TEAM SPAWAR

"Cost Models: Why Size DOES Matter" Presented at DONCAS 2010

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SPAWAR 1.6.1.1

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Statement A: Approved for public release; distribution is unlimited (21 SEPTEMBER 2010)

Really, it's COMPLEXITY and SIZE that matter!

Agenda

- Caveats
- Problem Statement
- General Rule for Cost Model Streamlining
- Cost Model Streamlining Tips
- Crystal Ball Lessons Learned
- Two Examples
  - GCCS-M
  - CANES
- Final Thoughts

Caveats

- This brief reflects my personal opinions based on my work experience, not necessarily the official position of SPAWAR 1.6
- This is not a Crystal Ball tutorial. However, Crystal Ball is utilized to demonstrate the benefits of cost model streamlining
- In-depth statistical theory will not be presented. Some practical Crystal Ball tips will be.
- The merits of using Crystal Ball versus other available software tools will not be discussed

Problem Statement: Why is This Important?

- Excel cost models of C4I programs at team SPAWAR have grown extremely large in size and complexity in recent years
  - More analysts are implementing complex Excel functions and formulas
  - Architecting automation and flexibility is sometimes pursued at the expense of simplicity (Excel has very tempting, powerful functionality)
- As a result, Crystal Ball cost risk simulation run times have become unacceptably long
  - Cost models are not responsive
  - Reconciliation efforts with NCCA and the establishment of the Navy Service Cost Position have been negatively impacted

General Rule for Cost Model Streamlining

- Excel recalculation speed is the key
  - Each Latin Hypercube or Monte Carlo simulation run requires an Excel autorecalc
  - Any model changes that significantly increase autorecalc time will directly increase Crystal Ball run times
  - The difference between an Excel model with a 1 second versus a 4 second recalc is 50 minutes (17 versus 67 minutes) for a 1000 Latin Hypercube simulation

Cost Model Streamlining Tips

- Excel cost model best practices
  - Separate your inputs from your outputs
  - Consider direct link formulas versus complex combination formulas (i.e., combined SUMPRODUCT, VLOOKUP, HLOOKUP, SUMIF formulas)
    - Enables other cost analysts to understand the logic behind the calculations
    - Instead of formulas that perform several functions at one time, consider laying out intermediate calculations to enhance understandability

Cost Model Streamlining Tips (cont)

- Excel cost model best practices (cont)
  - Create each WBS element worksheet to present stand-alone documentation of BOE
  - Format each worksheet for printing

Crystal Ball (CB): Some Lessons Learned

- Launch CB first
  - We've found that it's better to launch CB, then open the Excel file you will be running the simulation on
- Avoid CB conflicts
  - Have only one Excel file open when you are running a CB session
  - Also close other applications during the CB run to minimize runtime
- Don't stop runs
  - Pausing runs can give you different results than a continuous run
- Manual seed
  - CB generates an random seed when you begin the simulation
  - In order to get reproducible results, you must define a manual seed
- Eliminate links in your Excel cost model to other files
- Set the excel.exe process to 'high' priority in task manager

Example: GCCS-M

Two Cost Model Versions Compared

Cost Model Version:	May 2005	March 2010
Purpose:	MS B for 4.X	MS C for Incr 2 (4.1)
NCCA Role:	Sufficiency Review	Navy SCP
File Format:	Excel 2003	Excel 2003
File Size:	16.2 Mb	28.3 Mb
# of worksheets:		
Cover sheet	2	2
Table of Contents	2	2
Ground Rules	1	1
Summaries	4	4
CES elements	94	56
Exhibits	54	47
Input variables	1	1
Database Table	1	1
Other	0	4
TOTAL Worksheets	159	118

Example: GCCS-M (cont)

Three Crystal Ball runs were made

CB Set Up

Cost Model Version:	May 2005	March 2010	
# of CB assumptions:	6	6	54
# of CB forecasts:	6	6	324
Correlations:	0	0	8
Correlation groups:	0	0	2

CB Runtime Stats (Latin Hypercube, 100 iterations)

Cost Model Version:	May 2005	March 2010	
Total run time	7.0 sec	94.8 sec	112.4 sec
Trials/second	14 / sec	1 / sec	1 / sec
Random #s generated	86 / sec	6 /sec	55 / sec

What's Going On?

- Current model is larger in size and complexity
  - new functionality was added (e.g., withholds spreading, sunk cost smoothing, etc.)
- Adding many more CB assumptions and forecasts did not significantly increase run time

Is 19 minutes for a 1000 iteration Latin Hypercube run acceptable? If so, maybe time spent streamlining is not cost effective

Example: CANES

Two Cost Model Versions Compared

Cost Model Version:	June 2010	Aug 2010
Purpose:	MS B	MS B
NCCA Role:	Navy SCP	Navy SCP
File Format:	Excel 2003	Excel 2003
File Size:	22.0 Mb	13.9 Mb
# of worksheets:		
Cover sheet	1	1
Table of Contents	1	1
Ground Rules	1	1
Summaries	3	3
CES elements	62	63
Exhibits	36	36
Input variables	1	1
Database Table	1	1
Other	1	2
TOTAL Worksheets	107	109

Example: CANES (cont)

Two Crystal Ball runs were made

CB Set Up

Cost Model Version:	June 2010	Aug 2010
# of CB assumptions:	4	4
# of CB forecasts:	35	35
Correlations:	1	1
Correlation groups:	1	1

CB Runtime Stats (Latin Hypercube, 100 iterations)

Cost Model Version:	June 2010	Aug 2010
Total run time	~ 100 min. (est)	114.8 sec
Trials/second	~1 min. per trial	1 / sec
Random #s generated	?	3 /sec

What Happened?

- Initial CB runs by NCCA
  - simulation runtimes were simply unacceptable (~1 min. per iteration)
- Cost team streamlined the model
  - replaced SUMPRODUCT formulas on one worksheet that filled 20 columns and hundreds of rows. Other streamlining was done.

CB runtime is now acceptable

Final Thoughts

- A recommended Excel cost model layout for consideration
  - Cover sheet, table of contents
  - Ground rules and Assumptions
  - Cost summaries (e.g., annual costs by WBS element, appropriation, funding source, etc.)
  - Individual worksheets for WBS elements (parents and children) with standalone basis of estimate rationale within each worksheet
  - Exhibits (e.g., fielding plans, bills of material, mission personnel requirements by site type, salary tables, inflation indices)
  - An input variable worksheet is essential
  - A flat database table
    - If set up properly, it enables the analyst to present the cost estimate to customers in almost any way imaginable by utilizing pivot tables

Final, Final Thought

- If you really want to learn how to be a proficient Excel cost modeler
  - Get a copy of what is considered a well-constructed model
  - Recreate it from scratch from a blank Excel file
    - If done thoughtfully, you are forced to lay out a strategy upfront and think about how to implement it in logical steps
    - Create the exhibits and input variables worksheets first

Backup Slides

POC Information

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Brett Hays Biography

Mr. Hays leads the Cost Analysis - West Coast group within the SPAWAR cost department. He has over twenty-eight years of experience in production engineering and cost analysis, all within the defense industry. Mr. Hays has provided cost analysis support to PEO C4I programs since 1998, accepting a position with SPAWAR Code 1.6 in 2007. He has been responsible for the development of complex PLCCE models for numerous C4I programs, including Global Command and Control – Maritime (GCCS-M) and Consolidated Afloat Networks and Enterprise Services (CANES). Mr. Hays holds a bachelor's degree in Industrial Engineering from Iowa State University, an MBA from San Diego State University, and a database application developer certificate from the University of San Diego California. He is also a graduate of the Cisco Networking Academy program.