Acquisition Research Program:
Creating Synergy for Informed Change

Potential Impact of Collaborative and Three-dimensional Imaging Technology on SHIPMAIN

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Introduction

- The U.S. Navy (Navy) does not have a single portfolio containing lifecycle information for individual ships, classes of ships or shipboard systems from cradle-to-grave.
- 3D laser scanning and Product Lifecycle Management (PLM) technologies have potential to build coherent data structure and consolidate dispersed information sources (as-designed, as-planned, as-built and as-maintained data).
- Knowledge Value Added (KVA) + Real Options (RO) framework used in proof-of-concept case study to quantify process improvements of 3D laser scanning and PLM technologies on ship maintenance and modernization (SHIPMAIN) program.

Maintenance and Modernization Challenges

- Navy is transitioning into new era of maintenance for entire fleet of surface ships, submarines and aircraft.
- Navy spent approximately $39.1 billion (including all wartime supplemental funding) to operate, maintain and modernize 4,000-plus aircraft and 270-plus deployable battle force ships in FY 2006.
- Initiatives like Open Architecture (OA), the Entitled Process for Surface Ship and Carrier Modernization (SHIPMAIN EP) and rapid acquisition strategies are challenging old business models to obtain higher levels of mission capability for less cost in less time.
- Cost-estimation and comprehensive lifecycle management are two specific areas in which Navy must become more efficient to leverage new initiatives.

3 D Laser Scanning and PLM Benefits

- 3D terrestrial laser scanning and PLM technologies anticipated to provide benefits (e.g., more accurate cost-estimation, higher quality, less rework and more efficient system dynamics) across all phases of SHIPMAIN.

- Anticipated benefits include:
  - Minimizing lifecycle expenses and up-front cost overruns from poor cost-estimation.
  - Ensuring comprehensive lifecycle portfolio exists for each program of record and specific units of each program (i.e., specific hulls of each ship class).
  - Providing method to evaluate total cost of ownership and hold Program Managers (PM) accountable for efforts to evaluate lifecycle costs (not just up-front cost) in meeting program cost objectives.

3 D Laser Scanning and PLM Studies

- Potential benefits of these technologies on Naval processes have been found in several research studies; two conducted by Naval Shipbuilding Research Program (NSRP) and three by NPS.
- One NSRP study found that addition of 3D terrestrial laser scanning tools to just ship-check process decreased costs by as much as 44% and cycle-time by 49% (2006).
- Second study found technologies were beyond early adoption phase and mature to be used reliably to derive benefits (2007).
- Three studies conducted by NPS between 2005-2007 also found substantial benefits.

NPS Case Study Trilogy

Case Study #1 Shipyard Planning	**Case Study # 2 SHIPMAIN Phases IV and V**	**Case Study # 3 SHIPMAIN Cost Estimation**
Conducted by Lt. Christine Komoroski (2005)	Conducted by Lt. Nate Seaman (2006)	Conducted by LCDR David Cornelius (2007)

NPS Case Studies Methodology

- KVA+RO framework applied in each case study analyzing potential effects of 3D terrestrial laser scanning and PLM technologies.
- Current "As-Is" processes compared with "To-Be" processes.
- Data used in analysis derived from interviews with Subject Matter Experts (SMEs), surveys and secondary research.

NPS Case Study Trilogy

Case Study # 1: Shipyard Planning

- Lieutenant (LT) Christine Komoroski evaluated effects of 3D terrestrial laser scanning technology and PLM technologies in four public-sector naval planning yards.
- Research demonstrated that adding technologies to planning yards' core processes reduced process costs by more than 80%.

Case Study # 2: SHIPMAIN Phases V and VI

- Lt. Nate Seaman expanded scope of LT. Komoroski's research by mapping proof-of-concept case to specific phases of SHIPMAIN.
- Research demonstrated adding these technologies to reengineer current process resulted in annual cost savings of $78 million.

Case Study # 3: SHIPMAIN Cost Estimation

- LCDR David Cornelius researched potential benefits in cost estimation portion of SHIPMAIN.
- Results showed that costs could be reduced $176 million per year with potential ROI of 386%.

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

REAL OPTIONS ANALYSIS

Analyzes/Forecasts Risks and Projects Potential Value

- Risk Identification: *List projects and strategies to evaluate.*
- Risk Prediction: *Base case projections for each project.*
- Risk Modeling: *Develop static financial models.*
- Risk Analysis: *Dynamic Monte Carlo simulation.*
- Risk Mitigation: *Frame real options.*
- Risk Hedging: *Options analytics, simulation & optimization.*
- Risk Diversification: *Portfolio optimization and asset allocation.*
- Risk Management: *Iterative analysis.*

KVA METHODOLOGY

Captures Process Data

- Identify/Measure outputs.
- Calculate learning time for each sub-process.
- Derive costs and revenues for each sub-process.
- Calculate metrics:
  - *Return on Investment (ROI)*
  - *Return on Knowledge (ROK)*

DATA COLLECTION

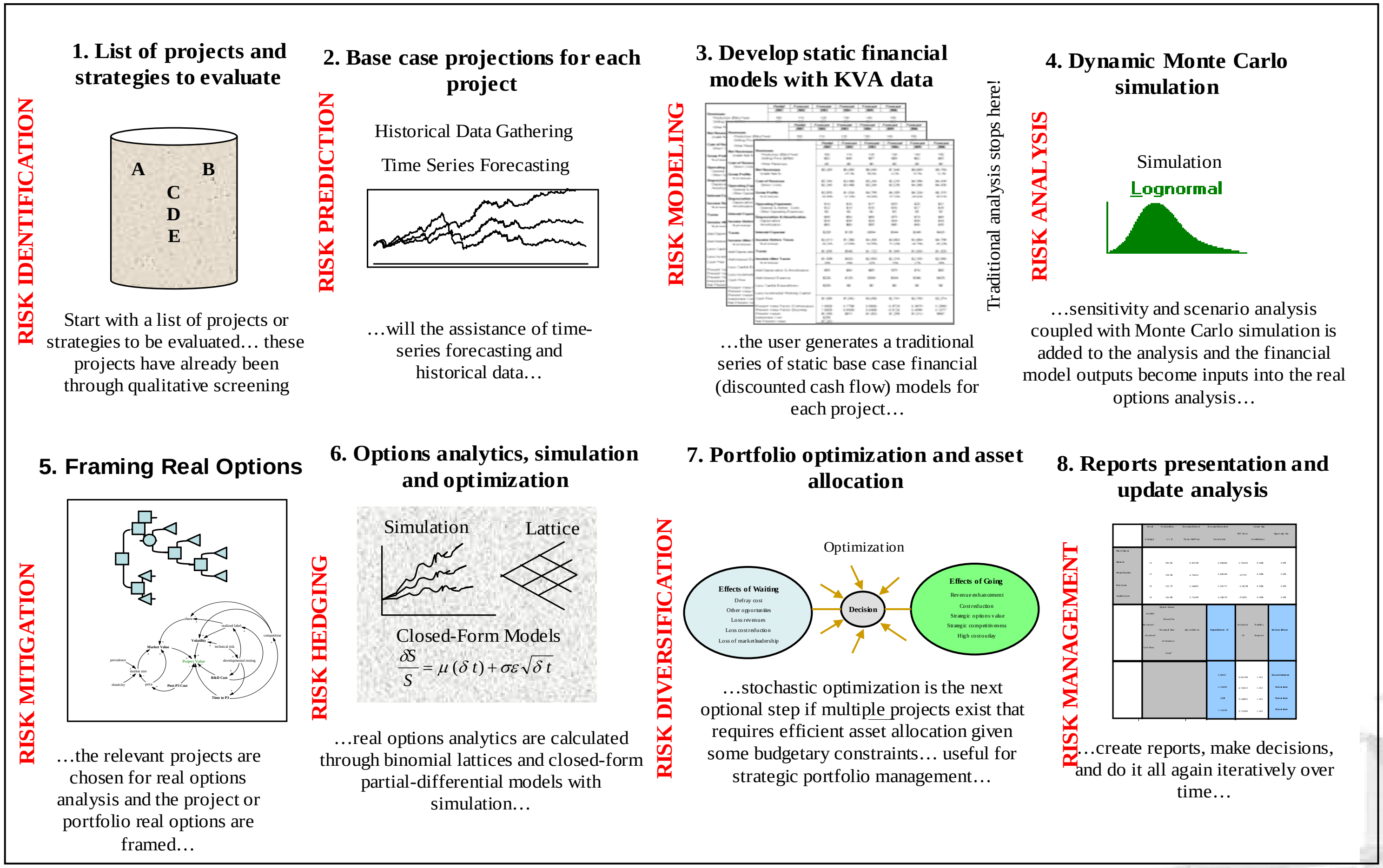
Establishes Market Comps

- Collect baseline data.
- Conduct interviews with subject matter experts.
- Identify sub-processes.
- Research market comparable data.
- Conduct market analysis.

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 (ROK= Revenue-Cost/Cost).

Real Options Analysis



Case Study #1: Ship-yard Planning

- LT. Komoroski analyzed potential benefits from collaborative and PLM technologies into specific aspects of the shipyard planning process.
- Seven sequential core processes and numerous sub-processes performed by planning yards for ship alterations on Navy surface ships analyzed under three scenarios:
  - ***As-Is Baseline***. Costs approximately $45 million to execute specific shipyard planning processes 40 times a year across four public shipyards.
  - ***To-Be.*** Costs could be reduced by 84% to less than $8 million with 3 D laser scanning technology only.
  - ***Radical-To-Be.*** Cost savings of more than $40 million could be derived with 3D laser scanning and collaborative PLM technologies.

Case Study #1: Ship-yard Planning Results

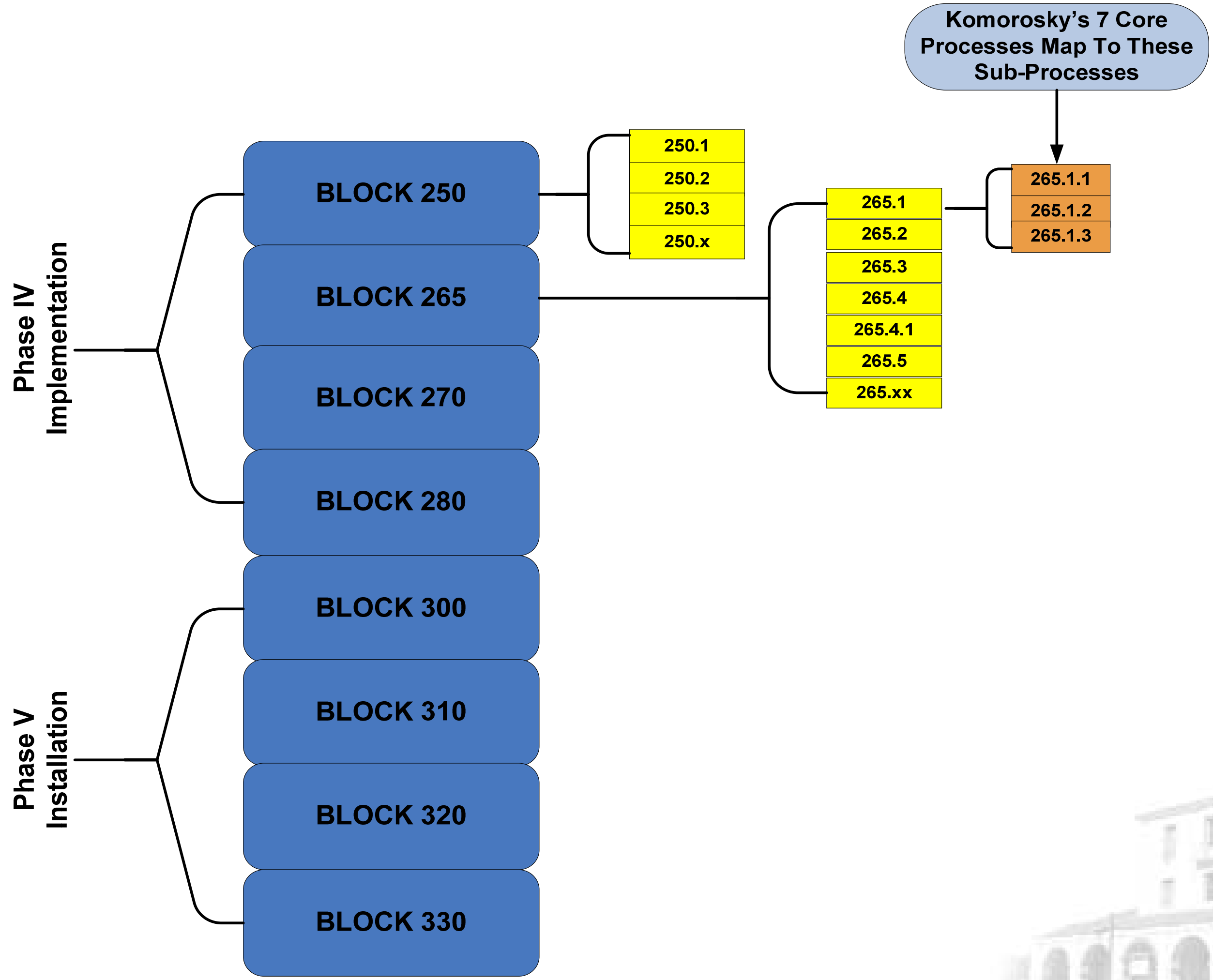
Projected Cost Savings

	Process Title	"AS IS"	"TO BE"	"RADICAL TO BE"	"AS IS" & "TO BE" Cost Savings	"AS IS" & "RADICAL" Cost Savings
1	ISSUE TASKING	$173,500	$173,500	$173,500	$0	$0
2	INTERPRET ORDERS	$520,000	$520,000	$328,000	$0	$192,000
3	PLAN FOR SHIP CHECK	$1,655,000	$714,000	$374,500	$941,000	$1,280,500
4	CONDUCT SHIP CHECK	$2,604,500	$1,364,000	$1,041,000	$1,240,500	$1,563,500
5	REPORT ASSEMBLY	$235,000	$235,000	$122,000	$0	$113,000
6	REVISE SCHEDULE	$131,000	$131,000	$131,000	$0	$0
7	GENERATE DRAWINGS	$39,386,000	$4,716,000	$2,319,000	$34,670,000	$37,067,000
	TOTALS	**$44,705,000**	**$7,853,500**	**$4,489,000**	$36,851,5000	$40,216,000

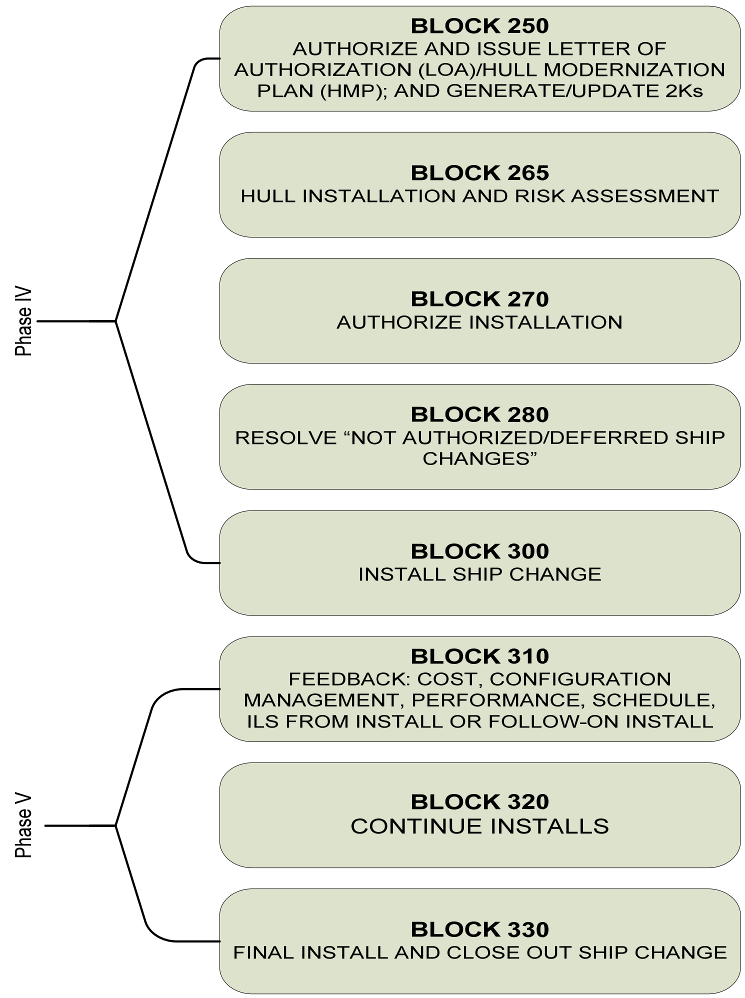
Case Study #2: SHIPMAIN Phases IV and V

- Lt. Nate Seaman's case study focused on introduction of 3D terrestrial laser scanning and PLM technologies to SHIPMAIN Phases IV and V.
- New research involved mapping Komoroski's case directly to applicable areas of SHIPMAIN. All major inputs, processes, and respective outputs were identified by comprehensive review of current SHIPMAIN directives and validated by SHIPMAIN SMEs.
- KVA+RO framework was first applied and then real-options analysis was conducted under two scenarios: As-is and To-be.

Mapping of Case Study # 1 Core Processes to Case Study # 2 SHIPMAIN



Case Study #2: SHIPMAIN Phases IV and V



Case Study # 2: SHIPMAIN Phases IV and V 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
Block 250	Authorize and Issue Letter of Authorization (LOA)/Hull Maintenance Plan (HMP); Generate 2Ks	$5,311,248	$22,619,472	$2,287,671	$15,215,872	326%	**565%**
Block 265	Hull Installation and Risk Assessment	$130,060,112	$94,928,918	$63,437,554	$161,749,816	-27%	**155%**
Block 270	Authorize Installation	$3,161,600	$24,710,347	$3,217,805	$24,710,347	682%	**668%**
Block 280	Resolve "Not Authorized/Deferred SC	$619,424	$3,706,552	$427,964	$3,706,552	498%	**766%**
Block 300	Install SC	$40,616,160	$94,722,998	$33,433,420	$94,722,998	133%	**183%**
Block 310	Feedback: Cost, CM, Performance, Schedule, ILS	$619,424	$1,853,276	$242,107	$1,853,276	199%	**665%**
Block 320	Continue Installs	$3,068,520	$4,633,190	$2,510,944	$5,791,488	51%	**131%**
Block 330	Final Install, Closeout SC	$309,712	$926,638	$304,059	$926,638	199%	**205%**
	Totals:	**$183,766,200**	**$248,101,392**	**$105,861,524**	**$318,820,901**	**35%**	**201%**

Case Study #2 : SHIPMAIN Phases IV and V Summary of Results

Substantial Cost Savings

- Navy spends nearly $184 million to implement and install 520 medium-complexity ship changes to all surface combat vessels.
- Costs drop 43% to less than $106 million.
- ROI increases to 201% from 35%.

Reduced Fleet Cycle-Time

- Cycle-time reduced from 80 days to 56 days (2.5-week reduction).

Improved Lifecycle Planning and More Efficient Business Processes

- Single record for specific ships, classes of ships or shipboard systems provides coherent data structure and consolidation of dispersed information sources (as-designed, as-planned, as-built and as-maintained data).
- Common access to single repository of comprehensive lifecycle information enables decision-makers to make informed decisions based on full spectrum of data.

Case Study #2 : Potential Strategic Options

• Do nothing and allow the As-is process to continue.
• Immediately acquire 3D laser scanning capability for public planning yards without PLM tools. • If successful, expand implementation to all planning yards.
• Immediately acquire 3D laser scanners and PLM technologies for public planning yards. • If successful, expand implementation across all planning yards.
• Immediately acquire comprehensive PLM software for all government agencies involved in Surface Fleet Modernization and Maintenance (SYSCOM, TYCOM, Fleet Commander, OPNAV, RMC, public shipyards, etc.) • Once business rules established and mature, extend PLM to all maintenance and modernization efforts (Submarine, Aircraft, Missiles, etc.)
• Immediately acquire minimal set of PLM product suite for enterprise maintenance and modernization efforts. • If successful, acquire additional functionality to support additional areas.

Case Study # 2: Real Options Results

	STRATEGY A *As-Is*	Strategy B *Partial Implementation*	Strategy C *Limited Layering*	Strategy D *Phased Implementation*
STRATEGIC OPTION	**Do nothing.**	**Implement All Changes Immediately.**	**Implement at 3 Public Shipyards, then at 3 Private Shipyards 2 Years Later.**	**Implement 3D Laser Scanning, then PLM 2 Years Later.**
Total Strategic Value	-$533M	$320M	$651M	$745M
Volatility	10%	50%	30%	50%
Total Cost	$1.4B	$800M	$948M	$883M

Case Study # 3 : SHIPMAIN Cost Estimation

- LCDR David Cornelius researched whether 3D terrestrial laser scanning and PLM technologies could lead to more precise cost estimation for ship maintenance, modernization and repair.
- KVA methodology applied to SHIPMAIN cost estimation processes under two hypothetical scenarios: As-Is and To-Be.
  - As-Is data developed from information consolidated from interviews, conversations and correspondence with select group of SMEs from NAVSEA and other recognized experts to establish baseline.
  - Major cost estimation process inputs, sub-processes, and respective outputs were identified by a comprehensive review of current SHIPMAIN directives.
  - Market comparable values then used estimate cost figures.
- Real-options analysis subsequently conducted on three potential scenarios to assess potential risks associated with each implementation strategy.

Case Study # 3 : SHIPMAIN Cost Estimation Summary of Results

Significant Cost Savings

- Navy spends over $313 million per year on labor to complete 655 SCDs.
- Costs reduced to $137 million, saving more than $176 million annually.

Optimized ROI

- ROI increases to 386%.

Enhanced Lifecycle Planning.

- Technologies facilitate creation of single source tracking mechanism of individual warship from cradle to grave.

Greater Cost Estimation Accuracy

- Greater accuracy in cost estimates with ship/ space represented in exacting detail by highly accurate models generated through 3 D laser scanning.

Research Implications

- 3D laser scanning and PLM technologies offer significant value to maintenance and modernization of Navy warships.
- High-quality, reliable, accurate and reusable digital 3D data capture, paired with information storage, distribution and collaboration capabilities of PLM provides single digital thread connecting as-desired, as-planned, as-built and as-maintained product data throughout lifecycle of any ship or program.
- Single digital environment has potential to provide decision-makers longitudinal views of product from cradle-to-grave that is non-existent.