



Acquisition Research Program:
Creating Synergy for Informed Change

The Impact of Collaborative and Three Dimensional Imaging Technology on SHIPMAIN Cost Estimates

LCDR David H. Cornelius Jr.

NAVSUP NMCI Program Manager

Report Documentation Page

Form Approved
OMB No. 0704-0188

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

1. REPORT DATE MAY 2008	2. REPORT TYPE	3. DATES COVERED 00-00-2008 to 00-00-2008			
4. TITLE AND SUBTITLE The Impact of Collaborative and Three Dimensional Imaging Technology on SHIPMAIN Cost Estimates		5a. CONTRACT NUMBER			
		5b. GRANT NUMBER			
		5c. PROGRAM ELEMENT NUMBER			
6. AUTHOR(S)		5d. PROJECT NUMBER			
		5e. TASK NUMBER			
		5f. WORK UNIT NUMBER			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Supply Systems Command (NAVSUP), 5450 Carlisle Pike, Mechanicsburg, PA, 17055		8. PERFORMING ORGANIZATION REPORT NUMBER			
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR'S ACRONYM(S)			
		11. SPONSOR/MONITOR'S REPORT NUMBER(S)			
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES 5th Annual Acquisition Research Symposium: Creating Synergy for Informed Change, May 14-15, 2008 in Monterey, CA					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 16	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

Outline

- Introduction
- Maintenance and Modernization-The Cost Question
- Knowledge Value Added and Real Options Analysis
- KVA + RO Valuation Framework
- KVA Methodology Process Steps
- Real Options Analysis
- Case Study Methodology
- Projected Benefits
- SHIPMAIN Cost Estimation Process Flow
- Case Study Results: Costs, Benefits, ROI
- Case Study Results
- Real Options Results
- Research Implications
- Questions



Introduction

- The U.S. Navy (Navy) owns 277 ships, 57 submarines and more than 4,000 aircraft that requires an inventory that includes: 551 different engines; 7,325 different motors; 36,979 types of valves; 268 air-conditioning unit models and ; 443 categories of generators. (Erwin, 2007)
- Research was conducted into the efficiencies and added value that could be realized by incorporating 3D laser scanning and Product Lifecycle Management (PLM) tools into the cost estimation portion of the ship maintenance and modernization (SHIPMAIN) program.
- Knowledge Value Added (KVA) + Real Options (RO) framework was used in a proof-of-concept case study to quantify process improvements and subsequent benefits of the addition of 3D laser scanning and PLM technologies on cost estimation in the SHIPMAIN program.



Maintenance and Modernization- The Cost Question

- For FY08, the Navy has requested \$5.5 billion for maintenance to support the Fleet Commanders.
- The Navy's next generation fleet (313 ships) will require an average annual shipbuilding investment of \$13.4 billion in Fiscal 2005 dollars. (Goddard, 2007)
- Because the complexity of the current and future ship-force, required design periods for these new systems can range from five to ten years from concept to initial construction. When one considers that the actual construction will add two to seven more years, proper planning and diligence becomes even more crucial to the cost estimation portion of the program.
- The Entitled Process for Surface Ship and Carrier Modernization (SHIPMAIN EP) is a five-phased program that leverages best practice techniques to provide a common planning process for fleet maintenance. The goal of this program is the "right" work at the "right" time for the "right" cost.
- Cost-estimation is just one area in the SHIPMAIN where the Navy can become significantly more accurate and efficient.

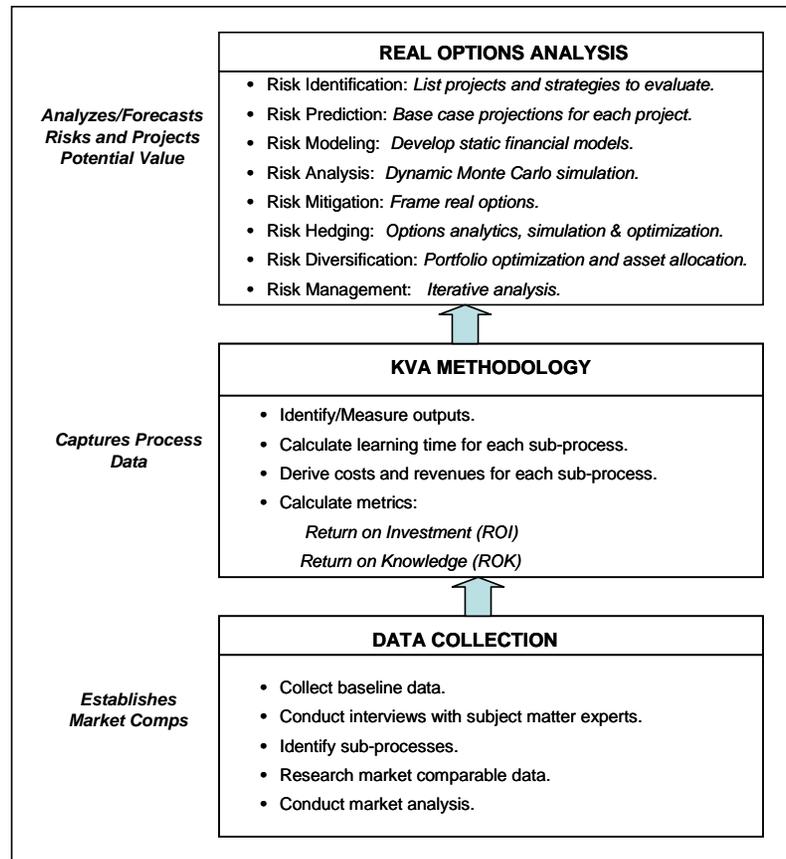


Knowledge Value Added and Real Options Analysis

- Measures value and cost of human and IT assets.
- Uses a “market comparables” valuation technique to establish revenue surrogates for discounted cash flow estimates.
- Allows for use of powerful financial metrics in forecasting value of strategic options of potential IT acquisitions.
- Estimates value and risk of strategic options using real options analysis (Hammer, 2007; measures drivers of value and risk).



Knowledge Value Added + Real Options Framework



KVA Methodology Process Steps

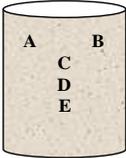
1. Identify core processes and sub-processes.
2. Establish common units and level of complexity to measure learning time.
3. Calculate learning time (i.e., knowledge surrogate) to execute each sub-process.
4. Designate sampling time period long enough to capture representative sample of the core processes' final product or services output.
5. Multiply learning time for each sub-process by number of times sub-process executes during sample period.
6. Calculate cost to execute knowledge (learning time and process instructions) to determine process costs.
7. Calculate ROK (ROK= Revenue/Cost) and ROI (ROI= Revenue-Cost/Cost).



Real Options Analysis

1. List of projects and strategies to evaluate

RISK IDENTIFICATION

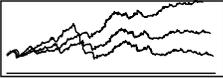


Start with a list of projects or strategies to be evaluated... these projects have already been through qualitative screening

2. Base case projections for each project

RISK PREDICTION

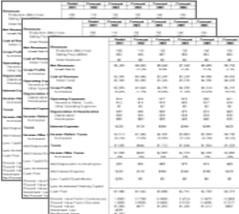
Historical Data Gathering
Time Series Forecasting



...will the assistance of time-series forecasting and historical data...

3. Develop static financial models with KVA data

RISK MODELING



...the user generates a traditional series of static base case financial (discounted cash flow) models for each project...

4. Dynamic Monte Carlo simulation

RISK ANALYSIS

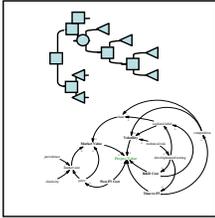
Simulation
Lognormal



...sensitivity and scenario analysis coupled with Monte Carlo simulation is added to the analysis and the financial model outputs become inputs into the real options analysis...

5. Framing Real Options

RISK MITIGATION



...the relevant projects are chosen for real options analysis and the project or portfolio real options are framed...

6. Options analytics, simulation and optimization

RISK HEDGING

Simulation Lattice

Closed-Form Models

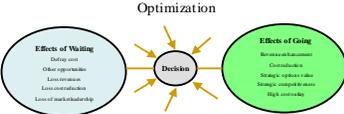
$$\frac{\partial S}{S} = \mu(\delta t) + \sigma\epsilon\sqrt{\delta t}$$

...real options analytics are calculated through binomial lattices and closed-form partial-differential models with simulation...

7. Portfolio optimization and asset allocation

RISK DIVERSIFICATION

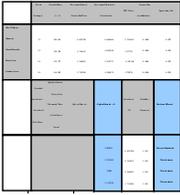
Optimization



...stochastic optimization is the next optional step if multiple projects exist that requires efficient asset allocation given some budgetary constraints... useful for strategic portfolio management...

8. Reports presentation and update analysis

RISK MANAGEMENT



...create reports, make decisions, and do it all again iteratively over time...



Case Study Methodology

- KVA+RO framework applied in case study analyzing potential effects of 3D terrestrial laser scanning and PLM technologies on SHIPMAIN cost estimation.
- Current “As-Is” processes compared with “To-Be” processes.
- Quantitative scope of research limited to cost estimation portion of SHIPMAIN.
- Data used in analysis derived from interviews with Subject Matter Experts, surveys and secondary research.

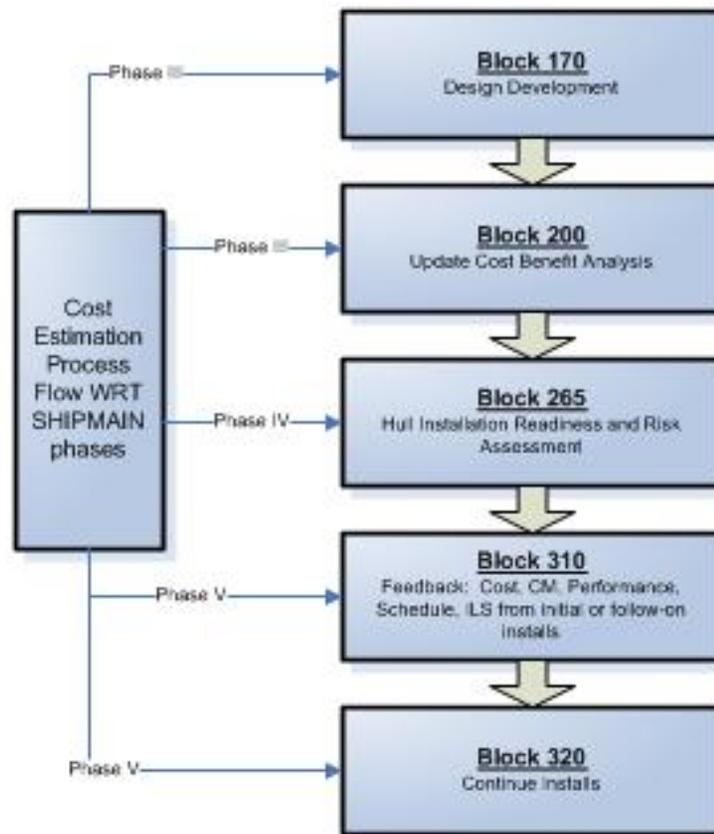


Projected Benefits

- The addition of 3D terrestrial laser scanning and PLM technologies to the SHIPMAIN program will allow for the creation of a central repository containing incredibly accurate models of ship spaces (a leap beyond the current 2D drawings). This will result in increased efficiencies and value to the cost estimation process.
- Anticipated benefits include:
 - Cost estimation accuracy
 - Cost savings
 - Better lifecycle planning
 - Increased ROI



SHIPMAIN Cost Estimation Process Flow



Case Study Results: Costs, Benefits, ROI

Core Process	Process Title	Annual As-Is Cost	Annual As-Is Benefits	Annual To-Be Cost	Annual To-Be Benefits	As-Is ROI	To-Be ROI
170	Design Development	\$214,570,062	\$360,388,939	\$91,999,022	\$539,639,982	67%	487%
200	Update Cost Benefit Analysis	\$1,129,316	\$5,660,559	\$432,559	\$11,321,119	505%	2517%
265	Hull Installation Readiness and Risk Assessment	\$95,146,354	\$57,991,301	\$42,612,154	\$106,168,950.08	-39%	149%
310	Feedback: Cost, CM, Performance, Schedule, ILS from Initial or follow-on Install	\$1,548,345	\$1,132,112	\$179,362	\$2,264,224	45%	1162%
320	Continue Installs	\$780,361	\$2,830,280	\$1,936,999	\$6,792,671	-27%	251%
Totals:		\$313,174,438	\$428,003,191	\$137,160,097	\$666,186,946	35%	386%



Case Study Results

- Enhanced Lifecycle Planning. With no single repository of data tracking an individual warship from cradle to grave, the addition of 3D laser scanning and PLM technologies facilitates the creation of a single source tracking mechanism. The repository could consolidate as-designed, as-planned, as-built and as-maintained warship data into a single record of the respective ship.
- Greater Cost Estimation Accuracy. A central repository enables more informed, accurate cost estimation decisions. Highly accurate models generated by 3D laser scanning enables greater accuracy in cost estimates because the ship/space will be correctly represented in exacting detail.
- Significant Cost Savings. The U.S. Navy currently spends over \$313 million per year on labor to complete 655 SCDs. Costs drop to just over \$137 million with the technologies, saving more than \$176 million per year.
- Increased Benefits. Annual benefits increased from over \$428 million to just over \$666 million.
- Optimized ROI. The potential ROI is 386%, compared to 35%.



Real Options Results

Strategic Option		Static Net Present Value	Total Strategic Value	ROI	Strategic Option Value	Factor Increase to Base Case
A	Current System (Do Nothing)	(\$890,063,204)	(\$890,063,204)	-36.81%	N/A	N/A
B	Implement all processes immediately	\$1,319,508,759	\$1,319,508,759	124.59%	N/A	2.81
C	Stage-gate implementation	\$1,056,660,389	\$1,596,169,863	125.46%	\$539,509,474	6.24



Research Implications

- 3D laser scanning and PLM technologies offers significant value when applied to the cost estimation portion of the SHIPMAIN environment.
- The combination of high-quality, reliable, accurate and reusable digital 3D data captured from the laser scanner and PLM, with its' information storage, distribution and collaboration capabilities, could provide the optimum mechanism for tracking product data of U.S. Navy ships from concept to decommission.



Questions?

