cost build up table as mentioned in Figure 3, but we will come back to this later.

Risk Forecast/Output

The Forecasts are a subset of the Pivot Source and that subset is driven by the Outputs. After analyzing the outputs, it was determined the forecasts would be need to be categorized into three groups as seen in Table 3.

Total by Appropriation

The first group is total by appropriation which serves three purposes. The first purpose is to crosscheck the lower two levels. The second purpose is to produce the all-important S-Curve chart. The third is to reconcile the deltas in Monte Carlo simulations if using percentiles. An interesting topic which is outside the scope of this paper.

Total by Appropriation, by Year

The second group is divided by appropriation and by year and by far the most useful for many of the high-level reports generated. For example, the Spruill, ACAT Status, Estimate Summaries, Estimate Tracker rely on cost output at this level.

Total by Appropriation, by Year, by WBS

Data by WBS is mostly used for data drills when risk adjusted cost data is required. Some cost models can set the assumption distribution to a desired percentile or mean to approximate the Monte Carlo simulation. This is also an interesting topic and outside the scope of this paper. The data at this level is also used to show risk adjusted cost contributors.

WBS	BY or TY	APPN	FY	Point Estimate	Mean	StdDev	0%	50%	100%
	TY	OPN	To Go Total	20,989	23,561	1,061	20,916	23,511	26,864
	BY	OPN	To Go Total	17,974	20,026	894	17,795	19,983	22,811
	TY	OPN	2019	2,592	2,592		2,592	2,592	2,592
	TY	OPN	2020	3,379	3,324	168	2,905	3,316	3,848
	TY	OPN	2021	3,447	3,391	172	2,963	3,382	3,925
	TY	OPN	2022	3,516	3,458	175	3,022	3,450	4,003
	TY	OPN	2023	3,586	3,528	178	3,083	3,519	4,083
	TY	OPN	2024	3,658	3,598	182	3,144	3,590	4,165
	TY	OPN	2025	812	3,670	186	3,207	3,661	4,248
2.1.1	TY	OPN	2019	2,592	2,592		2,592	2,592	2,592
2.1.1	TY	OPN	2020	2,644	2,644		2,644	2,644	2,644
2.1.1	TY	OPN	2021	2,696	2,696		2,696	2,696	2,696
2.1.1	TY	OPN	2022	2,750	2,750		2,750	2,750	2,750
2.1.1	TY	OPN	2023	2,805	2,805		2,805	2,805	2,805
2.1.1	TY	OPN	2024	2,861	2,861		2,861	2,861	2,861
2.1.1	TY	OPN	2025	-	2,919		2,919	2,919	2,919
2.3.4	TY	OPN	2019	-					
2.3.4	TY	OPN	2020	735	681	168	261	673	1,204
2.3.4	TY	OPN	2021	750	694	172	266	686	1,228
2.3.4	TY	OPN	2022	765	708	175	272	700	1,253
2.3.4	TY	OPN	2023	780	722	178	277	714	1,278
2.3.4	TY	OPN	2024	796	737	182	283	728	1,303
2.3.4	TY	OPN	2025	812	751	186	288	743	1,329

Table 3 Risk Forecast/Output Example

Most, if not all, Monte Carlo Simulators that work in Excel are written in VBA code and have a developer's kit for users to utilize. The developers kit will allow VBA code to set up a forecast along with all the outputs as desired. The PAC template builds Table 3 and sets up all the forecasts to output data such as the Mean, Standard Deviation, and percentiles when the simulation is run.

Cost Model Outputs

The cost model outputs were the last objects to be drawn into the automation by VBA process. Having the Pivot Source and Risk Forecast/Output automated with a standardized format allows all the cost model outputs such as the Spruill, APB Section C, etc. to be automated with VBA code.

Analyst Generated

In order for the code generated portion of the model to be successful, the PAC template needs four areas of standardization. The Normalization format, Key General Inputs, Risk Assumptions, and the Cost Build up table (see Table 2).

Normalization

RAW	2013	2014	2015	2016	2017	2018	2019
RDTEN	0.9320	0.9459	0.9563	0.9678	0.9842	1.0000	1.0169
OPN	0.9319	0.9459	0.9563	0.9678	0.9843	1.0000	1.0170
OMN	0.9329	0.9432	0.9530	0.9646	0.9821	1.0000	1.0090

WIEGHTED	2013	2014	2015	2016	2017	2018	2019
RDTEN	0.9442	0.9574	0.9692	0.9857	1.0021	1.0194	1.0383
OPN	0.9513	0.9636	0.9766	0.9922	1.0090	1.0268	1.0463
OMN	0.9371	0.9465	0.9563	0.9690	0.9865	1.0041	1.0135

CY2BY	2013	2014	2015	2016	2017	2018	2019
CY2BY_RDTEN	1.0149	1.0000	0.9891	0.9774	0.9610	0.9459	0.9302
CY2BY_OPN	1.0150	1.0000	0.9891	0.9774	0.9611	0.9459	0.9301
CY2BY_OMN	1.0110	1.0000	0.9897	0.9778	0.9604	0.9432	0.9347

BY2CY	2013	2014	2015	2016	2017	2018	2019
BY2CY_RDTEN	0.9853	1.0000	1.0110	1.0231	1.0405	1.0572	1.0751
BY2CY_OPN	0.9852	1.0000	1.0110	1.0231	1.0405	1.0572	1.0751
BY2CY_OMN	0.9891	1.0000	1.0104	1.0227	1.0413	1.0603	1.0699

Table 4 Normalization Example

Inflation is not required to be categorized by appropriation or based on component/service indices, however the table format must be followed. The Raw and Weighted tables are used to create conversion tables seen with purple headings in Table 4. The table will also include Base Year to Then Year and vice versa not shown. Standardization allows VBA code to know how to execute crosschecks such as varying the base year of the indices to ensure then year stays the same. Another benefit is one analyst can update the indices and the other analysts can copy and paste values into their respective cost models.

Key General Inputs

General Inputs	
Estimate Sponsor:	Program XYZ
BaseYear:	2014
"To Go" Start Year	2019
Estimate End Year	2025
Sunk Cost Begin Year	2013

Table 5 Key General Inputs

Having one spot and nomenclature for key general inputs gives all analysts a one-stop-shop for setting up key inputs in the PAC model. Key general inputs such as base year, estimate start year, estimate end year, and others are given named ranges which are accessed by the VBA code to setup Table 3 for example. There are many times when an estimate end year is changed due to schedule slip or another system variant for example. Adding 5 years to the estimate end year will change all standard tables in

the PAC template. The change, however, will not automatically add costs, the analyst will need to do their work in ensuring those years are populated.

Risk Assumptions

Name	Factor * Assumption	Factor	Assumption	Low	Most Likely	High	Mean	St Dev
Installation - System X	100	100	1.00				1.00	0.19
Installation - Analogy	1.30	1.30	1.00	0.769	1.000	1.077		

Table 6 Risk Assumption Example

Risk assumptions are setup on one tab for organizational purposes. Having all the assumptions on one tab allows VBA to know where all the assumptions are located when accessing the Monte Carlo Simulation Developer’s Kit. For example, one SPAWAR 1.6 cost model adjudication requirements is to show what factors are driving variance. VBA code can be set to run after a simulation and measure the variance by assumption which will be easy to find if they are all in one place. The table format is more driven by the SPAWAR 1.6 adjudication process, in that the organization is easy to follow when reviewing the risk elements in the cost model. It is highly recommended to normalize the assumption to one if possible, as seen in table 6, however the reasoning is not covered by this paper.

Cost Build Up

The PAC model can be organized by Phase, Appropriation, WBS, Performer, Contract/CLIN, WBS, Etc. Therefore, a cost build up sheet can represent a single phase, an appropriation, one WBS, or some combination. It is very rare to have a single cost build up sheet because most cost models need more organization in order to follow the logic.

The cost build up example in Table 2 has a specific format. However as noted previously the number of years in the estimate are generated using the year data inputted in Table 5. In addition, the general inputs tab stores the column descriptions shown in Table 2 such as WBS, Description, etc. which are up to the analyst to decide how many and the name qualifiers.

The ease of PAC model building by multiple analysts is another bonus. Keeping in mind the general inputs data, multiple analysts can work on various cost build up tabs and integrate at the end. Since Inflation, Risk Inputs, and the cost build up table are standard, integration is straight forward.

Model Demarcation

Its important to note the PAC template has standardized the way in which the VBA code finds a location. In Table 2 for example, there is an exclamation point next to the WBS column header (Seen as “WBS!”). Just like Excel uses the exclamation point to demarcate a sheet from the cell reference, eg, Sheet1!A1 would be the first cell on the tab named Sheet1. In the PAC model, the exclamation point must be used cautiously in the model in any text format for this reason. The exclamation point gives NIWC analysts a clue that the wording is important.

Conclusion

The three goals set out in the introduction were accomplished with the current version of the PAC template. The first goal reached is analysts now have more time for analysis. Data collection is becoming more important and collecting and analyzing data is much more satisfying then re-linking Spruill equations.

The second goal has had multiple unforeseen benefits. We can look at any analysts’ model, understand the structure, and focus on the data analysis and cost build up phasing. In addition, the program

sponsors and SPAWAR 1.6 cost organization are becoming more familiar with the construct. In fact, some program sponsors have abandoned maintaining a separate program office estimate and exclusively use the NIWC analyst PAC template.

The model construct made the third goal easy to achieve. The NIWC group keeps a working template shell model up to date with the latest VBA Code. This allows any analyst to copy the PAC template shell to their computer and start using it.