

# The Navy Modernization Program: Estimating the Cost of Upgrading AEGIS Guided Missile Cruisers

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- Induction Phase
- Sustainment Phase
- Hull, Mechanical, and Electrical (HM&E) Mid Life Extension (MLE)
  - Scope
  - Data Sources
  - Assumptions
  - Methodology
  - Calculations
- Combat System (CS) Modernization
  - Scope
  - Data Sources
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  - Methodology
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- Navy plans to modernize 84 total AEGIS warships over a 20 year period at a cost of \$16B (CY10\$)<sup>1</sup>
- Eleven of the CG 47 Class AEGIS Guided Missile Cruisers will receive an extended availability, including ship maintenance, HM&E MLE and CS Modernization
- Referred to as Phased Modernization, the program will include the following phases:
  - Induction: Ship is taken out of the fleet and de-activated
  - Sustainment: A periodic assessment is conducted on board to ensure the ship is not experiencing any damage or fatigue
  - HM&E Modernization (MLE): Hull, mechanical, and electrical equipment are upgraded
  - CS Modernization: Combat Systems are upgraded
- The NAVSEA In Service Surface Combatants Program Office (PMS 400F) tasked the Cost Estimating and Industrial Analysis Group (SEA 05C) with developing a cost estimate for the phased modernization program

1. [http://www.history.navy.mil/library/online/aegis\\_background.htm](http://www.history.navy.mil/library/online/aegis_background.htm)

- Induction phase takes place at the start of the availability and again after the HM&E modernization phase
- Ship is deactivated; engineers perform ship assessment and identify repairs that will be needed during modernization phases
- Assumptions
  - SURFMEPP measure of man-days required for this phase is accurate
  - Historical industry labor rates are reflective of future industry labor rates
- Cost Estimating Methodology is Engineering Build Up; data source is Surface Maintenance Engineering Planning Program (SURFMEPP)
- Calculations
  - $\text{Man-Days} \times \text{Labor Rates} = \text{Cost}$

- Sustainment phase takes place after induction and prior to modernization phases and can last from a few months to years
- Engineers perform ship assessment and identify any damage or fatigue that the ship is incurring as a result of being deactivated for an extended period of time
- Assumptions
  - SURFMEPP measure of man-days required for this phase is accurate
  - Historical industry labor rates are reflective of future industry labor rates
- Cost Estimating Methodology is Engineering Build Up; data source is Surface Maintenance Engineering Planning Program (SURFMEPP)
- Calculations
  - $\text{Man-Days} \times \text{Labor Rates} = \text{Cost}$

# HM&E MLE Scope & Data

- HM&E MLE is the process of upgrading the hull, mechanical, and electrical systems
- Considerations for the cost estimate included approved ship alterations (SHIPALTS), maintenance, dockside support, advanced planning, design services agent, and long lead-time material
- Data Sources:
  - Historical execution plans
  - Cost and Schedule Status Reports (CSSR)
    - 14 CSSRs were collected from shipyards in San Diego, Norfolk, and Pearl Harbor
    - Analyzing CSSRs resulted in a range of historical cost and hours per SHIPALT
  - Shipyard proposals
  - SURFMEPP Analysis
    - Used for estimating maintenance cost

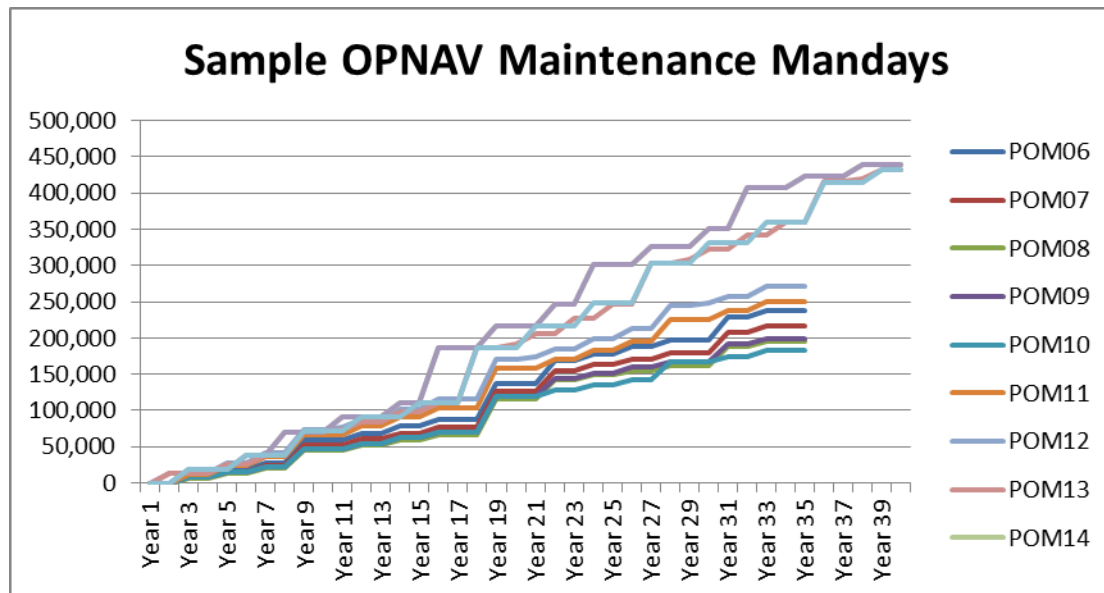
# HM&E MLE Assumptions

- Assumptions
  - No further scope required beyond the data available
    - Every ship is in a different state of maintenance and it is impossible for the cost team to predict the required maintenance
  - Advanced planning is a fixed percentage of total HM&E Modernization cost
  - No alterations require a different level of long lead-time materials than what were historically required
  - Total subcontractor cost captured in a CSSR includes the same ratio of materials to labor as the prime contractor
  - SHIPALTS not completed during the HM&E availability will not be completed in other phases of the phased modernization program
  - HM&E schedule will not be extended to accommodate schedule slips or expanded scope
  - Maintenance engineers will perform as much maintenance as possible within the allotted schedule and incomplete maintenance activities will be deferred to a later availability
  - Historical industry labor rates are reflective of future industry labor rates

# HM&E MLE

## Historical Maintenance

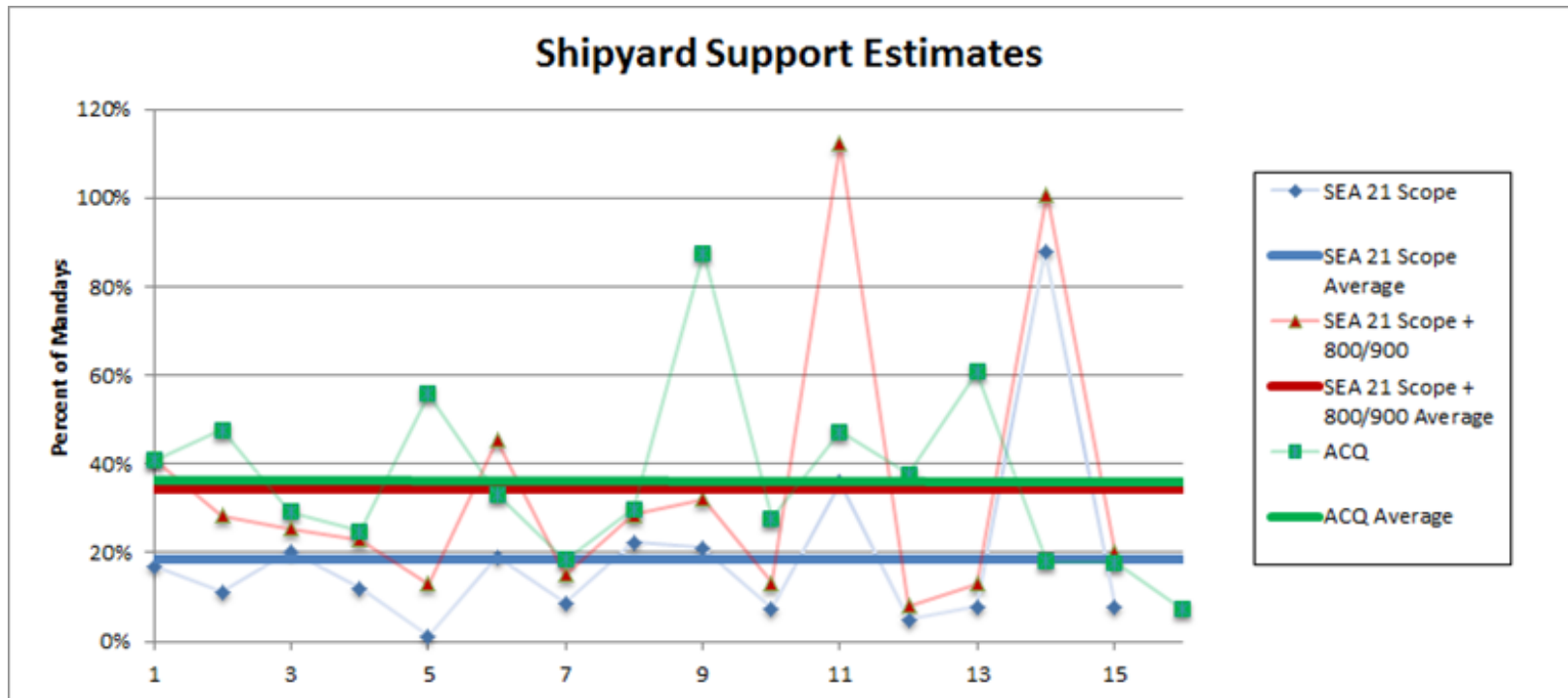
- Maintenance requirements are historically estimated during each Program Objective Memorandum (POM) cycle
- Historically, maintenance requests increase during each cycle
- This is interpreted as maintenance activities being delayed because they were not completed within their scheduled availability





- Cost Estimating Methodology
  - Advanced Planning – Extrapolation from Actuals
  - Long Lead Time Materials – Extrapolation from Actuals
  - DSA – Extrapolation from Actuals
  - SHIPALTS – Analogy to previous ship alterations
  - Superstructure Fatigue – Engineering Build Up
  - Maintenance and Support – Engineering Build Up
  
- Calculations
  - Advanced Planning: Developed a CER between AP and HM&E MLE based on historical AP cost for the CG 47 modernization program;  $MLE \times CER = Cost$
  - Long Lead Time Materials: Averaged across historical actuals
  - DSA: Averaged across historical actuals
  - ShipAlts: Averaged across historical actuals
    - In the case no actuals were available, interviewed SMEs to develop an analogous estimates for similar historical ShipAlts
  - Superstructure Fatigue: Analyzed shipyard proposals and developed independent estimate based on proposal inputs
  - Maintenance and Support:  $SURFMEPP \text{ man-days} \times \text{Labor Rate} = Cost$

# HM&E MLE Shipyards Support Cost

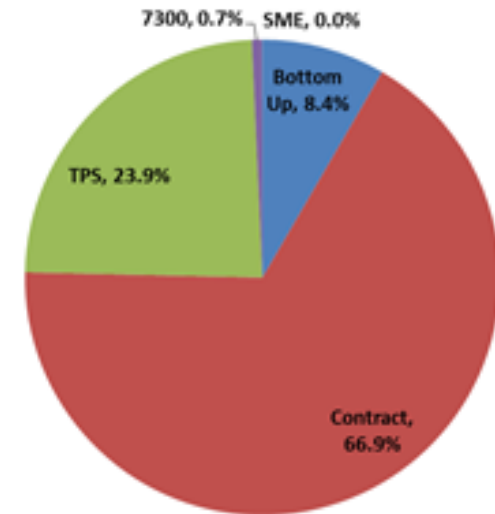


# CS Modernization Scope

- Scope
  - Procurement
  - Combat System Engineering Agent Support (CSEA)
  - Design Services Agent (DSA)
  - Installation
  - Sea Trials
  - Combat System Ship Qualification Test

<b>AEGIS</b>	<b>Non-AEGIS</b>
Displays	Moriah
Processors	CKT16TV & Topside
STAMO	SPA-25H
Computing Infrastructure	SPQ-9B
AEGIS AMOD Upgrade	VLS Upgrade
RCEM	GWS Upgrade
SPQ-15	CEC
TWT Monitoring Circuit	ICOMM
MK-666	LAMPS (Install Only)
	BFTT (Install Only)
	SQQ-89

- Data Collection
  - Procurement
    - Contract Values
    - Form 7300s
    - Task Planning Sheets
  - CSEA
    - Task Planning Sheets
  - DSA
    - Task Planning Sheets
  - Installation
    - Historical Contract Performance Reports
  - Sea Trials
    - Test Procedures and FTE Requirements
  - CSSQT
    - Task Planning Sheets



# CS Modernization Assumptions

- Global Assumptions
  - The 2014 OSD Joint Inflation Calculator is reflective of future inflation rates
  - Historical rates, contract prices, CPRs, and actuals are representative of future cost for the same work package
  
- Procurement
  - TPS allocations are representative of the actual cost required for support services
  - The effective award date of the contract is the same fiscal year as the funds that were obligated for the award (relevant to inflation adjustments)
  - ACB 16 and ACB 20 variants will be no more expensive on average to procure, install, and test than ACB 12
  
- Installations
  - Contractor fee is 10%
  
- Test Team
  - Aegis Test Team works a 40 hour week
    - AEGIS Sea Trials analysis was conducted on a person-week basis
  
- Risk Assumptions
  - Sample populations are bounded at the 10<sup>th</sup> percentile by an amount which is 20% below the point estimate
  - Sample populations are bounded at the 90<sup>th</sup> percentile by an amounts which is 20% above the point estimate
  - There is a 30% correlation between risk inputs

# CS Modernization Methodology Matrix

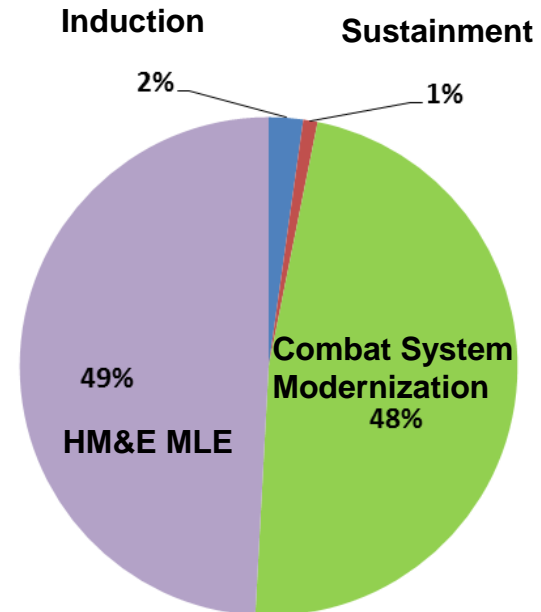
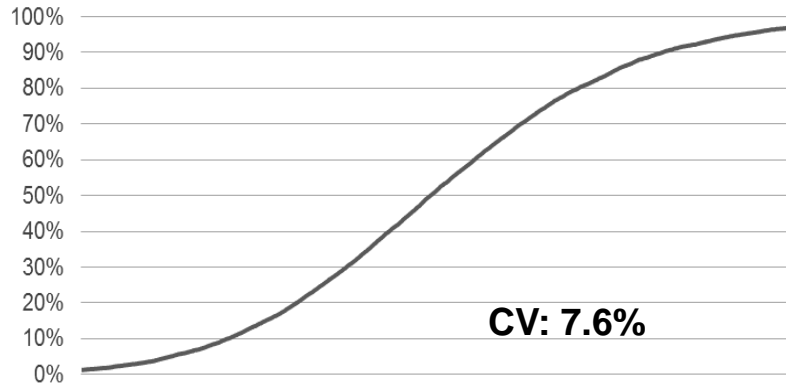
WBS	Methodology	Data	Comments
System Procurement	Extrapolation from Actuals	Contract Award	
CSEA Support	Engineering Build Up	FTE/Labor Rates	Scope and FTE analysis from TPSs
DSA	Engineering Build Up	FTE/Labor Rates	Scope and FTE analysis from TPSs
Installation	Extrapolation from Actuals	CPRs	
Sea Trials	Engineering Build Up	FTE/Labor Rates	Detailed FTE and Scope Analysis from external studies
CSSQT	Engineering Build Up	FTE/Labor Rates	Scope and FTE analysis from TPSs

# CS Modernization Calculations

- Procurement
  - PMP: Sum of CLIN award prices
  - Gov't Support: FTEs \* Labor Rate
- CSEA: FTEs \* Labor Rate
- DSA: FTEs \* Labor Rate
- Installation: Future cost = historical cost
- Sea Trials: FTEs \* Labor Rate
- CSSQT: FTEs \* Labor Rate
- Risk: Monte Carlo Simulation using 10,000 trails
  - S Curve and Tornado Chart Analysis

# Summary Results

## S Curve





# Conclusions

- Sufficient data and information is available to estimate the cost of the CG 47 Phased Modernization with a high level of detail
- Contracting strategies including competition, learning curve discounts, and economic order quantity discounts could reduce the program cost
- The estimate serves as a baseline for future AEGIS modernization efforts
- This estimate provides a framework for estimating modernization efforts for non-AEGIS platforms

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