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Exhibit R-2, RDT&E Budget Item Justification	Date: February 1999
APPROPRIATION/BUDGET ACTIVITY RDT&E,N / Demonstration & Validation BA-4	R-1 ITEM NOMENCLATURE SHIP CONCEPT ADVANCED DESIGN, PE 0603563N

COST (\$ in Millions)	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	Cost to Complete	Total Cost
Total P.E. Cost	5.264	7.077	5.318	5.675	6.495	6.595	6.677	6.863	Continuing	Cont.
DESIGN TOOLS, PLANS & CONCEPTS / S2196	5.264	7.077	5.318	5.675	6.495	6.595	6.677	6.863	Continuing	Cont.
Quantity of RDT&E Articles & cost	N/A	N/A								

A. (U) Mission Description and Budget Item Justification: The efforts within this PE directly support the Navy's ability to design more affordable mission capable ships with reduced manning, increased producibility, reduced operating and support costs, and greater utilization of the latest technology. The program directly supports the Navy Shipbuilding Plan with state-of-the-art design tools and methods for ship concept studies, and the actual conduct of design concept studies for the ships in that plan. The program provides the foundation for affordable surface ship design, construction, and life cycle support and is a required first step in the integration of total ship systems, including combat systems and hull, mechanical and electrical (HM&E) systems. Inadequate early planning and ship concept formulation can result in down-stream design/construction and operational problems. A more subtle and severely negative impact of neglecting this early effort is that the "best" concepts and technologies may never even be considered and our greatest potential ship design advances never realized. Designs and technologies must meet the threat. This project supports this requirement. Computer modeling and simulation developments will permit virtual operation and evaluation of the ship and enable reduction of ship production and support cost by allowing fleet representatives, shipbuilders and maintenance staffs to build, test, operate or repair the ship "in the computer" at a design stage where the design is flexible and where feedback and suggested changes can be incorporated relatively easily.

(U) This project accomplishes the following: (1) identifies future surface ship requirements and characteristics necessary to meet future threats and support mission needs; (2) investigates new affordable ship concepts and evaluates technologies necessary to support these concepts; (3) provides design methods and automated design tools to develop and evaluate ship concepts, support early ship design, and solve pressing fleet engineering problems; (4) develops design criteria and common standards to improve affordability; (5) improves the quality of the product in the design phases, to reduce or eliminate the costs of fixing problems after ships reach the fleet; (6) develops investment strategies for new concepts and technologies; (7) and supports development of Mission Need Statements (MNS) for future ships.

(U) Efforts under Project S2196 transition directly to early stage ship design in PE 0603564N, Ship Preliminary Design and Feasibility Studies. While these efforts support all surface ship acquisition programs, they are not direct efforts for specific authorized shipbuilding programs. This project is the only R&D effort (Government or commercial) that supports and maintains this country's naval ship design and engineering capabilities in the area of early stage (Concept through Contract Design) design tools, criteria, and methods.

(U) The FY 1998 funds for the Affordability Through Commonality (ATC) Program were budgeted and executed under this PE/Project. The FY 1999 funds for ATC were budgeted under this PE/Project as displayed in the FY 1999 President's Budget but transitioned to PE 0603513N / Project 32469 for execution. ATC funding has transferred to PE 0603513N, Project 32469 for both budget and execution in FY 2000 and out-years.

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(U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 1998 ACCOMPLISHMENTS:

Note: Accomplishments for FY 1998 reflect actual executed funding of \$6.276M.

- (U) (\$1.165) Pre-Milestone 0 Ship Concepts and Mission Need Analysis / Total Ship Technology Assessment: Developed ship concepts for potential ships 5-10 years out in the SCN plan, including ship size, configuration, capabilities and rough order of magnitude (ROM) ship costs. Integrated new technologies in total ship concepts. Conducted pre-Milestone 0 ship concept studies for large deck amphibious assault ship, joint command ship, and medical capabilities afloat in support of SCN planning. Analyzed the benefits and impacts of new concepts and technologies. Supported trimaran advanced hull form concept development.
- (U) (\$1.706) Ship Design and Engineering Tools, Methods, and Criteria: Developed and improved early stage ship design methods, criteria, standards, and data bases. Improved surface ship synthesis/assessment models in the following areas: integrated improved performance assessment capabilities, updated program executive, link to commercial CAD II system, increased ability to handle common modules and other large space objects, developed a link to industry STEP data exchange protocols, updated capabilities to support on-going future ship designs to handle new ship configurations, hull form alternatives, and signature reduction features. Supported development of advanced computer aided design methods and tools for early stage ship design in the following areas: updated design weight estimating tool, developed surface ships structural rational design tools, integrated structural analysis tools with CAD II system, began upgrades to manning estimation tools, completed development of infrared and magnetic signature assessment tools, upgraded ship hydrostatics and stability analysis for new geometry definition, and upgraded general arrangements tool capabilities. Developed a materials selection database. Supported Navy Industry Digital Data Exchange Specification Committee (NIDDESC) development of STEP computer aided design (CAD) systems data and parts library exchange protocol standards for shipbuilding industry. Identified and characterized new and emergent technologies and updated the HM&E technology database. Finished migration of HM&E technology database to commercial software.
- (U) (\$1.425) Simulation Based Ship Design & Engineering: Began broad-based implementation of state-of-the-art visualization and simulation techniques for ship design and engineering applications. Acquired and started validation, adaptation, and implementation of commercial visualization and simulation tools for the areas of: fluid / piping systems simulation, and crew reduction performance simulation. Developed custom visualization and simulation tools where no alternate source exists in the following areas: automated ventilation duct routing and analysis. Began development of standard "wrapper" program to integrate visualization and simulation tools with legacy computer aided design and physics-based hull, mechanical and electrical (HM&E) analysis tools. Began development of capabilities for realistic, physics-based simulation of ship performance, behavior, and response in the following area: survivability, damage tolerance, and damaged mission capability simulation by developing an integrated survivability assessment and analysis capability.

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- (U) (\$0.980) Reliability Based Structural Design Criteria: Collected and analyzed long-term hydrodynamic loads data. Developed and validated seaway loads prediction method. Completed assessment and methods for predicting extreme and cumulative lifetime loads. Developed non-dimensional response amplitude operators for vertical and lateral bending moments. Completed updating of compressive strength of plating stiffeners study. Begun large scale grillage strength tests and assessments. Completed stiffener geometry testing. Completed compressive strength of stiffener testing. Completed analysis of fatigue test data and update design data sheet (DDS). Updated reliability inputs and assessment techniques. Developed stiffened panels (part III) of the reliability-based load and resistance factor design (LRFD) structural rules for naval surface ships. Validated processes and utilized technologies/improved design methods on existing ships and new designs. Co-sponsored with the American Bureau of Shipping (ABS) and the Ship Structure Committee (SSC) transition planning and technical review of the Development of Load and Resistance Factor Design Rules for Ship Structures.
 - (U) (\$1.000) Total Ownership Cost Methods and Modeling: Developed total ownership cost modeling and cost decision making tools for ships. Supported Navy-Shipbuilding Industry cost model development team. Implemented the Product Oriented Design and Construction (PODAC) cost model at two more shipyards. Validated the prototype PODAC cost model at two more shipyards. Used PODAC cost model to analyze new technologies to validate model capabilities to correctly reflect acquisition cost impacts. Added a capability to the PODAC cost model for incorporating separately estimated combat systems and C4I, or other independent system/equipment costs into a total ship procurement cost. Developed initial high level parametric cost estimating method using gross compensated tonnage and complexity factors. Investigated risk and schedule capabilities to PODAC cost model. Began developing a plan to develop a ship operating and support cost model. Coordinated efforts with cost modeling and cost analysis for on-going ship programs.
 - (U) Note: Affordability Through Commonality (ATC) program efforts shown in PE 0603513N, Project 32469.
2. (U) FY 1999 PLAN:
- (U) (\$1.535) Pre-Milestone 0 Ship Concepts and Mission Need Analysis: Develop ship concepts and perform mission area analysis (MAA) for potential ships 5-10 years out in the SCN plan, including ship size, configuration, capabilities and rough order of magnitude (ROM) ship costs. Conduct pre-Milestone 0 ship concept studies for LHA replacement (large deck amphibious assault ship), joint command ship, medical capabilities afloat, and other potential ship concepts / configurations in support of SCN planning. Develop future surface warfare vision including mission needs and concepts, and technology needs and plans.
 - (U) (\$0.435) Total Ship Technology Assessment: Analyze the benefits and impacts of new ship and hull, mechanical and electrical (HM&E) concepts and technologies. Identify, characterize and assess new and emergent technologies and update the HM&E technology database. Support integration and transition of new technologies in total ship concepts. Establish baseline ship concepts and technology attributes for use in technology assessments.

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- (U) (\$1.365) Ship Design and Engineering Tools, Methods, and Criteria: Develop and improve early stage ship design methods, criteria, standards, and data bases. Improve surface ship synthesis/assessment models in the following areas: improve performance assessment capabilities, complete link to commercial CAD II system, increase ability to handle alternative distributed system architectures, link to industry STEP data exchange protocols, begin efforts to link with operational effectiveness models, update and enhance capabilities to support on-going future surface ship designs to handle new ship configurations, hull form alternatives, signature reduction features, address minimum required shipboard manning, reduced construction cost, and increased capabilities to determine ship size impacts of new technologies. Improve ship cost estimating capabilities: link new acquisition cost modeling capability to ship synthesis/assessment models. Support development of advanced computer aided design methods and tools for early stage ship design in the following areas: complete development and integration of structural analysis tools with CAD II system, upgrade manning estimation tools, enhance machinery design tools, complete general arrangements tool upgrades, and integrate distributed systems analysis software with CAD II system. Support Navy Industry Digital Data Exchange Specification Committee (NIDDESC) development of STEP computer aided design (CAD) systems data and parts library exchange protocol standards for shipbuilding industry.

- (U) (\$1.420) Simulation Based Ship Design and Engineering: Broad-based implementation of state-of-the-art visualization and simulation techniques for ship design and engineering applications. Integrate visualization and simulation tools from all sources, including DARPA, ONR, and other government activities for areas such as ship motions, maneuvering, powering, personnel flow, stores flow, structural response, command and communications systems, electric power systems, piping systems, HVAC systems, and combat systems. Acquire and validate, adapt, and implement commercial and other source visualization and simulation tools for the areas of: fluid / piping systems simulation, and crew reduction performance simulation. Develop custom visualization and simulation tools where no alternate source exists in the following areas: aircraft handling simulation, signature visualization and simulation. Complete development of standard "wrapper" program to integrate visualization and simulation tools with legacy computer aided design and physics-based hull, mechanical and electrical (HM&E) analysis tools. Develop capabilities for realistic, physics-based simulation of ship performance, behavior, and response in the following areas: survivability, damage tolerance, and damaged mission capability simulation by developing an integrated survivability assessment and analysis capability.

- (U) (\$1.160) Reliability Based Structural Design Criteria: Add new reliability inputs and assessment techniques to design rules. Incorporate methods for predicting extreme and cumulative lifetime loads into design rules. Collect and analyze long-term hydrodynamic loads data. Correlate full scale loads measurements with model test results. Validate and adapt advanced seaway loads prediction methods for use with design rules. Develop methodology for bow form effects on hull loads. Establish safety indices for naval ship structures for hull girders. Perform large scale grillage strength tests. Begin assessment of grillage strength test data. Update design data sheet for compressive strength of plating stiffeners and grillages. Develop structural fatigue (part IV) of the reliability-based load and resistance factor design (LRFD) structural rules for naval surface ships. Validate processes and utilize technologies/improved design methods on existing ships and new designs. Support transition to industry through Ship Structure Committee (SSC).

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- (U) (\$1.060) Total Ownership Cost Methods and Modeling: Develop total ownership cost modeling and cost decision making tools for ships. Support Navy-Shipbuilding Industry cost model development team. Validate the prototype PODAC cost model at two or more additional shipyards. Develop plan for PODAC cost model extensions for combat systems and C4I costs. Collect and analyze cost data of shipbuilders for development of activity cost factors for naval ships. Develop PODAC cost model estimating ratios for shipbuilding interim products, parametric scaleable systems, and shipboard equipment for ships. Develop a plan for risk and schedule capabilities to PODAC cost model. Use PODAC cost model to analyze new technologies to validate model capabilities to correctly reflect acquisition cost impacts. Begin execution of plan to adapt and integrate an existing ship operating and support (O&S) cost module with the PODAC cost model. Link O&S cost analysis methodology with product work break down of PODAC cost model. Develop a link between PODAC and computer aided ship design tools, so that cost-related information produced by these design tools can be readily imported into the cost model. Support cost modeling and cost analysis for on-going ship programs.
 - (U) (\$0.102) Portion of extramural program is reserved for Small Business Innovation Research assessment in accordance with 15 USC 638.
 - (U) Note: Affordability Through Commonality (ATC) program efforts are shown in PE 0603513N, Project 32469.
3. (U) FY 2000 PLAN:
- (U) (\$0.935) Pre-Milestone 0 Ship Concepts and Mission Need Analysis: Develop ship concepts and perform mission area analysis (MAA) for potential ships 5-10 years out in the SCN plan, including ship size, configuration, capabilities and rough order of magnitude (ROM) ship costs. Conduct pre-Milestone 0 ship concept studies for LHA replacement (large deck amphibious assault ship), medical capabilities afloat, future mine countermeasures ships, and other potential ship concepts / configurations in support of SCN planning. Develop potential future fleet architecture concepts and high level ship concepts for the ships in these fleet concepts.
 - (U) (\$0.345) Total Ship Technology Assessment: Analyze the benefits and impacts of new ship and hull, mechanical & electrical (HM&E) concepts and technologies. Identify, characterize and assess new and emergent technologies and update the HM&E technology database. Support integration and transition of new technologies in total ship concepts. Update baseline ship concepts and technology attribute database for use in technology assessments. Support development of total ship and HM&E technology roadmaps.
 - (U) (\$1.178) Ship Design and Engineering Tools, Methods, and Criteria. Improve capability for rapid and accurate ship performance/cost/risk assessments and tradeoff studies and improve interoperability of Navy and shipbuilder design systems. Improve surface ship synthesis/assessment models in the following areas: improve performance assessment capabilities, increase ability to handle alternative distributed system architectures, update and enhance capabilities to handle new ship configurations, hull form alternatives, signature reduction features, characterize advanced machinery technologies, address minimum required shipboard manning, reduced construction cost, and increased capabilities to determine ship size impacts of new technologies. Continue development of interoperability standards and capability between and among: synthesis/assessment models, cost estimation models, operational effectiveness models, shipbuilder computer aided design (CAD) models, and Navy-developed analysis tools by participation in and support for collaborative efforts such as the Navy Industry Digital Data Exchange Standards Committee (NIDDESC) and the Maritech Advanced Shipbuilding Enterprise (ASE).

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- (U) (\$1.180) Simulation Based Ship Design & Engineering: Continue to adapt state-of-the-art visualization and simulation techniques for ship design and engineering applications. Review pending ship design needs and ship technology developments to identify top priority simulation requirements. Acquire, validate, adapt, and implement commercial visualization and simulation tools for the areas such as piping systems simulation and ergonomic models in crew reduction performance simulation. Validate and implement visualization and simulation tools from DARPA, ONR, and other government sources for areas such as ship motions, maneuvering, powering, personnel flow, stores flow, structural response, command and communications systems, electric power systems, piping systems, HVAC systems, and combat systems. Develop custom visualization and simulation tools where no alternate source exists in areas such as aircraft handling simulation, signature visualization and simulation. Continue development of interoperability standards and capability between visualization and simulation tools, ship synthesis/assessment models and computer aided design (CAD) models.

- (U) (\$0.740) Reliability Based Structural Design Criteria: Begin development of methodology for overall strength analysis of surface ships. Add new reliability inputs and assessment techniques to design rules. Incorporate methods for predicting extreme and cumulative lifetime loads into design rules. Collect and analyze long-term hydrodynamic loads data. Correlate full scale loads measurements with model test results. Validate and adapt advanced seaway loads prediction methods for use with design rules. Develop methodology for bow form effects on hull loads. Establish safety indices for naval ship structures components (unstiffened and stiffened plates). Continue performing large scale grillage strength tests. Assessment of grillage strength test data. Update design data sheet for compressive strength of plating stiffeners and grillages. Begin integration of all four parts of the reliability-based load and resistance factor design (LRFD) structural rules for naval surface ships. Validate processes and utilize technologies/improved design methods on existing ships and new designs. Support transition to industry through the Ship Structure Committee (SSC).

- (U) (\$0.940) Total Ownership Cost Methods and Modeling: Develop total ownership cost modeling and cost decision making tools for ships. Support Navy-Shipbuilding Industry cost model development team. Enhance the PODAC cost model capability to incorporate separately estimated cost for C4I and combat systems. Execute development plan for risk and schedule capabilities of PODAC cost model. Collect and analyze cost data of shipbuilders for development of activity based cost estimation factors. Continue to develop PODAC cost model estimating ratios for shipbuilding interim products, parametric scaleable systems, and shipboard equipment for ships. Develop cost estimation ratios for world class shipbuilding processes and practices and for new ship production processes, technologies, and materials. Continue integration of operating and support (O&S) cost modeling and analysis capabilities. Develop O&S cost estimating ratios for naval ships through analysis of VAMOSOC and other historical O&S databases. Continue work on design data analysis module to link PODAC with computer-aided ship design tools.

- (U) Note: Affordability Through Commonality (ATC) program efforts transferred to PE 0603513N, Project 32469 in FY 2000 and out years.

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B. Program Change Summary:			
	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>
FY 1999 President's Budget	15.713	14.900	14.019
Appropriated Value	16.198	14.900	
Adjustment to FY 1998 Appropriated Value/ FY 1999 President's Budget	-10.934	-7.823	-8.701
FY 2000/01 PRES Budget Submit	5.264	7.077	5.318
<p>(U) Funding: FY 1998, FY 1999 and FY 2000 large funding changes reflect realignment of Affordability Through Commonality funding and efforts to PE 0603513N, Project 32469. FY 1998 funding also decreased due to Below Threshold Reprogramming actions, Congressional general adjustments and revised economic assumptions, and SBIR reduction. Note that actual FY 1998 executed funding was \$6.276M. FY 2000 funding also decreased due to sponsor POM 00 modifications and outsourcing reductions.</p> <p>(U) Schedule: None.</p> <p>(U) Technical: None</p>			
C. Other Program Funding Summary: Not applicable.			
<p>(U) Related RDT&E</p> <ul style="list-style-type: none"> (U) PE 0602121N (Surface Ship Technology) (U) PE 0603513N (Shipboard Systems Component Development) (U) PE 0603564N (Ship Preliminary Design and Feasibility Studies) (U) PE 0604300N (SC21 Total Ship Systems Engineering) (U) PE 0604567N (Ship Contract Design/Live Fire T&E) 			
D. Acquisition Strategy:			
<p>This is a non acquisition program that develops, demonstrates, evaluates, and validates early stage total ship concepts, architectures, tools, methods that are used by on-going and future ship acquisition programs.</p>			

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E. Schedule Profile				
	FY 1998	FY 1999	FY 2000	
Program Milestones	(Not applicable - Non-Acquisition Program)			
Engineering Milestones		Complete joint command ship concept studies 4Q	Complete LHA replacement concept studies 4Q	
	Complete Feasibility Tool (ASSET) Integration w/CAD II 4Q	Complete Feasibility Tool (ASSET) to Cost Model interface. 4Q	Complete Feasibility Tool interface to major operational assessment tool (eg NABEM II) 4Q	
	Complete "Focus Problem" CAD to analysis program demonstration project. 3Q	Simulation of Distributed Fluid Systems behavior 4Q	Visualization/Simulation of advanced aircraft handling station 4Q	
	Publish "Ship Engineering Framework" system architecture for collaborative, interoperable design system development. 4Q	Standardize interface mechanism (eg, STEP, COM) for design tool interoperability. 4Q	Publication of interface specifications for 20 analysis programs. 4Q	
	Stiffened Panel LRFD structural rules 4Q	Structural Fatigue LRFD structural rules 4Q	Safety indices for naval ship structures components (unstiffened and stiffened plates). 4Q	
	Updated design data sheet for fatigue of ship metal structures (DDS) 4Q	Establish safety indices for naval ship structures for hull girders. 4Q	Fracture & Grillage Tests of Shipyard Fabrication Specimens Complete 4Q	
	PODAC Cost Model Validation Complete at 2 shipyards 4Q	PODAC Cost Model Validation Complete at 2 additional shipyards 4Q		
		PODAC Cost Model Version 1 4Q		
Testing Milestones	(Not applicable - Non-Acquisition Program)			
Contract Milestones	(Not applicable - Non-Acquisition Program)			

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Exhibit R-3 Cost Analysis		Date: February 1999
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Cost Categories (Tailor to WBS, or System/Item Requirements)	Contract Method & Type	Performing Activity & Location	Total PYs Cost	FY99 Cost	FY99 Award Date	FY00 Cost	FY00 Award Date				Cost To Complete	Total Cost	Target Value of Contract
Systems Engineering, Concept Development, Engineering Development, Demonstration & Evaluation	C/CPFF	Advanced Marine Enterprises (AME) Arlington, VA	5.006	0.700	Note (1)	0.600	Note (1)				Cont.	Cont.	N/A
Cost Model Development, Demonstration & Evaluation and Cost Analysis	C/CPFF	SPAR Assoc, Annapolis MD Note(2)	0.700	0.800	Note (2)	0.700	Note (2)				Cont.	Cont.	N/A
Systems Engineering, Concept Development, Engineering Development, Demonstration & Evaluation	various	Other Contractors	42.104	1.490	various	0.925	various				N/A	N/A	N/A
Systems Engineering, Concept Development, Engineering Development, Demonstration & Evaluation	WR	NSWC/Carderock Division, Carderock. MD	19.374	3.337	N/A	2.900	N/A				N/A	N/A	N/A
Systems Engineering, Concept Development, Engineering Development, Demonstration & Evaluation	WR & MIPR	Other Govt. Activities	6.593	0.750	N/A	0.193	N/A				N/A	N/A	N/A
Subtotal Product Development			73.777	7.077		5.318							
Remarks: Note (1): Existing Contract awarded April 1995. Modifications award 1 st quarter of FY. Note (2): Existing Contract awarded March 1998. Modifications award 1 st quarter of FY. This contract also includes Avondale Industries, New Orleans, LA; Bath Irons Works, Bath, ME; Ingalls Shipbuilding, Pascagoula, MS; NASSCO, San Diego, CA; Designers & Planners, Arlington, VA; and The University of Michigan Transportation Research Institute, Ann Arbor, MI													
Subtotal Support			0	0	N/A	0	N/A				N/A	N/A	N/A
Remarks:													
Subtotal T&E			0	0	N/A	0	N/A				N/A	N/A	N/A
Remarks: Demonstration & Evaluation Costs are included in product development cost category.													
Subtotal Management			0	0	N/A	0	N/A				N/A	N/A	N/A
Remarks:													
Total Cost			73.777	7.077		5.318							