DEPARTMENT OF THE NAVY
FISCAL YEAR (FY) 2003
BUDGET ESTIMATES

JUSTIFICATION OF ESTIMATES
FEBRUARY 2002

RESEARCH, DEVELOPMENT, TEST & EVALUATION, NAVY
BUDGET ACTIVITIES 1-3

Department of the Navy
FY 2003 RDT&E Program

Exhibit R-1

APPROPRIATION: 1319n Research, Development, Test and Evaluation, Navy

DATE: February 2002

R-1 Line Number	Program Element Number	Item Nomenclature	Budget Activity	FY 2001 (Thousands of Dollars)	FY 2002 (Thousands of Dollars)	FY 2003 (Thousands of Dollars)	Security Classification
1	0601152N	IN-HOUSE LABORATORY INDEPENDENT RESEARCH	1	13.698	16.147	16.352	U
2	0601153N	Defense Research Sciences	1	371.665	388.353	393.557	U
		Total Basic Research		385.363	404.500	409.909	
3	0602111N	AIR AND SURFACE LAUNCHED WEAPONS TECHNOLOGY	2	56.315	0.000	0.000	U
4	0602114N	Power Projection Applied Research	2	0.000	83.413	76.612	U
5	0602121N	SHIP, SUBMARINE & LOGISTICS TECHNOLOGY	2	54.094	0.000	0.000	U
6	0602122N	Aircraft Technology	2	21.032	0.000	0.000	U
7	0602123N	Force Protection Applied Research	2	0.000	130.870	89.390	U
8	0602131M	MARINE CORPS LANDING FORCE TECHNOLOGY	2	12.144	30.961	30.274	U
9	0602232N	C3 Technology	2	113.270	0.000	0.000	U
10	0602233N	HUMAN SYSTEMS TECHNOLOGY	2	40.994	2.577	0.000	U
11	0602234N	Materials, Electronics & Computer Technology	2	100.177	19.129	0.000	U
12	0602235N	Common Picture Applied Research	2	0.000	124.370	75.594	U
13	0602236N	Warfighter Sustainment Applied Research	2	0.000	107.842	68.852	U
14	0602270N	ELECTRONIC WARFARE TECHNOLOGY	2	24.398	0.000	0.000	U
15	0602271N	RF Systems Applied Research	2	0.000	68.300	56.263	U
16	0602314N	UNDERSEA WARFARE SURVEILLANCE TECHNOLOGY	2	41.754	0.000	0.000	U
17	0602315N	MCM, Mining & Special Warfare Technology	2	52.360	0.000	0.000	U
18	0602435N	OCEANOGRAPHIC AND ATMOSPHERIC TECHNOLOGY	2	75.375	62.035	55.180	U
19	0602633N	UNDERSEA WARFARE WEAPONRY TECHNOLOGY	2	34.563	1.685	0.000	U
20	0602747N	Undersea Warfare Applied Research	2	0.000	75.834	71.294	U
21	0602782N	Mine and Expeditionary Warfare Applied Res.	2	0.000	57.158	56.813	U
22	0602805N	DUAL USE SCIENCE AND TECHNOLOGY PROGRAM	2	9.992	12.489	0.000	U
		Total applied Research		636.468	776.663	580.272	
23	0603114N	Power Projection Advanced Technology	3	0.000	117.756	78.247	U
24	0603123N	Force Protection Advanced Technology	3	0.000	139.782	57.604	U
25	0603217N	AIR SYSTEMS AND WEAPONS ADVANCED TECHNOLOGY	3	62.621	0.000	0.000	U
26	0603235N	Common Picture Advanced Technology	3	0.000	49.807	37.753	U
27	0603236N	Warfighter Sustainment Advanced Technology	3	0.000	72.798	82.542	U
28	0603238N	PRECISION STRIKE AND AIR DEFENSE TECHNOLOGY	3	90.193	0.000	0.000	U
29	0603270N	ADVANCED ELECTRONIC WARFARE TECHNOLOGY	3	24.803	0.000	0.000	U
30	0603271N	RF Systems Advanced Technology	3	0.000	80.433	65.098	U
31	0603508N	Ship Propulsion System	3	74.222	2.973	0.000	U
32	0603640M	MC Advanced Technology Demo	3	57.456	61.843	51.606	U
33	0603706N	MEDICAL DEVELOPMENT	3	83.331	58.479	0.000	U
34	0603707N	MANPOWER, PERSONNEL AND TRAINING ADV TECH DEV	3	46.494	1.982	0.000	U
35	0603712N	Environmental Quality & Logistics Adv Tech	3	32.259	1.388	0.000	U
36	0603727N	Joint Experimentation	3	64.615	102.868	97.872	U
37	0603729N	Warfighter Protection Advanced Technology	3	0.000	28.425	19.040	U
38	0603747N	UNDERSEA WARFARE ADVANCED TECHNOLOGY	3	59.860	59.175	40.125	U
39	0603758N	Navy Warfighting Experiments and Demonstrat.	3	0.000	42.827	43.460	U
40	0603782N	Shallow Water MCM Demos	3	46.538	49.339	43.725	U
41	0603792N	Advanced Technology Transition	3	100.618	0.000	0.000	U
42	0603794N	C3 Advanced Technology	3	48.399	0.000	0.000	U
		Total Advanced Technology Development		791.409	869.875	617.072	
		Total Science and Technology (S&T)		1,813.240	2,051.038	1,607.253	

Department of the Navy
FY 2003 RDT&E Program
Alphabetic Listing

Exhibit R-1

APPROPRIATION: 1319n Research, Development, Test and Evaluation, Navy

DATE: February 2002

R-1 Line Number	Program Element Number	Item Nomenclature	Budget Activity	FY 2001 (Thousands of Dollars)	FY 2002 (Thousands of Dollars)	FY 2003 (Thousands of Dollars)	Security Classification
29	0603270N	ADVANCED ELECTRONIC WARFARE TECHNOLOGY	3	24.803	0	0	U
41	0603792N	Advanced Technology Transition	3	100.618	0	0	U
3	0602111N	AIR AND SURFACE LAUNCHED WEAPONS TECHNOLOGY	2	56.315	0	0	U
25	0603217N	AIR SYSTEMS AND WEAPONS ADVANCED TECHNOLOGY	3	62.621	0	0	U
6	0602122N	Aircraft Technology	2	21.032	0	0	U
42	0603794N	C3 Advanced Technology	3	48.399	0	0	U
9	0602232N	C3 Technology	2	113.27	0	0	U
26	0603235N	Common Picture Advanced Technology	3	0	49.807	37.753	U
12	0602235N	Common Picture Applied Research	2	0	124.37	75.594	U
2	0601153N	Defense Research Sciences	1	371.665	388.353	393.557	U
22	0602805N	DUAL USE SCIENCE AND TECHNOLOGY PROGRAM	2	9.992	12.489	0	U
14	0602270N	ELECTRONIC WARFARE TECHNOLOGY	2	24.398	0	0	U
35	0603712N	Environmental Quality & Logistics Adv Tech	3	32.259	1.388	0	U
24	0603123N	Force Protection Advanced Technology	3	0	139.782	57.604	U
7	0602123N	Force Protection Applied Research	2	0	130.87	89.39	U
10	0602233N	HUMAN SYSTEMS TECHNOLOGY	2	40.994	2.577	0	U
1	0601152N	IN-HOUSE LABORATORY INDEPENDENT RESEARCH	1	13.698	16.147	16.352	U
36	0603727N	Joint Experimentation	3	64.615	102.868	97.872	U
34	0603707N	MANPOWER, PERSONNEL AND TRAINING ADV TECH DEV	3	46.494	1.982	0	U
8	0602131M	MARINE CORPS LANDING FORCE TECHNOLOGY	2	12.144	30.961	30.274	U
11	0602234N	Materials, Electronics & Computer Technology	2	100.177	19.129	0	U
32	0603640M	MC Advanced Technology Demo	3	57.456	61.843	51.606	U
17	0602315N	MCM, Mining & Special Warfare Technology	2	52.36	0	0	U
33	0603706N	MEDICAL DEVELOPMENT	3	83.331	58.479	0	U
21	0602782N	Mine and Expeditionary Warfare Applied Res.	2	0	57.158	56.813	U
39	0603758N	Navy Warfighting Experiments and Demonstrat.	3	0	42.827	43.46	U
18	0602435N	OCEANOGRAPHIC AND ATMOSPHERIC TECHNOLOGY	2	75.375	62.035	55.18	U
23	0603114N	Power Projection Advanced Technology	3	0	117.756	78.247	U
4	0602114N	Power Projection Applied Research	2	0	83.413	76.612	U
28	0603238N	PRECISION STRIKE AND AIR DEFENSE TECHNOLOGY	3	90.193	0	0	U
30	0603271N	RF Systems Advanced Technology	3	0	80.433	65.098	U
15	0602271N	RF Systems Applied Research	2	0	68.3	56.263	U
40	0603782N	Shallow Water MCM Demos	3	46.538	49.339	43.725	U
31	0603508N	Ship Propulsion System	3	74.222	2.973	0	U
5	0602121N	SHIP, SUBMARINE & LOGISTICS TECHNOLOGY	2	54.094	0	0	U
38	0603747N	UNDERSEA WARFARE ADVANCED TECHNOLOGY	3	59.86	59.175	40.125	U
20	0602747N	Undersea Warfare Applied Research	2	0	75.834	71.294	U
16	0602314N	UNDERSEA WARFARE SURVEILLANCE TECHNOLOGY	2	41.754	0	0	U
19	0602633N	UNDERSEA WARFARE WEAPONRY TECHNOLOGY	2	34.563	1.685	0	U
37	0603729N	Warfighter Protection Advanced Technology	3	0	28.425	19.04	U
27	0603236N	Warfighter Sustainment Advanced Technology	3	0	72.798	82.542	U
13	0602236N	Warfighter Sustainment Applied Research	2	0	107.842	68.852	U
		Total Science and Technology (S&T)		1,813.240	2,051.038	1,607.253	

Fiscal Year 2003 Budget Estimates
Budget Appendix Extract Language

RESEARCH, DEVELOPMENT, TEST & EVALUATION, NAVY (RDTEN)

For expenses necessary for basic and applied scientific research, development, test and evaluation, including maintenance, rehabilitation, lease, and operation of facilities and equipment, **[**$11,498,506,000**]** *$12,501,630,000*, to remain available for obligation until September 30, **[**2003**]** *2004: Provided, That funds appropriated in this paragraph which are available for the V–22 may be used to meet unique operational requirements of the Special Operations Forces. (10 U.S.C. 174, 2352–54, 7522; Department of Defense Appropriations Act, 2002; additional authorizing legislation required.)*

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 1 PROGRAM ELEMENT: 0601152N
PROGRAM ELEMENT TITLE: In-House Laboratory Independent Research (ILIR)

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
0601152N	13,698	16,147	16,352	17,082	17,254	17,531	17,853	CONT.	CONT.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This program sustains U.S. Naval Science and Technology (S&T) superiority, provides new technological concepts for the maintenance of naval power and national security, and helps avoid scientific surprise, while exploiting scientific breakthroughs and providing options for new Future Naval Capabilities. It responds to S&T directions of the Department of the Navy (DON) Integrated Warfare Architecture Requirements for long term Navy and Marine Corps improvements, is in consonance with future warfighting concepts and doctrine developed at the Naval Warfare Development Command and the Marine Corps Combat Development Command, and enables technologies to significantly improve the Joint Chiefs of Staff's Future Joint Warfighting Capabilities. It is managed by the Chief Scientist of the Office of Naval Research (ONR) and executed by the Commanding Officers (COs) and Technical Directors (TDs) of the Naval Warfare Centers, Naval Personnel Research, and Bureau of Medicine and Surgery laboratories.

The vision of the DON S&T strategy is "to inspire and guide innovation that will provide technology-based options for future Navy and Marine Corps Capabilities", where "Innovation is a process that couples Discovery and Invention with Exploitation and Delivery". DON Basic Research, which includes scientific study and experimentation directed toward increasing knowledge and understanding in national-security related aspects of physical, engineering, environmental and life sciences, is the core of Discovery and Invention. Basic research projects are developed, managed, and related to more advanced aspects of research in some hundred-plus technology and capability-related 'thrusts', which are consolidated in 22 research areas. These in turn support the major motivational research focus areas of the Navy and Marine Corps after Next: maritime and space environments that impact operational capability, information science/knowledge management in network-centric operations, sensors and electronic systems for surveillance and tactical applications, energy/power/propulsion for performance gain and sustainment advanced air/surface/undersea and multi-environment Naval platforms design/signature reduction, and superior human performance/training/care of Sailors and Marines.

BUDGET ACTIVITY: 1 PROGRAM ELEMENT: 0601152N
PROGRAM ELEMENT TITLE: In-House Laboratory Independent Research (ILIR)

This portion of the DON Basic Research Program provides participating Navy Centers and Laboratories with funding for basic research to support the execution of their assigned missions, for developing and maintaining a cadre of active research scientists who can distill and extend results from worldwide research and apply them to Naval problems, to promote hiring and development of new scientists, and to encourage collaboration with universities, private industry, and other Navy and Department of Defense laboratories, in particular the corporate Naval Research Laboratory (NRL).

Navy ILIR procedures were revised in FY00 to further encourage collaboration and the participation of new scientists, to relate the program more closely to the overall DON S&T strategy and the ONR/NRL thrusts, and to strongly encourage projects comprising teams of investigators that are of sufficient scope and risk to have a potentially significant impact on DON priorities. Those procedural changes resulted in additional S&T initiatives between ONR and the Naval Warfare Centers and laboratories in FY02 and the trend is expected to continue in FY03. ILIR status, results, and management are reported annually to the Deputy Under Secretary of Defense (Science and Technology).

ILIR projects are selected by Center/Lab COs and TDs near the start of each Fiscal Year through internal competition. Projects typically last 3 years, and are generally designed to assess the feasibility of new lines of research. Successful efforts attract external, competitively awarded funding. Because the Warfare Centers and Labs encompass the full range of naval technology interests, the scope of ILIR topics roughly parallels that of PE 0601153N, Defense Research Science. In FY01, about 50 projects were completed and 70 initiated.

JUSTIFICATION FOR BUDGET ACTIVITY: This program is funded under BASIC RESEARCH because it encompasses scientific study and experimentation directed towards increasing knowledge and understanding in broad fields directly related to long-term DON needs.

B. (U) PROGRAMS ACCOMPLISHMENTS AND PLANS:

1. (U) FY 2001 ACCOMPLISHMENTS:
    - (U) ($3,560) Ocean/Space Sciences: Extended large eddy simulation hydrodynamic methodology for predicting turbulence in complex generalized geometries. Improved acoustic propagation models in the littoral regime. Demonstrated automatic detection of a submarine in the littoral environment using an inexpensive deployable line array of hydrophones.

- (U) ($2,603) Advanced Materials: Identified specific molecular interactions involved in binding biofilms to surfaces to improve biofouling coatings. Improved the characterization of dielectric films for infrared scattering. Developed improved polyurethanes with reduced creep properties for improved acoustic coatings.

- (U) ($1,654) Information Sciences: Investigated the automatic processing of spoken language for team training and analysis of tactical communications in stressing military environments. Determined that a non-linear antenna could be switched between radiating periodic and chaotic electrical fields. Developed a methodology for modeling a distributed object-oriented software system with a defined set of users on a heterogeneous hardware system.

- (U) ($2,055) Electronics/Sensor Sciences: Developed improved sensors to detect Methyl tert-butyl ether, a gasoline additive that has become a serious ground water contaminant. Developed improved modeling algorithms for hyperspectral data processing. Developed algorithms for fully automated detection and classification of sea mines in the littoral.

- (U) ($1,106) Energy Sciences: Synthesized a new insensitive energetic heterocyclic material. Demonstrated the control and anti-control of chaos in thermal pulse combustor systems. Improved surface stabilization and characterization of electro-chemical catalysts in semi-fuel cells.

- (U) ($1,634) Human Performance Sciences: Completed a study of shipboard stressors to enable better preparation of new sailors to the afloat environment. Developed a test to identify Sailors/Marines with good multitasking abilities to improve person-to-job matching. Investigated whether hot or cold environments influence decompression sickness.

- (U) ($1,086) Naval Platform Design Sciences: Developed techniques for improved design of underwater maneuvering and control surfaces. Utilized the farfield wake theory to estimate impact of naval operations on nearby commercial vessels. Improved environmental quality of navy bioreactors with reduced downtime.

2. (U) FY 2002 PLAN:

- (U) ($4,198) Ocean/Space Sciences: Develop an efficient range-dependent elastic propagation model for improved undersea surveillance. Develop an inverse method for analyzing three dimensional shallow water sound propagation. Develop a new matrix for classification of non-stationary acoustic transient signals.

- (U) ($3,068) Advanced Materials: Develop structural amorphous metals for improved wear and corrosion applications. Develop low cost, rugged magnetostrictive alloys for naval and industrial transduction needs. Investigate advanced complex metal oxide materials for electromagnetic shielding.

- (U) ($1,948) Information Sciences: Develop improved receiver synchronization for continuous-phase modulation waveforms. Develop improvements in the ultra high frequency advanced digital waveform. Investigate improved software agents for dissemination of sensor information and tasking.

- (U) ($2,422) Electronics/Sensor Sciences: Improve navigation accuracy of microelectro-mechanical sensor gyroscopes by exploiting nonlinear oscillator dynamics. Design an efficient and extremely wideband phased array antenna. Demonstrate a second order convergence of an adaptive tracking algorithm.

- (U) ($1,302) Energy Sciences: Develop new organometallic energetic materials with the potential for twice the energy content of CL-20. Develop improved energy and power densities for thermal batteries and enable critical weight and volume savings. Investigate stabilized aluminum-based nanocomposite materials.

- (U) ($1,928) Human Performance Sciences: Investigate reducing metabolic demand as a treatment for battlefield injuries that involve major blood loss. Develop a novel approach to estimating parasite challenge to enhance development of anti-malarial prophylactic agents. Research to develop a method to increase the time a hypoxic pilot can safely control an aircraft.

- (U) ($1,281) Naval Platform Design Sciences: Extend current computational fluid dynamics techniques to cavitation and super-cavitation flow regimes. Improve underwater shock analysis of naval structures to reduce testing costs. Develop improved high density passive components for power electronics.

3. (U) FY 2003 PLAN:

- (U) ($4,252) Ocean/Space Sciences: Develop advances in maneuvering target tracking and classification algorithms based on continuous-state Markov processes. Determine the effects of compressibility of surrounding air on the stability properties of a high speed shell of liquid. Develop techniques to use buried seismometers to detect submarines.

- (U) ($3,107) Advanced Materials: Develop improved high temperature materials for micro-electro-mechanical sensors for ships and aircraft. Develop improved high temperature composite matrix materials. Investigate ductile to brittle fracture of high strength low alloy steels.

- (U) ($1,972) Information Sciences: Demonstrate that an adaptive robust tracking parameter provides smoothed estimates of targets during a maneuver. Improve receiver syncronization for continuous-phased modulation waveforms to enhance digital communications. Investigate application of stochastic nonlinear dynamics to communications arrays.

- (U) ($2,453) Electronics/Sensor Sciences: Investigate properties of a new gyroscope design based on squeezed light beams to enable highly accurate navigation systems. Develop stand-off detection of explosive signatures on mine-like objects. Investigate and develop new non-Markov switching matrix-based adaptive multiple model tracking filters.

- (U) ($1,318) Energy Sciences: Investigate synthesis of high-Nitrogen salts for propellants of missile and guns systems. Investigate use of a hydrogen peroxide catholyte in combination with an aluminum anode for improved fuel cells. Characterize and extend current expertise in battery technology through lithium-manganese oxides.

- (U) ($1,952) Human Performance Sciences: Develop rapid inexpensive screening tests for industrial chemicals in the littoral environment. Enhance training techniques with simulation-based computer games. Study the importance of information prioritization and organization in submarines.

- (U) ($1,298) Naval Platform Design Sciences: Investigate novel use of particle imaging velocimetry to quantify bubbly flow and fluid-bubble coupling. Develop understanding of the role that critical surface tension plays on biofilm adhesion. Develop a series of closely integrated hydrodynamic tools for hull form design and optimization.

C. (U) PROGRAM CHANGE SUMMARY:

	2001	2002	2003
FY 2002 President's Budget Submission	16,193	16,291	
SBIR	-68		
Execution Adjustment	-2,427		
Section 8123 Mgmt Reform Initiative Reduction		-144	
FY 2003 President's Budget Submission	13,698	16,147	16,352

(U) CHANGE SUMMARY EXPLANATION:

(U) Funding: Not Applicable.
(U) Schedule: Not Applicable.

(U) OTHER PROGRAM FUNDING SUMMARY:

(U) NAVY RELATED RDT&E:
(U) 0601153N Defense Research Sciences

(U) NON NAVY RELATED RDT&E:
(U) 0601101A In-House Laboratory Independent Research (Army)
(U) 0601101F In-House Laboratory Independent Research (Air Force)

(U) SCHEDULE PROFILE: Not applicable.

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 1 PROGRAM ELEMENT: 0601153N
PROGRAM ELEMENT TITLE: Defense Research Sciences

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TO COMPLETE
0601153N	371,665	388,353	393,557	395,418	404,006	411,991	420,429	CONT.	CONT.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION:. This program sustains U.S. Naval science and technology (S&T) superiority, provides new technological concepts for the maintenance of Naval power and national security, and helps avoid scientific surprise, while exploiting scientific breakthroughs and providing options for new Future Naval Capabilities. It responds to S&T directions of the Department of the Navy (DON) Integrated Warfare Architecture Requirements for long term Navy and Marine Corps improvements, is in consonance with future warfighting concepts and doctrine developed at the Naval Warfare Development Command and the Marine Corps Combat Development Command, and enables technologies to significantly improve the Joint Chiefs of Staff's Future Joint Warfighting Capabilities. It is managed by the Office of Naval Research (ONR) through Program Officers at ONR Headquarters, and the base program of the corporate Naval Research Laboratory (NRL).

The vision of the DON S&T strategy is "to inspire and guide innovation that will provide technology-based options for future Navy and Marine Corps Capabilities", where "Innovation is a process that couples Discovery and Invention with Exploitation and Delivery". DON Basic Research, which includes scientific study and experimentation directed toward increasing knowledge and understanding in national-security related aspects of physical, engineering, environmental and life sciences, is the core of Discovery and Invention. Basic research projects are developed, managed, and related to more advanced aspects of research in some hundred-plus technology and capability-related 'thrusts', which are consolidated in 22 Research Areas. These in turn support the major motivational research focus areas of the Navy and Marine Corps after Next: maritime and space environments that impact operational capability, advanced materials, information science/knowledge management in network-centric operations, sensors and electronic systems for surveillance and tactical applications, energy/power/propulsion for performance gain and sustainment, advanced air/surface/undersea and multi-environment Naval platforms design/signature reduction, and superior human performance/training/care of Sailors and Marines.

Key aspects of the program are the four ONR Grand Challenges which 'inspire and guide' the direction of research: Naval Battlespace Awareness, Electric Power Sources for the Navy and Marine Corps, Naval Materials by Design, and

Multifunctional Electronics for Intelligent Naval Sensors; and the National Naval Responsibilities (NNRs), fields upon which a wide range of fundamental Naval capabilities depend, and in which ONR is and likely will remain the principal US research sponsor. NNRs are ratified only after close scrutiny, and currently comprise Ocean Acoustics (started in FY99), Underwater Weapons (started in FY01), Naval Architecture and Hydrodynamics (starts in FY02), with ongoing assessment of Precision Time and Time Transfer.

JUSTIFICATION FOR BUDGET ACTIVITY: This program is funded under BASIC RESEARCH because it encompasses scientific study and experimentation directed towards increasing knowledge and understanding in broad fields directly related to long-term DON needs.

B. (U) PROGRAMS ACCOMPLISHMENTS AND PLANS: Basic research in each ONR thrust includes a continuing core program to advance the state of knowledge and maintain top talent with interest and skill in Naval problems. Core programs are supplemented by initiatives at the ONR/NRL, department, or division level, to explore promising new avenues or take advantage of breakthroughs and potentially disruptive technologies. Initiatives typically last 2 to 5 years. Due to the volume of efforts included in this program element, the programs described in the Accomplishments and Plans sections are representative selections of the work.

1. (U) FY 2001 ACCOMPLISHMENTS:

- (U) ($141,233) Ocean/Space Sciences: Investigated thin ocean layer biological structures and demonstrated that the presence of biologics has strong optical and acoustic consequences impacting acoustic and non-acoustic predictive models. Investigated and showed effects of wave-current-gravity on ocean shelf sediment deposition and dispersal which will lead to improved shelf sediment characterization and more accurate mine burial and detection models and sensors. Studied phenomena of high latitude cloud-ice albedo dynamics and the impacts on rapid polar ice melting and the associated environmental changes. Improved existing ocean and atmospheric models to simulate and forecast the operational environment and provide accurate predictions of optimum sensor and weapon employment. Developed an Acoustic Integration Model to enable planners to synthesize quantitative 4-D information about deep and shallow ocean sound fields and marine mammal movements. Employed the NRL Space Physics Simulation Chamber coupled with theoretical investigations to demonstrate the Earth's magnetospheric boundary layer response to stresses imposed by increased solar activity. Conducted a hyperspectral biological and chemical assessment and the dynamics of Chesapeake Bay outflow plume. Determined effects of microbial oxidation-reduction of humus substances for improved environmental cleanup techniques. Employed autonomous undersea vehicles based sensors to investigate coastal ocean processes and enable expanded future oceanographic data collection at reduced cost.

- (U) ($66,900) Advanced Material Sciences: Improved heat treatments and low alloy compositions for high strength low alloy steels with superior strength and toughness for enhanced shipboard blast protection, reduced weight, and reduced production cost. Developed an innovative shell casting methodology for reduced maintenance and weight of shipboard watertight doors. Determined the fundamental relationship between the thermal contrast of materials and other physical parameters to allow for a new non-destructive evaluation technique for inspection of metals and composites. Invented two families of methods to compute fluid flow in complex configurations to improve understanding of blast shock mitigation to ships/submarines, ground vehicles, and buildings and other structures. Developed nuclear quadrapole resonance sensors for detection of explosives and contraband. Investigated field emission capabilities of carbon nanotubes leading to new opportunities in x-ray tubes, power amplifiers, and information displays. Developed new thin-film deposition methods to deposit fragile polymers and organic materials for micro-electromechanical devices, micro sensors, and for biological research. Synthesized new functional dendrimeric materials for use in hand held and unmanned air vehicle based chemical weapons sensors. Developed science base for high power millimeter wave beam processing of ceramic materials for piezoelectric actuator assemblies, ceramic heat engine components, thermal barrier coatings, and anti-corrosion coatings.

- (U) ($52,033) Information Sciences: Improved embedded learning techniques to enable autonomous vehicles on long duration missions to adapt to unanticipated events. Developed method to process digital terrain elevation data into a model that accurately represents the true geography. Developed principles for producing safe and secure software-intensive systems. Developed ability to characterize a computer network and determine patterns of anomalies to enable network intrusion detection. Developed algorithms to solve very large scale integer combinatorial optimization problems. Developed efficient use of Turbo codes and iterative processing in a wireless communication receiver to increase data rate, increase number of potential users, and provide for higher anti-jam capabilities. Developed intelligent agent software architectures to increase effectiveness of Joint Command and Control Teams. Developed tracking and recognition algorithms for a battlefield augmented reality system. Developed hierarchical level of detail algorithms to enable the visualization of very large ship design data sets.

- (U) ($44,599) Electronics/Sensor Sciences: Developed instrument for spatial imaging of electron and ion spins to enable study of impurities, defects, and trapped electron in nano-electronic devices. Developed plasma filled diodes for generating high power electron beams for nuclear weapons effects simulation and radiology applications. Developed physics-based target scattering modeling and signal processing algorithms for improved target identification and tracking. Developed a hybrid millimeter wave/infrared lens for improved sensor fusion and day/night imagery. Developed coordinated network-based electronic warfare techniques to achieve battleforce defense. Developed networked radio frequency and infrared offboard countermeasure grid techniques for anti-ship missile terminal defense and radar acquisition denial. Developed and demonstrated techniques to permit the design of a millimeter wave capable ship's decoy. Identified environmentally friendly infrared obscurants and investigated efficient expendable deployment approaches for these materials. Investigated forward radar scatter in the ocean environment and determined the reflection coefficient under a variety of conditions to enable better radar performance predictive models.

- (U) ($29,733) Energy Sciences: Demonstrated jet noise reduction feasibility using passive control techniques thus enabling compliance with increasingly stringent environmental requirements. Developed steady state combustion model to predict missile propellant combustion behavior. Demonstrated a new generation of environmentally preferable and reduced cost green energetic materials. Analyzed the effect of inlet enthalpy on active combustion control effectiveness and demonstrated robust control over a wide range of inlet temperatures and missile flight conditions up to Mach 2.75. Demonstrated the capability for sustained pulse detonation engine operation utilizing standard aircraft fuel. Demonstrated efficiencies of a compact, automated vortex combustor for incineration of solid waste.

- (U) ($22,300) Human Performance Sciences: Developed therapies for treatment of hyperbaric oxygen poisoning to enable safer operations in diving and decompression conditions. Completed a characterization of relationship between brain activity and memory load. Developed basic understanding of hybrid architectures for complex learning with applications in tactical decision making. Developed a novel inner ear treatment approach for noise-induced hearing losses. Exploited improved understanding of human cognition and performance to create more realistic, capable, and cost effective simulated forces to populate training simulations and improve decision aid algorithms. Obtained Food and Drug Administration approval for Algal Hemostatic Dressing which will greatly reduce field combat deaths due to blood loss.

- (U) ($14,867) Naval Platform Design Sciences: Demonstrated feasibility of an integrated full stern/propulsor concept. Implemented radar holography measurement system for both radiation and scattering studies. Developed numerical models of ferromagnetic signatures that minimize the number of actuators and sensors for closed-loop degaussing. Developed high power density ceramic capacitor material to enable smaller volume power converters for shipboard applications. Developed basic understanding of the phenomenology and control of above water signatures for evolving threat scenarios. Integrate hydrodynamic and electromagnetic models to predict scattering from breaking waves and improve ship hull design.

2. (U) FY 2002 PLAN:

- (U) ($145,484) Ocean/Space Sciences: Develop an improved predictive capability of beach characteristics including berm heights and vehicle trafficability to enhance expeditionary force mobility through the surf-zone and across the beach. Continue to refine techniques for utilizing autonomous undersea vehicles to investigate coastal and ocean basin processes thereby increasing data collection in areas that are difficult to access. Develop new techniques for advanced sensors for emission monitoring, improved membranes for water waste treatment, anti-fouling/foul-release coatings knowledge base for fate/effects of metal and organic materials in the marine environment, and reduction or elimination of Chloro-Fluorocarbon-based cooling. Advance current understanding of high level/nonlinear acoustic propagation and measurement of jet noise to enable passive and active noise reduction techniques. These efforts will result in reduced hearing loss by sailors and marines and reduced jet noise in areas where civilian population is closely adjacent to military facilities. Continue study and characterization of solar coronal mass ejections to enable determination of space velocities and predict impacts on critical Naval and national space-based sensors and communication systems. Develop improved Earth upper atmospheric neutral density models for more accurate satellite drag prediction and improved estimates of useful satellite life. Employ the upgraded Polar Ice Prediction System for improved assessments of the wind-current dynamics of arctic ice movements to reduce the sea ice threat to military and civilian shipping. Continue investigation of the marine geology mechanisms for the formation of sedimentary flood deposits on continental shelves and the impacts those mechanisms have on sea mine burial and detection. Develop new techniques for extracting useful environmental information from existing observing systems in the most efficient and cost-effective way.

- (U) ($68,914) Advanced Material Sciences: Develop improved piezoelectric crystal growth techniques to revolutionize electromechanical transduction for sonar and undersea weapons applications. Develop an automated and cost effective process of liquid molding manufacturing of composite components for ship and aerospace applications. Continue work to improve understanding techniques for blast shock mitigation to ships/submarines. Develop novel luminescent quantum dot bio-conjugates for chemical and biological weapons sensor applications. Develop the science for thermally-stable, long living, highly efficient, light emitting diodes for use in maps and displays. Investigate the synthesis and assembly of nanoscale electro-active structures and composites for optical and thermal management applications. Continue investigation of engineering nano-structures into functional mesoscopic materials for advanced power sources, low cost technologies for display and transfer of information, and new methods for thermal management. Investigate corrosion fatigue cracking and stress corrosion resulting from employing friction stir welding construction techniques on type 2519 aluminum components of amphibious assault vehicles. Continue work to improve techniques for high power millimeter wave beam processing of ceramic materials.

- (U) ($53,599) Information Sciences: Develop techniques to enable a collaborating team of heterogeneous agents/robots to operate in unknown environments with uncertain sensing. Develop a fundamental basis for image recognition and understanding. Extend methods for detecting, removing, modifying, decrypting, and creating hidden messages in shared digital media. Develop methods to map large three dimensional urban areas with accurate geo-positioning in real time. Create science base for intelligent software agents that can reason about physical phenomena and communicate with human collaborators. Continue development of novel algorithms for energy-efficient broadcasting and multi-casting on wireless communication networks. Continue to investigate methods for employing automated systems as substitutes for human vision for monitoring surveillance and reconnaissance. Initiate investigation of time-reversal imaging with application to array imaging, secure wireless communications, and nondestructive testing. Start investigation on applications to micro-fluids such as detection and analysis of genetic materials used for chemical sensing. Continue work on image enhancement and feature extraction techniques for applications to target identification, strike and battle damage assessment.

- (U) ($45,942) Electronics/Sensor Sciences: Develop methods for utilizing Raleigh waves for detection of land mines in various realistic soil types. Identify basic principles and techniques to allow precise control over atomic motion and enable more precise atomic clocks. Characterize the effects on performance of target echoes and boundary and volume scattering for shallow water active sensors. Quantify electromagnetic characteristics in the littoral environment to support mine countermeasures and surveillance systems. Develop autonomous undersea vehicle compatible sensors that can provide two and three-dimensional images for small target recognition. Develop techniques for extending the average power of solid state lasers by eliminating the heating of the laser medium. Continue to improve radio frequency and electronic warfare emission and reception by using wide bandwidth optical fiber signal processing techniques. Develop a set of advanced digital signal processing algorithms that support Naval information extraction requirements and throughput capabilities of emerging digital receiver technologies.

- (U) ($30,628) Energy Sciences: Develop dynamic loading/spectroscopic tools for combustion initiation processes. Investigate novel composites for lightweight long life rechargeable batteries. Investigate interactions between oxidizer and fuel in ammonium-per-chlorate based propellants. Continue study on pulse detonation engine dynamics and gaseous and spray detonations. Explore development of fuel cell power sources that can operate on common logistic fuels for Marine combat units. Investigate multi-axis fluidic thrust vectoring to enable elimination of missile fin structure and reduce heat and drag for hypersonic missile applications. Continue work to develop a compact, efficient, and automated vortex combustor for incineration of solid waste. Investigate techniques for developing deformable missile warheads to increase missile lethality by creating an asymmetric blast pattern focussed in the desired direction.

- (U) ($22,971) Human Performance Sciences: Develop theories and models that address re-configurable organizational structures to support command decision making and command and control team performance. Develop techniques for rapid control of arterial bleeding in the far-forward battlespace. Determine which brain areas are active in performing cognitive tasks and detect likely conflicts among multiple tasks due to loading of same brain areas. Characterize the physiologic basis of operational bio-effects on the warfighter such as heat, cold, radiation and g-forces. Initiate a stress physiology program to identify parameters of individual stress resilience and develop novel therapeutics/strategies catering to the individual warfighter.

- (U) ($15,364) Naval Platform Design Sciences: Develop new hull structural acoustic measurement methodologies to enable advanced machinery support systems and improved hull coatings. Develop hull structural assessments capabilities for determining the integrity of the ship throughout its service life. Identify and analyze physics of stratified wakes. Identify active control and system stability criteria for very high (greater than 200MW) power systems. Identify and quantify bubble sources around surface ships including wave-breaking and turbulence effects.

3. (U) FY 2002 Congressional Plus-ups:

- (U) ($991) Marine Mammal Low Frequency Sound Research: Conduct Navy research on the possible effects of man-made underwater noise on protected marine life. Includes work associated with the University of Hawaii Marine Mammal

Facility and related programs in the state of Hawaii. These programs are unique in providing species of marine mammals (Risso's dolphin, false killer whale) not found elsewhere, and in providing the unique coral reef sheltered, warm, clear waters needed for certain experiments involving open water work with trained research marine mammals.

- (U) ($495) Quantum Optics Research: Basic research to investigate the feasibility of developing quantum optics technologies for use in Naval applications.

- (U) ($3,965) Southeast Atlantic Coastal Ocean Observing System: Develop a four-state, inter-institutional partnership that would develop a regional coastal ocean observing system designed to measure conditions in and above the coastal ocean and to report these observations to a broad user base. The system will cover the region between the Virginia/North Carolina border to the Dry Tortugas. The effort is conducted under the auspices of the National Ocean Partnership Program.

4. (U) FY 2003 PLAN:

- (U) ($149,552) Ocean/Space Sciences: Develop techniques for utilizing high resolution, motion imagery methods to predict beach evolution. Develop global on-scene, accurate, theater scale, high resolution environmental characterizations and forecasts to improve all weather operations and defense, capabilities of acoustic/EO/IR sensors, and the performance of Naval weapon in the atmosphere and under the sea. Improve and extend durability of foul-control marine coatings to reduce energy use and adverse environmental impacts and to extend the time between physical removal of hull and marine structure foulants. Initiate investigation of fate and effects of unexploded ordnance in the marine environment to reduce the threat to civilian population and military explosive ordnance disposal personnel. Develop improvements to specification and prediction of the space environment to improve space system performance and their on-call availability. Develop new techniques and algorithms for remote sensing of ocean and atmospheric properties including winds, waves, currents, and surface topography. Continue validation of environmental data and models used by S&T community to ensure reliability and realistic depiction of actual ocean and atmospheric conditions. Develop understanding of physical and biological processes responsible for the formation, maintenance, and breakdown of thin oceanographic layers which have a significant impact on undersea warfare sensors and weapons. Initiate an integrative ecosystem study to develop environmental predictors of whale presence or absence to reduce impacts of Naval systems to marine mammals. Develop new methods for combining "through the sensor" data with other views of the battlespace environment to improve real-time environmental predictions. Investigate the fate and effects of chemical and biological contaminants in marine/estuarine environments.

- (U) ($70,840) Advanced Material Sciences: Explore three-dimensional nature of solid phases in opaque ferrous alloys for improved high strength steels. Continue to investigate pulsed laser deposition techniques to deposit thin films of fragile polymers and organic materials for use in micro-sensors and biological research. Design macromolecules composed of photo-active molecules for underwater mine detection applications. Develop an understanding of electron and ion transport at nano-scale dimensions for power sources and micro-electro-mechanical systems. Develop materials and fabrication science for new agile optical limiter materials for eye and sensor protection. Develop novel magnetic materials for ship board high power electronic applications. Design, synthesize and develop advanced polymers including high temperature and flame resistant polymeric composites and ceramics for aerospace and ship applications. Continue work to improve heat treatments and low alloy compositions for high strength low alloy steels with superior strength and toughness for enhanced shipboard blast protection, reduced weight, and reduced production cost. Explore materials and structures capable of limiting optical transmission at variable wavelengths for enhanced eye and sensor protection against agile laser illumination.

- (U) ($55,098) Information Sciences: Develop theory and algorithms for autonomous systems to recognize a particular scene from different perspectives. Continue refinement of techniques for ensuring privacy of information transferred across public networks. Develop collaborative mission planning tools to facilitate knowledge sharing and management, regulation of information flow, and work-process monitoring. Continue development of turbo-codes and iterative processing techniques to enable high data rates for wireless communication applications. Develop adaptive routing protocols to select the links for routing information packets that maximize communication network throughput with minimum energy consumption. Initiate development of improved tactical and battlespace decision aids through creation of synthetic natural environments. Continue to refine techniques for extracting maximal knowledge from multi-modal imagery, text, and electromagnetic signal data. Continue to investigate methods to deal with light dispersion on image formation underwater to enable precise navigation, station keeping, and mapping capabilities for unmanned underwater vehicles.

- (U) ($47,227) Electronics/Sensor Sciences: Develop high voltage gradient particle linear accelerators by using wakefield acceleration techniques. Explore concepts for new compact tunable short wavelength radiation sources. Develop novel large area plasma processing system for high density plasma etching for microelectronics applications. Continue development of physics-based, broadband, bi-static active classification algorithms to achieve low false alarm rates. Extend development of a hybrid millimeter wave/infrared lens to a 2-color capability for use in advance focal plane arrays. Continue development of radio frequency scattering models to more effectively account for composite structures and coated surfaces. Establish proof-of-principle of a new aircraft defense capability involving acquisition and laser countermeasure against threat missile seekers prior to their launch. Continue to collect and analyze millimeter wave radar time-series data on ships, decoys, and low grazing angle sea clutter and identify potential countermeasure techniques and incorporate millimeter wave phenomena into high fidelity models.

- (U) ($31,485) Energy Sciences: Develop mechanistic understanding of steady and unsteady combustion characteristics of advanced solid propellants. Develop nanoscale metalized explosives for enhanced lethality. Investigate interaction of combustion gases with engine nozzles at high temperatures and pressures to develop techniques for mitigation of nozzle erosion at high pressures. Synthesize and characterize new energetic materials with higher energy density and reduced sensitivity. Develop materials for enabling rechargeable batteries with an energy density of 500 watt-hours per kilogram. Continue investigation of combustion control techniques to enable improved thrust vector control, jet noise reduction, more efficient jet engines, and signature reduction.

- (U) ($23,613) Human Performance Sciences: Exploit improved understanding of human cognition and performance to create more realistic simulations and to improve decision algorithms. Develop new theoretical treatment of the differences in individual humans. Develop computational linguistic techniques to emulate one-to-one tutoring behavior. Research the efficacy of a group of compounds that mimic or assist endogenous defenses to hearing damage to sailors and marines. Determine dosimetry profiles for exposure to multiple frequency microwaves, evaluate cognitive performance effects, and develop predictions on the most hazardous exposure conditions for humans. Develop an understanding of the mechanistic basis of object detection and classification in biologic vision/audition and transform this understanding into robust algorithms for threat and situation assessment decision aids, automatic target recognition in cluttered environments, and detection and classification of buried mines.

- (U) ($15,742) Naval Platform Design Sciences: Develop reliable sea-keeping prediction methods for advanced surface ship hull forms in heavy seas. Develop an integrated acoustics model for complex propulsors. Develop infrared ship predictions for low observable ships that include bi-directional reflectance distribution functions. Develop physics-based analysis tools and models for non-linear circuits and loads and highly coupled ship board power systems. Develop robust turbulence models in three dimension boundary layers to improve submarine maneuvering predictions. Continue work on understanding, predicting, and controlling scattering from discontinuities such as antennas and ship-sea surface radar cross section interactions. Develop next-generation infrared scene model to enable optimal infrared reflectance ship surfaces.

(U) PROGRAM CHANGE SUMMARY:

	FY 2001	FY 2002	FY 2003
FY 2002 President’s Budget Submission	377,642	389,829	
Adjustments from FY 2002 President’s Budget:			
SBIR	-6,759		
Execution Adjustment	782		
Program Growth Reduction	0	-3,500	
Congressional Plus-ups	0	5,500	
Section 8123 Mgmt Reform Initiative	0	-3,463	
FFRDC Reduction	0	-13	
FY 2003 President’s Budget Submission	371,665	388,353	393,557

(U) CHANGE SUMMARY EXPLANATION:

(U) Funding: Not Applicable.
(U) Schedule: Not Applicable.

(U) OTHER PROGRAM FUNDING SUMMARY: Not Applicable

(U) NAVY RELATED RDT&E:
(U) PE 0601152N In-House Laboratory Independent Research

(U) NON NAVY RELATED RDT&E:
(U) PE 0601102A Defense Research Sciences (Army)

BUDGET ACTIVITY: 1 PROGRAM ELEMENT: 0601153N
PROGRAM ELEMENT TITLE: Defense Research Sciences

(U) PE 0601102F Defense Research Sciences (Air Force)

Activities are coordinated through Defense S&T 6.1 Reliance Scientific Planning Groups

(U) SCHEDULE PROFILE: Not applicable.

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602111N
PROGRAM ELEMENT TITLE: Air and Surface Launched Weapons Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE
	Air and Surface Launched Weapons Technology	
	56,315	*

*This PE was restructured in FY 2002. FY 2001 efforts are described in PEs 0602114N, 0603114N and 0603123N.

Congressional Plus-ups appropriated in this PE are described under the following restructured program element:

TITLE	PE NUMBER	FY 2001
Free Electron Laser (FEL) Upgrade	0602114N	$4,826
Pulse Detonation Engine Technology	0602114N	$4,833
Solid Fuel RAMJET	0602114N	$3,868
Spike Urban Warfare System	0602114N	$3,963

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602114N
PROGRAM ELEMENT TITLE: Power Projection Applied Research

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
Power Projection Applied Research	**	83,413	76,612	63,221	61,206	62,659	63,125		
Defense Emergency Response Fund (DERF)			7,300	20,300	20,000	19,000	13,900	CONT.	CONT.

**The Science and Technology Program Element (PEs) were restructured in FY 2002. The work described in FY 2001 was funded in PEs 0602111N, 0602122N, 0602232N, 0602270N, and 0603217N.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project addresses the technology issues involving the Navy's capability to project naval power on the broad seas and in the littoral regions. In particular the technology developed in this Program Element (PE) will support Navy power projection requirements related to fleet defense and protection of naval assets in the littoral area, naval strike operations against critical shore targets, and support for Naval expeditionary forces ashore. This PE supports the Time Critical Strike (TCS) Future Naval Capability (FNC) and the Autonomous Operations (AO) FNC.

(U) Fleet Defense & Air Dominance: The focus of this thrust is on those technologies that will support defense of the fleet in the littoral area and to provide for air dominance in all of the operating areas that Naval forces will operate in the future. Technology areas include: advanced Air-to-Air (A-A) missile seeker and propulsion technologies, Infrared focal plane arrays (IRFPA) and hyperspectral algorithms for target detection, laser tracker and identification, automatic target recognition (ATR) for air targets, High Energy Lasers (HEL) and Directed Energy weapons, advanced warhead and fuzes for use against high speed maneuvering threats, Radio Frequency (RF) photonics to increase bandwidth and reduce size/weight of phased array detectors, radar detection technology in clutter, and advanced Counter-Counter Measure (CCM) techniques for improved missile performance.

(U) Naval Precision Strike Operations: The focus of this thrust is on those technologies that will support Naval Precision Strike Operations and provide the Navy of the future the ability to quickly locate, target, and strike critical targets ashore. Some of the technologies employed to support the Navy strike capability include: Unmanned Air Vehicles (UAV) to locate, identify, and target critical enemy resources and weapons, rapid targeting technologies to enable rapid employment of long range precision strike weapons, smart/high speed weapons to support the attack of time critical targets, and improved explosives with energetic capabilities that will inflict greater damage against the target. This area also includes advanced navigation S&T which is developing technologies in the areas of precision clock and time distribution, Precision Terrain Aided Navigation (PTAN), Laser light sources for fiber optic gyros (FOG), and Relative Navigation.

(U) Support for Naval Expeditionary Forces Ashore: The focus of this thrust is on those technologies that will support expeditionary operations of marines operating in the littoral areas. Some of the technologies developed in this thrust include: advanced gun launched seekers and propulsion techniques that will provide more accurate Naval Fire Support (NFS) at longer ranges, Unmanned Ground Vehicles (UGV) development to provide improved surveillance/targeting support to marines on the ground, smart sensor networks to link UAVs in urban environments, and improved explosive formulations that will provide greater lethality against NFS type targets.

(U) Due to the number of efforts in the PE, the programs described are representative of the work included in the PE.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the APPLIED RESEARCH Budget Activity because it investigates technological advances with possible applications toward the solution of specific Naval problems, short of a major development effort.

B. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 2001 ACCOMPLISHMENTS:

- (U) ($4,159K) FLEET DEFENSE & AIR DOMINANCE (FY01 accomplishments were funded in PE 0602111N.)

  (U) The Air weapons effort is focused on the goal of developing anti-air weapons for ship defense and aircraft. The Aim Airframe control task developed lightweight high temperature material airframe components and peak demand, low drag airframe control concepts. The Surface Wave antenna guidance (SWAG) task performed Ultra High Frequency (UHF) seeker design tradeoffs and completed a test of antennas on Advanced Medium Range Air-to-Air Missile (AMRAAM) test body and composite test fixture. The reactive material warhead Target Interaction, Lethality, and Vulnerability (TILV) task continued lethality testing for model development and validation purposes. The Clutter Rejection Involving Temporal Techniques in the Infrared (CRITTIR) task utilized previously collected data to demonstrate that algorithms based on clutter and target fluctuation statistics could successfully aid early target detection and tracking targets within the solar corridor, completing the effort. The Integrated/Aimed Warhead and the Cumulative Damage TILV tasks were terminated.

  (U) The Integrated High Performance Rocket Technology (IHPRPT) program is a joint Air Force, Army, Navy, NASA, and industry initiative sponsored by DDR&E. The goal of the IHPRPT program is to double rocket propulsion performance by 2010. The Navy is responsible for the tactical rocket propulsion portion. Completed air-to-air missile static test of hardware for two dual-movable nozzle thrust vector control concepts, and baseline testing of low/no erosion, reduced smoke, propellant nozzle materials. The IHPRPT program conducted full-scale gun launched rocket motor firings of aluminized propellant nozzle materials. The IHPRPT program conducted full-scale gun launched testing of an advanced aluminum metal matrix composite gun munition motor case. Surface launched demo program conducted subscale tests of pintle motor operation with reduced smoke propellant.

- (U) ($14,102K) NAVAL PRECISION STRIKE OPERATIONS:

  (U) The Autonomous Operations (AO) Unmanned Air Vehicle (UAV) technology program identified key autonomy technology drivers (autonomous guidance, navigation and control; collaborative communications; intelligent autonomy). Also, developed a database that defined industry state-of-the-art technologies for increasing UAV mission capabilities. (FY01 accomplishments were funded in PE's 0602122N and 0602111N).

  (U) The Micro UAV (MAV) program developed technologies (autonomous flight, radar micro-jammer, low Reynolds number aerodynamics) that enable valuable Navy missions (close-in radar jamming, over-the-hill reconnaissance) with the smallest practical unmanned air vehicles. In FY01 MAV efforts demonstrated an altitude hold capability using optical flow sensors. Small test vehicles were flight-tested thereby demonstrating both the flight operations of the vehicles, as well as the sensor operation aboard these MAVs. (FY01 accomplishments were funded in PE 0602270N).

  (U) The Global Positioning System (GPS) effort developed technology to mitigate GPS limitation and develop back up capabilities if GPS is denied. The Distributed Time Standards (DTS) task designed a system to synchronize multiple high precision clocks (e.g. GPS, Joint Tactical Information Distribution System (JTIDS), Tomahawk) that are on Naval ships. DTS task developed a preliminary design for a DTS system and acquired the testbed hardware. The GPS-JTIDS/Enhanced Position Location Reporting System(EPLRS) task performed a Threat Analysis of the GPS-JTIDS/EPLRS Relative Navigation and Communications System Capabilities. Performed a Threat Analysis in the area of GPS. The Navigation task developed a Precision Terrain-aided Navigation capability that will provide terrain information for ship and aircraft navigation and a polarized Fiber Optic Gyro (FOG) laser source.(FY01 accomplishments were funded in PE 0602232N).

  (U) The Mission Responsive Ordnance (MRO) effort developed ordnance technologies that enable a single ordnance configuration to modify its kill mechanism in flight to optimize lethality against a variety of targets. Completed the down select of various ordnance concepts for implementation into Tactical Tomahawk and produced a draft performance specification for the MRO payload. (FY01 accomplishments were funded in PE 0602111N)

  (U) The Technology for Strategic System Sustainment (TSSS) Program goal is to sustain, reduce operational and maintenance costs, maintain the industrial capability, for the existing strategic weapon systems. In addition, the TSSS program will also improve strategic system capabilities by developing the technology for higher performance and more affordable systems. FY01 tasks completed include: definition of requirements and integration of radiation hardened (RAD HARD) codes into database; development of modeling codes for solid rocket motor (SRM) propellant ignition and flight performance; and development of Computational Fluid Dynamics (CFD) software for flight performance prediction and drag reduction. (FY01 accomplishments were funded in PE 0602232N)

  (U) The Hypersonic Weapons Development effort is focused on the development of the technologies necessary to demonstrate a high speed (Mach 6.0+) missile that can be used to attack high value, buried and/or time critical targets. Demonstrated Dual Combustion Ramjet (DCR) efficient combustion of tactically acceptable hydrocarbon fuels at Mach 4 to Mach 6. Completed durability tests of Leading Edge (LE) component materials. Fabricated and conducted high temperature tests on sub-scale and limited full-scale seeker windows and domes. Investigated advanced airbreathing flow control sensors and actuators. (FY01 accomplishments were funded in PE's 0602111N and 0603217N)

(U) The Weapons program Supersonic Airframe control task performed detailed design assessment of conformal control concepts. The Configurable Automatic Target Recognition (CATR) task developed an ATR framework, developed confidence propagation factors, and characterized algorithm performance. The Micro Electro Mechanical Systems (MEMS) antenna task designed and fabricated the space feed and initiated the design of the demonstration seeker aperture. Testing continued on explosive survivability for high-speed ordnance application. The Rapid Ordnance Dispense System systems/technology analysis was completed and folded into the TCS FNC MRO project. (FY01 accomplishments were funded in PE's 0602111N and 0603217N).

- (U ($13,903K) SUPPORT FOR NAVAL EXPEDITIONARY FORCES ASHORE:
  (U) As part of the Micro UAV Sensor program a demonstration of remote telemetry of magnetic sensors was performed. In addition, the analysis and lab measurements of thermal sensors task was completed leading to the development of a unique thermal sensor for Micro UAV applications. (FY01 accomplishments were funded in PE 0602270N).
  (U) The Weapons program Precise Tactical Targeting (PTT) task incorporated real time processing and began the development station. The Energetic Gun Propulsion task began a co-layered disk propellant investigation and shredder propulsion investigation. The High Energy Density Materials (HEDM) task completed mechanical property and response characterization and began fabrication and testing of HEDM structural composites in weapon shapes. The Mission Responsive Ordnance task completed and transitioned to TCS FNC funding for FY02. The Aeroprediction task that developed improved aerodynamic prediction models for NFS projectiles was completed. The Image and Video Analysis task completed and transitioned to TCS FNC funding for FY02. The Low Cost Gun-Launched Seeker task was terminated. (FY01 accomplishments were funded in PE 0602111N).

(U) FY 2001 Congressional Plus-ups:

- (U)($4,826) Free Electron Laser (FEL) upgrade: Completed Phase 1 deliverables for the FEL program. Deliverables included complete design for the 10-kilowatt (k W) upgrade, RF power upgrade, RF power system, and the high power Infrared (IR) wiggler for 2-10 microns. (Funded in PE 0602111N in FY 01).

- (U)($2,899) Hyperspectral Research: Developed advanced algorithms and processor architecture for Hyperspectral sensors. Optimized, validated, and demonstrated these algorithms for transition to hyperspectral sensors such as the planned F-18 SHARPS POD. (Funded in PE 0602232N in FY 01).

- (U)($4,833) Pulse Detonation Engine Technology: Completed development of Integrated Test Rig (ITR) for single converter. Conducted successful engine test using Ethylene and Propane fuel. (Funded in PE 0602111N in FY 01).

- (U)($3,868) Solid Fuel RAMJET: Completed database of solid fuel ramjet technology. Determined the missile performance, propulsion thrust and fuel characteristics for the axi-symmetric nose inlet and the chin inlet configurations. Performed mission trajectory and booster performance trade off analyses and flight vehicle thermal analysis. (Funded in PE 0602111N in FY 01).

- (U)($3,963) Spike Urban Warfare System: Completed the subsystem level designs for the guidance section electronics, servo drives, aero surfaces, and rocket motor designs. Performed final tests on the rocket motor igniter, three different warhead designs, and initial rocket motor propellant tests. (Funded in PE 0602111N in FY 01).

2. (U) FY 2002 PLAN:

- (U) ($9,620) FLEET DEFENSE AND AIR DOMINANCE
  (U) The longwave Infrared (LWIR) program goal is to develop low loss, high strength fibers (8-12um) required for the Navy's threat warning system and infrared countermeasures. The LWIR fiber task in FY02 will produce fibers at 75 kpsi strength and multifiber coherent bundles up to 3m in length.
  (U) The Multispectral Infrared Focal Plane Array (IRFPA) effort will develop advanced infrared detectors and focal plane arrays that will improve sensitivity, operating range, field of view (FOV), and counter measure hardness in Forward Looking Infrared Receivers (FLIR), missile seeker, missile warning and surveillance sensors. In FY02 the IRFPA task will demonstrate improved color detector materials, an improved long wavelength detector, and laser hardening approaches for uncooled detectors.
  (U) The Electro Optic/Infrared (EO/IR) effort will develop sensors and nanotechology-based gyroscope/accelerometer sensor stabilization mechanisms to provide more accurate targeting and identification of potential targets. The Hyperspectral algorithm effort will evaluate and improve algorithm packages for a family of hyperspectral sensors to improve detection and identification of targets in camouflage and complex environments. The Laser tracker and identification Automatic Target Recognition (ATR) effort will demonstrate the ability to detect, track and identify air targets. The effort will develop an approach that uses laser vibrometry to classify/ identify threats. This work will fly a stabilized, eye safe laser on a gimbal to measure sensor and platform vibration. The purpose is to determine the impact of vibration and atmospheric turbulence on laser beam divergence and coherence.
  (U) The Air-to-air weapons effort will complete this year. The Aim Airframe control task will fabricate and assess an advanced high temperature missile section. The Surface Wave Antenna Guidance (SWAG) effort will conduct field test and evaluation to evaluate the performance of the SWAG seeker in potential air-to-air environments. The Short Pulse Laser Target Detection Device (TDD) task will complete with demonstrations against targets in fog and clutter. A systems assessment for weapon needs addressing asymetric threats will be conducted. A systems assessment of high performance, solid state RF seeker technology that is appropriate for the advanced cruise missile defense problem will be initiated. The Reactive Material Warhead TILV effort will continue.
  (U) The High Energy Laser (HEL) weapons development effort will initiate the fabrication of test equipment to be used for propagation measurements of beam coherence in aerosol rich environments. Analyze existing climatology data for aerosol microphysical and meteorological properties in maritime and coastal environments. Develop multi-

year climatologies and probabilities of severe propagation impacts in sensitive marine/coastal regions. A field test will be conducted in a sensitive region of the world to provide a short term, detailed characterization of the vertical distribution of aerosols. Demonstrate 10 kW output on a Free Electron Laser (FEL).
(U) The IHPRPT program will demonstrate an air launched rocket with a high-pressure nozzle and composite motor case. The air-to-air project will demonstrate a flight weight, high pressure, highly loaded, full scale air-to-air motor incorporating an end-burner motor with reduced smoke propellant, advanced composite case (T-1000 & Ultra High Modulus (UHM) fibers), dual movable nozzle, and thrust vector control (TVC). The gun launched motor project will demonstrate in flight a high pressure, highly loaded, full scale, gun launched munition motor incorporating an end-burner motor with aluminized propellant, and advanced composite case (aluminum metal matrix) technologies. The surface launched effort will conduct full scale testing of a 40 to 1 turndown ratio pintel motor with aluminized boost propellant.

- (U) ($34,345) NAVAL PRECISION STRIKE OPERATIONS

(U) The AO UAV technology task will develop software to detect threats, collision situations and targets of opportunity with operator, and pre-programmed reaction. Develop secure jam resistant communications links and architecture for networking and multi-vehicle operations. Develop command, control and information display for multiple UAVs conducting simultaneous imaging missions using a single UAV operator. Develop software technologies that permit single frequency multi-point communications between multiple UAVs and their ground station.
(U) UAV Radar effort will be started to develop a radar concept and signal processing algorithms for the Navy’s planned Tactical Ultra Light Unmanned Air Vehicles (UAV’s). This will provide the Navy with the ability to safely detect and direct weapons against over-the-horizon, slow moving, ground targets. FY 02 work will include obtaining and assembling components, and the integration and test of the UAV radar system and instrumentation hardware.
(U) The MAV program will demonstrate autonomous flight, conduct mission demonstrations and integrate payloads and sensors/autopilots with Micro Air Vehicles. The applied research portion of this program will transition to next-generation advanced single vehicle and distributed multiple-vehicle programs.
(U) The DTS portion of the GPS task will develop an initial specification for the DTS and fabricate the testbed. The Navigation task will develop a Precision Terrain-aided Navigation capability that will provide terrain information for ship and aircraft. Perform a Threat Analysis of the GPS-JTIDS/EPLRS Relative Navigation and Communications System Capabilities and Threat Analysis in the area of GPS. Complete polarized Fiber Optic Gyro (FOG) laser source development.
(U) The Weapons Imagery Link (WIL) program is a RF communications link, which will provide data bandwidth for the transport of moving imagery (video) and weapon control data for standoff weapons such as SLAM-ER. Will conduct a test of a dynamic network using a complex array of terminals, a simulated weapons delivery under multiple scenarios, and a video relay through two terminals and a long distance video relay. This effort will transition to PE0603114N in FY03.

(U) The MRO effort will perform Small Scale Penetrator Tests to quantify various design constraints against depth in concrete. Down select to two structural concepts and two safe arm architectures. Select baseline warhead size.
(U) The Hypersonic Weapons Development will complete Leading Edge airframe component testing and test data analysis. The seeker window/dome task will prototype window/airframe integration. The airbreathing hypersonic propulsion task will integrate flow control algorithms and actuators into test hardware and demonstrate the ability to control combustion. Direct connect measurements of the DCR will be completed and free jet tests will be performed.
(U) The TSSS program will involve upgrading Radiation Hardened (RAD HARD) models, codes and databases. The Solid Rocket Motor (SRM) effort will produce structural and gas dynamic coupled models. The drag reduction device task will finalize the database, identify Computational Fluid Dynamics (CFD) tool candidates, and identify the static stability method.
(U) The Weapons program Supersonic Airframe control task will select, fabricate and integrate the control concept for the strike weapon, and investigate the extendibility of the concept into the hypersonic speed regime. The Configurable ATR task will define the tasks necessary for the ATR LADAR identification of targets and evaluate reconfigurable architectures for the CATR system. The Micro Electro Mechanical Systems (MEMS) antenna task completes the fabrication of the demonstration seeker and will investigate the applicability of MEMS in high power RF seeker applications.

- (U) ($21,755) SUPPORT FOR NAVAL EXPEDITIONARY FORCES ASHORE

(U) The AO Unmanned Undersea Vehicle (UUV) task will develop enabling technologies in autonomy, navigation, sensors, energy, and communication in support of UUV missions. Initiate development of UUV-deployed Intelligence, Surveillance and Reconnaissance (ISR) electro-magnetic and electro-optic (EM/EO) sensors; software to detect, evaluate and avoid obstacles and threats using various sensor inputs; sensor data fusion for situational awareness; and integrated autonomous UUV control approaches for Maritime Reconnaissance mission capabilities.
(U) The AO UAV propulsion and power technology development task for the Navy UAV will refine Navy UAV propulsion technologies through individual component design, fabrication and component rig testing under realistic operational conditions under the Integrated High Performance Turbine Engine Technology (IHPTET) program. Demonstrate the UAV engine component technologies that will provide high performance and robust operational utility, reduce parts count and decrease component costs when integrated into an advanced UAV turbine engine.
(U) The AO Intelligent Autonomy task will develop system and associated sensor processing for unmanned vehicles to enable adaptation and independent actions. Develop architecture for combining reactive and deliberative behaviors for autonomous vehicles.
(U) The Unmanned Ground Vehicle (UGV) program will focus on technologies that address capability gaps in robotic communications and control, mobility, survivability, durability, modularity, and signature reduction in support of the Marine Corps Gladiator Tactical Unmanned Ground Vehicle (TUGV) program.

(U) The Micro UAV sensor program will demonstrate a magnetic fiber micro sensor and complete the development of a radiometer.
(U) The Enhanced Target Acquisition & Location System (ETALS) effort will develop an advanced, affordable, azimuth sensing Micro-Electro-Mechanical-Sensor (MEMS) based gyroscope. ETALS will enable improved and more rapid targeting when operating in urban environments and areas of high iron concentration. Develop a gyrocompass model for ETALS. Perform ETALS Selective Availability Anti-Spoofing Module (SAASM) integration test and MAGU-1 (Miniature Azimuth Gyrocompass Unit) gyrocompass test.
(U) Smart sensor network effort will evaluate and demonstrate different sensor packages linked to form a grid for surveillance and tracking of targets in urban environments.
(U) The Weapons program Precise Tactical Targeting (PTT) task will begin ground and aircraft testing. The Energetic gun propulsion will begin preliminary support to the barrel wear and advanced propulsion FY03 tasks. The High Energy Density Materials (HEDM) task will continue performance enhancement evaluation of selected HEDM candidates.

(U) FY 2002 Congressional Plus-ups:

- (U)($3,469) Combustion Light Gas Gun: This work will develop options for cryogenic storage and handling, gas fuzing and electronic ignition of the propellant gas used in the gun. In addition Computational Fluid Dynamic (CFD) modeling and systems analysis will be performed to identify scaling parameters for future gun systems.

- (U)($1,982) Fast Pattern Processor, SLAM-ER: This effort will develop a dedicated Application Specific Integrated Circuit (ASIC) implementation of algorithms that perform correlation based Automatic Target Recognition (ATR). These pattern recognition algorithms will perform rapid comparison of stored and real time images, using gradient and frequency transformations, to emphasize features of military targets that can be correlated.

- (U)($1,388) Hybrid Fiber Optic/Wireless System for Secure Communications: This effort will develop a millimeter wave, optical transmitter that will generate the optical and millimeter carriers within a mode-locked microchip laser. The laser will operate an eye safe optical wavelength of 1.55mm with a millimeter modulation of 60 GHz for covert communications.

- (U)($4,163) Hyperspectral SAR: Develop a retro-reflector modulator for laser data link that can support megabit per second data rates for hyperspectral electro-optical and infrared sensors and synthetic aperture radar data. Furthermore adapt this technology to small (4') unmanned aerial vehicles to allow exchange of space-time information for geolocation and time sensitive targeting.

- (U)($2,478) Integrated Biological & Chemical Warfare Defense Technology Platform: This effort supports development of a small, low powered chemical sensor and expands the R&D to include a biological detection capability. Semi-conducting Metal Oxides (SMO's) will be used for chemical detection and it is anticipated that molecular beacons will be developed for biological weapon detection.

- (U)($1,239) Real World Based Immersive Imaging: Develop a low power optimized single instruction multiple data (SIMD) system processor for enhanced real-time hyperspectral image processing on-board a small (4') unmanned aerial vehicle. The processor will also support hyperspectral data compression/de-compression and encryption/decryption.

- (U)($2,974) SAR for All Weather Targeting: This effort will develop a time critical targeting system using Global Positioning System (GPS) information to provide an all weather precision target location and weapon guidance capability that will significantly increase the accuracy of precision weapons. The FY02 effort will develop a prototype relative GPS system for guided weapons and integrate the Stereo Synthetic Aperture Radar (SAR) targeting package into the Lynx targeting system.

3. (U) FY 2003 PLAN:
- (U) ($13,602) FLEET DEFENSE AND AIR DOMINANCE

(U) The LWIR fiber development will produce 8-12 um fiber at greater than 100 kpsi strength and 1 micron core material in lengths greater than 1 km.
(U) The Multispectral Infrared Focal Plane Array (IRFPA) will demonstrate color techniques for air to surface targeting and transition IRFPA hardening techniques to industry.
(U) The gyro stabilization portion of the EO/IR effort will fabricate and test the gyroscope, accelerometer, and inertial measurement unit designs. The Hyperspectral task will demonstrate the algorithm packages in operational exercises. The ATR effort will upgrade a high coherence eyesafe laser and demonstrate laser vibrometry ATR of airborne platforms and target discrimination (threat vice non-threat). Demonstrate extended range laser tracker and identification of air targets.
(U) Asymetric threat weapon systems technologies as identified by FY02 analysis efforts will be initiated. Development of high performance solid state RF seeker technology for defeat of advanced anti-ship cruise missiles will continue. A study of technology requirements to enable hit-to-kill missile defense against anti-ship cruise missiles will be performed. The Reactive Material TILV effort will conclude. The HEL weapons development effort will continue to make detailed propagation measurements to evaluate the performance of the HEL when conducting shipboard operations in the ocean/littoral environment.
(U) The Advanced Reactive Material effort will continue development of advanced Reactive Material compositions. Reactive Materials are warhead material formulations that result in warhead fragments that combine both kinetic and chemical energy. This combination of kinetic and chemical energy produces structural kills rather than the component kills that inert fragments generate.

(U) The IHPRPT surface launched demonstrator will include full scale testing of an aluminized boost propellant. Concept evaluation will begin for the advanced Thrust Vector Control (TVC) concepts incorporating pitch, yaw, and roll control along with thrust magnitude control capability. Propellant ingredient and formulation investigations will begin for advanced reduced smoke propellant for air-launched applications.

- (U) ($39,170) NAVAL PRECISION STRIKE OPERATIONS

(U) The UAV advanced technology task will develop single frequency, multi-UAV imaging ops capability using only the secondary UHF data link. Develop command, control and information display for multiple UAVs conducting simultaneous imaging missions using only a single UAV operator.
(U) Conduct lab and field tests of UAV radar system.
(U) The DTS portion of the GPS task will define the Precision Time subsystem interfaces between the GPS, JTIDS and other system clocks. Complete the development of the GPS navigation Precision Terrain-aided Navigation task.
(U) The MRO effort will perform mid-scale penetration tests to validate survivability of structure. Demonstrate dispenser component functionality. Perform static arena tests of warhead against various targets.
(U) The TSSS program will involve upgrading and linking Radiation Hardened (RAD HARD) codes and evaluating the software. The Solid Rocket Motor (SRM) effort will perform code validation with legacy models and preliminary verification on new models. The drag reduction device task will develop a first order CFD model, complete the CFD model test trials, and integrate static stability models.
(U) The Ordnance Systems for High speed penetration work will develop advanced fuze, warhead and structural components that can be integrated into high speed strike weapons which are used to attack high value, deeply buried targets.
(U) The Hypersonic Weapons Development program will develop a lightweight Dual Combustion Ramjet (DCR) concept vehicle for the airframe integration task. The advanced airbreathing propulsion task will develop a full-scale test device and demonstrate full-scale combustion control. The supersonic inlet task will begin evaluation of inlet concepts and the preliminary inlet design.
(U) The National Aerospace Initiative effort will design and develop flight weight hardware that can be integrated into a hypersonic strike vehicle.
(U) The Weapons program Supersonic Airframe control task will design for a ground test to demonstrate a section level integrated control concept extendable into the hypersonic speed regime. The Configurable ATR work, which has integrated a family of tunable algorithms, will continue with the development of a process oversite manager that will provide for the tuning of the ATR algorithms. The Micro Electro Mechanical Systems (MEMS) antenna task will evaluate the fabricated seeker and then begin development of the high power RF seeker. Initiate the development of moving target and ATR algorithms. An effort will be initiated to advance the technologies needed to further automate the management and control of several retargetable weapons and unmanned vehicles providing ISR/targeting functions.

- (U) ($23,840) SUPPORT FOR NAVAL EXPEDITIONALRY FORCES ASHORE

(U) Continue development of AO UUV-deployed Intelligence, Surveillance and Reconnaissance (ISR) electro-magnetic and electro-optic (EM/EO) sensors; software to detect, evaluate and avoid obstacles and threats using various sensor inputs; sensor data fusion for situational awareness; and integrated autonomous UUV control approaches for Maritime Reconnaissance mission capabilities. Continue multi-vehicle undersea search and survey and communication link development.

(U) The AO UAV propulsion and power technology development effort for the Navy UAV will refine Navy UAV propulsion technologies through individual component design, fabrication and component rig testing under realistic operational conditions under the IHPTET program. Demonstrate the UAV engine component technologies that will provide high performance and robust operational utility, reduce parts count and decrease component costs when integrated into an advanced UAV turbine engine.

(U) The AO Intelligent Autonomy task will develop system and associated sensor processing for unmanned vehicles to enable adaptation and independent actions. Develop architecture for combining reactive and deliberative behaviors for autonomous vehicles.

(U) The UGV program will develop technologies that address capability gaps in robotic communications and control, mobility, survivability, durability, modularity, and signature reduction in support of the Marine Corps Gladiator Tactical Unmanned Ground Vehicle (TUGV) program.

(U) Develop ETALS Target Location Designation and Handoff system (TLDHS) interface prototype. Develop AN/GVS-5 production interfaces for ETALS. Perform a Limited User Test for the AN/GVS-5 and TLDHS.

(U) To complete the Micro UAV Sensor program, a micro acoustic sensor will be demonstrated and, along with the other sensors developed by the program, they will be made available for Micro UAV applications.

(U) To complete the Smart sensor Network, sensors will be linked into a grid to demonstrate different sensor packages observing and tracking targets in urban environments.

(U) The Advanced Gun Barrel and propulsion task will develop a complete, next generation, gun barrel design for current and future Naval gun systems. This system will yield significant improvement in barrel life and gun system performance. Tasks will involve analysis of thermal transfer between materials and load transfer between layers. Structural and thermal predictive models will be developed.

(U) The Weapons program Precise Tactical Targeting (PTT) task will complete ground and aircraft testing and begin the 1-meter targeting effort. The High Energy Density Materials (HEDM) task will continue performance enhancement evaluation of selected HEDM candidates and continue fabrication and testing of HEDM structural composites. An effort will be initiated to address moving targets using tactical/expeditionary assets such as tactical UAVs and guided projectiles. An effort will be initiated to further the technologies needed for next-generation high performance gun systems for land attack (light gas or EM).

(U) **Accelerate technology modernization of strategic systems.**

C. (U) PROGRAM CHANGE SUMMARY:

	FY 2001	FY 2002	FY 2003
FY 2002 President's Submission	**	66,322	
Adjustments from FY 02 PRESBUDG:			
Congressional Plus-ups		+17,850	
Section 8123 Management Reform Initiative Reduction		-744	

FFRDC Reduction		-15	
FY 2003 President's Submission:	**	83,413	76,612

**The Science and Technology PEs were restructured in FY 2002. FY 2001 efforts were funded in PEs 0602111N, 0602122N, 0602232N, 0602270N, and 0603217N.

(U) PROGRAM CHANGE SUMMARY EXPLANATION:

(U) Schedule: Not applicable
(U) Technical: Not applicable

D. (U) OTHER PROGRAM FUNDING SUMMARY:

(U) RELATED RDT&E:

(U) NAVY RELATED RDT&E:
(U) PE 0601152N (In-house Laboratory Independent Research)
(U) PE 0601153N (Defense Research Sciences)
(U) PE 0602123N (Force Protection Applied Research)
(U) PE 0602235N (Common Picture Applied Research)
(U) PE 0602131M (Marine Corps Landing Force Technology)
(U) PE 0603114N (Power Projection Advanced Technology)
(U) PE 0603640M (Marine Corps Advanced Technology Demonstration)
(U) PE 0603790N (NATO Research and Development)

(U) NON NAVY RELATED RDT&E:
(U) PE 0602303A (Missile Technology)
(U) PE 0602618A (Ballistics Technology)
(U) PE 0602624A (Weapons and Munitions Technology)
(U) PE 0603004A (Weapons and Munitions Advanced Technology)
(U) PE 0602173C (Support Technologies – Applied Research)
(U) PE 0603763E (Marine Technology)
(U) PE 0603739E (Advanced Electronics Technologies)
(U) PE 0602702E (Tactical Technology)
(U) PE 0602203F (Aerospace Propulsion)
(U) PE 0602601F (Space Technology)
(U) PE 0602602F (Conventional Munitions)

(U) PE 0603216F (Aerospace Propulsion and Power Technology)

E. (U) SCHEDULE PROFILE:

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602121N
PROGRAM ELEMENT TITLE: Ship, Submarine and Logistics Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE
	Ship, Submarine and Logistics Technology	
	54,094	*

*This PE was restructured in FY 2002. FY 2001 efforts are described in PEs 0602123N, 0602236N, and 0603123N.

Congressional Plus-ups appropriated in this PE are described under the following restructured program elements:

TITLE	PE NUMBER	FY 2001
Biodegradable Polymers	0602236N	$1,206
Bioenvironmental Hazards Research Program	0602236N	$1,931
Non-Magnetic, Stainless Steel Advanced Double Hull	0603123N	$3,887
Three Dimensional Printing (3DP) Metalworking Technology	0602123N	$4,839

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602122N
PROGRAM ELEMENT TITLE: Aircraft Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE
	Aircraft Technology	
	21,032	*

*This PE was restructured in FY 2002. FY 2001 efforts are described in PEs 0602114N, 0602123N and 0603236N.

Congressional Plus-ups: NONE

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 2 PROGRAM ELEMENT: 0602123N
PROGRAM ELEMENT TITLE: Force Protection Applied Research

COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
Force Protection Applied Research	**	130,870	89,390	80,864	77,540	73,039	75,036	CONT.	CONT.

** The Science and Technology PEs were restructured in FY 2002. FY 2001 efforts were funded in PE(s) 0602121N, 0602122N, 0602232N, 0602270N, 0602633N.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project addresses applied research associated with providing the capability of Platform and Force Protection for the U.S. Navy. This project supports the development of technologies associated with all naval platforms (surface, subsurface, terrestrial and air) and the protection of those platforms. The goal of this project is to provide the ability to win or avoid engagements with other platforms or weapons and, in the event of engagement, to resist and control damage while preserving operational capability.

(U) SURFACE SHIP & SUBMARINE HULL MECHANICAL & ELECTRICAL (HM&E) thrusts include: signature reduction, hull life assurance, hydromechanics, distributed control for automated survivability and advanced electrical power systems. Signature reduction addresses electromagnetic, infrared and acoustic signature tailoring, both topside and underwater. Hull life assurance addresses development of new structural system approaches for surface ships and submarines, including the management of weapons effects to control structural damage and the improvement of structural materials. Hydromechanics addresses hydrodynamic technologies, including the signature aspects of the hull-propulsor interface. Distributed intelligence for automated survivability addressees both the basic technology of automating damage control systems as well as distributed auxiliary control with self-healing capability. Advanced electrical power system addresses electrical and auxiliary system and component technology to provide improvement in energy and power density operating efficiency and recoverability from casualties.

(U) SENSORS & ASSOCIATED (S&A) PROCESSING thrust focuses on applied research for complementary sensor and processing technologies for 21st century warfighting success and platform protection. Current small platforms (both surface and airborne) have little to no situational awareness (S&A) or self-protection against air, surface, and asymmetric threats. The goal of this effort is to provide these platforms with effective self-protection. The technology areas specific to platform protection will develop individual or multispectral (Electro-Optic (EO)), Infrared (IR), Radio Frequency (RF), electromagnetic (EM), visual and acoustic) sensors and associated processing. To defend platforms from current and advanced threats in at-sea littoral environments and in port, these technologies must improve multispectral detection and distribution of specific threat information.

(U) MISSILE DEFENSE (MD) applied research develops enabling technology for littoral Theater Air and Missile Defense (TAMD) enhancements for transition to acquisition programs. These enhancements will interact efficiently, effectively, and in time to detect, control, and engage projected anti-ship cruise missiles, overland cruise missiles, aircraft and theater ballistic threats. The Missile Defense Science and Technology (S&T) projects directly provide elements of the capability required by the Joint Requirements Oversight Council (JROC) TAMD Capstone Requirements Document (CRD) (2001). This PE includes those MD elements that perform risk reduction for Force Protection Capability. In addition, emerging S&T requirements for Discovery and Invention in the area of Directed Energy and Strike Technology are also included under Missile Defense. In the terminology of the TAMD CRD, Attack Operations (Strike) is a necessary element of Theater Air and Missile Defense in order to attack the air threat before they are launched.

(U) AIRCRAFT TECHNOLOGY thrust develops enabling technology for naval aviation, with emphasis on the demands imposed by aircraft carrier flight operations and Marine Corps amphibious and field operations relating to the Joint Mission Areas of Strike and Littoral Warfare. This program exploits emerging technologies of: (a) structures and flight controls to reduce the total life-cycle-cost and extend the operational life of legacy air vehicles; (b) reduced observables, (c) aerodynamic designs of Navy-unique aircraft components; (d) advanced gas turbine engine component designs and power systems for extended range/endurance; and (e) predicting safer, more reliable at-sea operating envelopes. The program provides mission area analysis and concept definition required for the applied research phase of air vehicle programs.

(U) Applied research efforts address manned and unmanned airborne platform technologies for future joint warfighting capabilities to promptly engage regional forces in decisive combat on a global basis and to employ a range of more suitable actions at the lower end of the full range of military operations, which achieve military objectives with minimum casualties and collateral damage. This thrust adheres to Defense Science and Technology (S&T) Reliance Agreements and supports the Department of Defense Science and Technology Strategy, which coordinates and minimizes duplication of aircraft technology efforts. Individual Navy aircraft technology applied research efforts fill Naval Aviation needs that are not met by Air Force, Army, National Aeronautics and Space Administration (NASA), Defense Advanced Research Projects Agency (DARPA) and industry programs.

(U) Aircraft Technology applied research addresses goals and payoffs set forth in the Air Platforms Defense Technology Area Plan (DTAP). At the Project Reliance Fixed Wing Vehicle taxonomy level, goals include Aerodynamics, Flight Control, Subsystems, Structures and Integration technologies.

(U) UNDERWATER (UW) PLATFORM SELF DEFENSE thrust develops enabling technologies that will increase the survivability of surface ship and submarine platforms against torpedo threats. Proposed technologies focus on defeating high priority threats including torpedoes (i.e. straight running, wake homing, acoustic homing, high speed torpedoes, air dropped torpedoes, and salvoes of torpedoes). The long-term goal of the UW Platform Self Defense effort is to develop technologies that will ultimately be placed on board ship. Technologies should be developed to minimize shipboard impact, allow automatic employment, and require no organizational maintenance. Specific technology includes two programs. The Next Generation Countermeasure (NGCM): A mobile adaptive acoustic countermeasure with acoustic communication links to enable countermeasure connectivity and group behavior to defeat threat torpedoes. The Anti-Torpedo Torpedo (ATT)/Tripwire Demonstration: Technologies that improved passive shipboard detection, classification, and localization (DCL) of incoming torpedoes and an ATT to engage the threat torpedoes.

(U) Due to the number of efforts in the PE, the programs described are representative of the work included in the PE.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is funded within the APPLIED RESEARCH Budget Activity because it investigates technological advances with possible applications toward solution of specific Naval problems, short of a major development effort.

B. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 2001 ACCOMPLISHMENTS:

(U) ($32,106) SURFACE SHIP & SUBMARINE HM&E

- (U) Signature Reduction:

  Initiated:

  (U) For Submarines - Evaluation of control algorithms for advanced degaussing/de-amping of submarine hulls. Feasibility study to develop realizable modular hull/payload modules. For Surface Ships – Assessment of optional degaussing coil arrangements coils arranged internal to hull. Planning of next generation IR scene model. (Funded in PE 0602121N).

  Continued:

  (U) For Submarines - Evaluation of submarine flanking path acoustic propagation with a multi-component evaluation. Development of advanced numerical acoustic codes and gridding methods with limited benchmarking. For Surface Ships – Development of physics based numerical model for electromagnetic scattering of hydrodynamic disturbances. (Funded in PE 0602121N).

  Completed:

  (U) For Submarines – Full-scale trial to establish hull response and radiated noise levels with hull treatments applied. For Surface Ships – Electric field measurements made on an existing 1:96 scale model DDG-51 physical model, validating Boundary Element Model (BEM). Evaluated and procured High Frequency (HF) transmit and receive antennas for at-sea measurements. (Funded in PE 0602121N).

- (U) Hull Life Assurance:

Initiated:
(U) Analytical tool development for dynamic magazine protection. (Funded in PE 0602121N)
Continued:
(U) Installation and demonstration of the fiber-optic health monitoring system on the RV-Triton. Extension of numerical models and methods to better predict sub-detonation reactions in propellants and explosives. Design tool for integrated antenna and composite topside. Design guidelines for stainless steel advanced doublehull. Design concepts for hybrid composite/stainless steel joints. (Funded in 0602121N).
Completed:
(U) Concept design and requirements definition for dynamic magazine protection. Characterization of composite hull response to explosive loads. Development of composite hull criteria. Large-scale laboratory demonstration of the hardware and software for a fiber-optic hull monitoring system for ship hulls under cyclic load and high strain conditions. Hybrid hull design concept with reduced signature composite bow and stern, and potentially lower whipping stresses. (Funded in PE 0602121N).

- (U) Hydromechanics:

Initiated:
(U) For Submarines: Explorations of two advanced, multi-shaft (multi-propulsor), water-jet/pump propulsion systems with the goals of significantly reducing low-frequency noise and facilitating ship arrangement improvements. (Funded in PE 0602121N).
Continued:
(U) For Submarines: Improved maneuvering simulation capability. For Surface Ships: Development, validation, and application of numerical methods to integrated propulsor/hull for advanced surface ship configurations. (Funded in PE 0602121N).
Completed:
(U) For Submarines: Concept design of a looped-blade propeller for a full-stern propulsor. For Surface Ships: Developed experimental techniques for acquiring hydro surface data. Study on the variable pitch prop design. (Funded in PE 0602121N).

- (U) Distributed Intelligence for Automated Survivability:

Continued:
(U) Investigation of fire and smoke spread modeling for damage control. (Funded in PE 0602121N).
Completed:
(U) Validation of viability of self-healing control network and Commercial Off the Shelf (COTS) automation by demonstration on YP-679. Completed demonstration of automation technology to provide 85% reduction in damage control manning. (Funded in PE 0602121N).

- (U) Advanced Electrical Power Systems:

Initiated:

(U) Concept studies and validation efforts for a Universal Controller Architecture concept. Design for a Power Quality (PQ) product in the 1-2MVA range and a Distributed Power Generation product in the .1-.5 MVA ranges. Efforts to transfer wafer-bonding technology to commercial production to allow affordability for Navy applications. (Funded in PE 0602121N).

Continued:

(U) Development of solid-state technology for high power distribution systems. (Funded in PE 0602121N).

Completed:

(U) Quiet solid-state circuit breaker operation. Power Electronics Building Block Concept (PEBB) accepted as an Institute of Electrical and Electronic Engineers (IEEE) standard (IEEE, WG 18). Demonstration of the capability of Fast-Turn-Off (FTO) modules. Transition of Power Node Control Center to Navy Sea Systems Command (NAVSEA). ON-Switch (N type Metal Oxide Semiconductor (MOS) Controlled Thyristor, (NMCT) qualified for multiple “smart munitions” systems. (Funded in PE 0602121N).

(U) ($6,850) SENSORS & ASSOCIATED PROCESSING:

- (U) Distributed Aperture System:

Continued:

For Surface Ship, the Shipboard Laser Acquisition System (SBLAS), a common laser warning solution for all naval surface vessels that can detect and locate tactical laser threats by indirect scattering as well as direct illumination, successfully demonstrated proof of concept of single sensor laser-threat warning for large ships and wide area protection for amphibious assault vehicles. SBLAS Critical Design Review (CDR) was successfully conducted and long-lead procurement initiated for system fabrication, delivery and testing under the Platform Protection FNC (PPFNC) Electronic Warfare (EW) Integrated Self-Protection for Small Surface Platforms (EWISSP) program commencing in FY02. (Funded in PE 0602270N)

Completed:

(U) For Surface Ships, the Navy studied various concepts and designs for ship based Infrared Search and Track (IRST). The study looked at two technology options for shipboard IRSTs-- full staring and step-staring. The study results recommend the full staring technology, using anemorphic optics and electronic stabilization techniques. This study provides the bases for the Distributed Aperture System (DAS) and the technology to pursue for the DDX, CGX, and CVNX. Also, the Navy has successfully demonstrated the porting of shipboard IRST signal processing algorithms to processor independent Middleware interface software for application in the DAS. (Funded in PE 0602270N and 0602232N).

(U) Supports the EW Electro-Optic/Infra Red (EO/IR) technology development projects within the PPFNC. Current small platforms (both surface and airborne) have little to no situational awareness (SA) or self-protection against threat missile systems which EW threat warning and self-protection capabilities can provide. The focus of FY01 efforts was to develop EO/IR technologies that could provide these platforms the capability to achieve very accurate hemispheric direction-finding (DF) of radio frequency (RF) signals and deny the enemy their effective use or exploit their weaknesses. This capability, when integrated with emitter identification and Low Probability of Intercept (LPI) detection systems, will provide netted targeting information and cueing that allows for platform self protection against various threat systems. (Funded in PE 0602270N and 0602232N).

Continued:

(U) For Naval Aircraft, the Electrical IR Decoy Launcher project successfully evaluated alternate decoy launcher concepts including the rail gun and coil gun concepts and successfully conducted a single shot demonstration firing of a full size decoy to deployment velocity. (Funded in PE 0602270N).

Completed:

(U) For Naval Aircraft,the Multicolor Threat Warning project demonstrated the capability to use a charged coupled device to obtain wide-angle search to detect narrow atomic line emissions in missile plumes using a very narrow bandpass spectral filter to remove clutter. This capability will aid in the detection of threat non-radio frequency (RF) missiles in order to effectively deploy countermeasures improving aircraft survivability. (Funded in PE 0602270N).

(U) ($13,564) AIRCRAFT TECHNOLOGY:

- (U) Integrated Avionics:

Continued:

(U) Overall multi-mode visually-coupled display system technology integration enhancement between visor optics, three dimensional (3-D) audio, precision head tracking and selected threat protection technology. (Funded in PE 0602122N).

Completed:

(U) Field demonstration of the baseline Navy Crusader flightworthy day/night helmet-mounted display system including night cameras and baseline image fusion module operations. (Funded in PE 0602122N).

(U) Advanced digital magnetic head tracker acceptance and performance validation testing. (Funded in PE 0602122N).

- (U) Naval Air Vehicle Technology:

Continued:

(U) Development of prediction of corrosion-assisted fatigue degradation within a scatter factor of four to development engineering guidelines for maintenance practices. (Funded in PE 0602122N).

(U) Development of analysis of dynamic load effect on fatigue life. (Funded in PE 0602122N).

(U) Development and simulation of automated maneuvering algorithms to improve lethality, safety, and survivability for Naval Mission tasks. (Funded in PE 0602122N).

(U) Development, integration, and testing of intelligent flight control prognostics and reconfiguration to improve safety, survivability, and maintainability. (Funded in PE 0602122N).

(U) Flight-testing with DARPA and Boeing of a Unmanned Air Vehicle (UAV) to demonstrate conversion from rotary-wing to fixed-wing flight using a canard/rotor wing concept. (Funded in PE 0602122N).
Completed:
(U) Implementation and simulation testing of seven different non-linear, intelligent, and adaptive guidance and control laws for the Intelligent and Adaptive Guidance and Control Law Study. (Funded in PE 0602122N).
(U) Initial non-real-time high-fidelity simulation testing of system level fault diagnostics including system failure identification and reconfiguration. (Funded in PE 0602122N).
(U) Initial development testing of flight control hardware prognostics algorithms using data sets. (Funded in PE 0602122N).
(U) Initial simulation of advanced carrier landing algorithms using both an F/A-18 and an unconventional aircraft. (Funded in PE 0602122N).
(U) Medium fidelity Uninhabited Combat Air Vehicle (UCAV) simulation with no distribution limitations for university participants. (Funded in PE 0602122N).
(U) Two high-speed wind tunnel tests of the F/A-18E in the NASA-LaRC 16-ft Transonic Tunnel (TT). The first test used highly instrumented wings to measure both steady and unsteady pressure coefficients as well as root mean square (RMS) data of the forces and moments. This pressure data was then used to validate several structured and unstructured computational fluid dynamics (CFD) codes. (Funded in PE 0602122N).

- (U) Classified program. (Funded in PE 0602122N).

(U) ($2,138) UNDERWATER PLATFORM SELF DEFENSE

- (U) Underwater Platform Self Defense:

(U) Initiated: None
Continued:
(U) Development of ATT and Tripwire Torpedo Defense System (TDS) technology. (Funded in PE 0602633N).

- (U) Classified program. (U) Classified program. (Funded in PE 0602633N).

(U) FY 2001 Congressional Plus-Ups:

- (U) ($4,839) Three Dimensional Printing (3DP) Metal Working Technology: Demonstrate an electronic-based manufacturing capability that would incorporate a Three Dimensional Printing (3DP) machine and supporting process equipment. Three Dimensional Printing is a rapid solid freeform process for metal and metal composite parts and tooling equipment. (Funded in PE 0602121N)
- (U) ($1,931) Electromagnetic Propulsion Systems: Develop new high-energy technologies for electric power storage, distribution, and electric propulsion systems on Navy ships. (Funded in PE 0603508N)

- (U) ($7,726) Advanced Hull Form In-Shore Demonstrator (AHFID): Complete preliminary design of complete subscale AHFID Rim Driven Propulsor (RDP) electric drive system installation on Hybird Small Waterplane Area Craft (HYSWAC) vehicle, preliminary design of all components and some long lead procurements. Complete redesign and model tests of RDP for improved efficiency is underway. (Funded in PE 0603792N)

2. (U) FY 2002 PLANS:

(U) ($55,638) SURFACE SHIP & SUBMARINE HM&E

- (U) Signature Reduction:

Initiate:
(U) For Submarines: Development of analytical models to further define modular submarine hull concepts. For Surface Ships - Planning of tow tank acoustic tests and numerical model of uncoated surface combatant hull for surface ship acoustic program. Antenna isolation measurement for both high band and low arrays integrated into topside structures. Assessment of technology options for electromagnetic, thermal, electro-optical and visual signature reduction of Low-Observable Integrated Deckhouse (LID). Assessment of susceptibility of surface ships electrical fields causing mines to trigger for Near Field Deamping program. Development of a measurement system to evaluate scaling relationships for hydrodynamic disturbances.
Continue:
(U) For Submarines - Evaluation of control algorithms for advanced degaussing/de-amping of submarine hulls. Development of advanced numerical acoustic codes and gridding methods. For Surface Ships - Development of technology options for electromagnetic, thermal, electro-optical and visual signature reduction of LID. Assessment of susceptibility of surface ships electrical fields causing mines to trigger for Near Field Deamping program. Development of physics based numerical model for electromagnetic scattering of hydrodynamic disturbances.
Complete:
(U) For Submarines – Feasibility study to develop realizable modular hull/payload modules. Analyze full-scale trial data to establish hull response and radiated noise levels with hull treatments applied. For Surface Ships – Validate numerical model to predict the eddy current contribution to magnetic signatures. Assessment of both internal and external degaussing coil arrangements. Recommendations for physics and software architecture for the next-generation infrared scene model.

- (U) Hull Life Assurance:

Initiate:
(U) Component design for dynamic magazine protection. Study of Advanced Design Hardening Methods for hull structure design for Stainless Steel Advanced Double Hull (SSADH), Composite Hybrid Hull and other hull forms. Dynamic Behavior of Composite Ship Structures (DYCOSS) joint effort with Dutch Navy. Develop tools to describe failure mechanisms of sandwich composites.
Continue:

(U) Characterization of composite hull shock response with shock table tests on topside joints. Design tool for integrated antenna and composite topside. Analysis of results for composite hull shock tests performed in the Baltic Sea (joint effort with Germany).

Complete:

(U) Complete analytical tool development for dynamic magazine protection. Demonstrate the fiber-optic health monitoring system on the RV-Triton during rough weather trials.

- (U) Hydromechanics:

Initiate:

(U) For Submarines: Maneuvering experiments using existing/modified propulsor hardware from the VIRGINIA and Office of Naval Research (ONR) Advanced Stern Programs. For Surface Ships: Identification and quantification of bubble sources around surface ships, including wave-breaking and turbulence effects.

Continue:

(U) For Submarines: Improved maneuvering simulation capability. For Surface Ships: Numerical prediction of hydrodynamic disturbances generated by surface ships. Development, validation, and application of numerical codes to integrated propulsor/hull for advanced surface ship configurations. Numerical prediction of radar returns from nearby waves to surface waves at ship position and the resulting motion response prediction.

Complete:

(U) For Submarines: Comparison of computational and experimental results for a looped-blade propulsor concept and design a looped-blade propeller for a full-stern propulsor. For Surface Ships: Demonstration and evaluation of the variable pitch prop design.

- (U) Distributed Intelligence for Automated Survivability:

Initiate:

(U) Assessment of explosion mitigation through preemptive use of water mist for advanced damage countermeasures.

Continue:

(U) Investigation of fire and smoke spread modeling for damage control

Complete:

(U) Automated damage control effort to provide design criteria for automated systems.

- (U) Advanced Electrical Power Systems:

Initiate:

(U) Support of power & energy research infrastructure, including major test and instrumentation needs, for such things as advanced prototype testing, Superconducting Magnetic Energy Storage (SMES), and other applications of superconductivity, as well as, power and control systems.

(U) Studies to define advanced system state estimation concepts for controls and sensors. Development of technology basis for a family of electromechanical actuators. Advanced thermal management concepts and components.

Continue:
(U) Evaluation of the potential of impact wafer bonded FTOs for future Navy systems. Evaluate potential applications of silicon-carbide in future high voltage and high power applications. Power electronics technology to reduce the size, weight and cost of Electromagnetic Aircraft Launch and Recovery System.
Complete:
(U) Demonstration of advanced passive components for high voltage application.

(U) ($14,136) SENSORS & ASSOCIATED PROCESSING:

- (U) Distributive Aperture System:

(U) Initiated:
For Surface Ships, the Navy intends on beginning advanced research for the development of a ship based Distributed Aperture System (DAS) Infrared Search and Track (IRST) for DDX, CGX, and CVNX platforms. The DAS will address future surface combatant needs to win or avoid engagements by weapons and platforms, and asymmetric threats faced in the littorals. The DAS program will investigate, examine and evaluate new technologies and techniques for focal plane arrays, anemographic optics, stabilization techniques, modularized replaceable packaging, and high-speed processors and algorithms. The DAS sensor, consisting of eight modules for surface ships will vary based on the size of ship. It will provide surface ships with a 360-dgree panoramic staring view on the horizon to line of sight, and will detect, declare, and track air contacts and surface contacts within 2-3 seconds. The sensor modules can pan downward to view the surface from near the ship to line of sight for in port counter terrorism awareness. DAS will address the surface naval ships needs for a passive fighting ability and in-port security capability. Two International FY02 Project Agreements (United Kingdom and Australia) will assist the DAS program in the development of sensor, signal processing algorithms, and high-speed technologies.
(U) For Naval Aircraft, As anti-air threat missile systems increase in both number and technical sophistication, the Navy is developing a Missile Warning System (MWS) project that uses a solid-state two color staring sensor and tracking system to provide aircraft systems with the detection, location and identification of sophisticated threat missiles with the fidelity required to queue laser-based directional infrared countermeasures (DIRCM) systems and launch off-board decoys. The MWS system will demonstrate a time-to-go accuracy of +/- 15% for missile ranges greater than 1.5 kilometers and a 75% increase in the minimum detection range for Man Portable Air Defense Systems (MANPADs) with no increase in the false alarm rate.
(U) For Naval Aircraft, the EO/IR Laser Jammer for Tactical Aircraft (TACAIR) project will focus on components related to the jamming portion of the DIRCM system that also includes the MWS project. These components include technology enhancements to the power and beam characteristics of the laser-based countermeasure and demonstrating effective jam codes for all Tier 1 and Tier 2 threat missiles and a common jam code with 95% effectiveness for all Tier 1 and Tier 2 threat missiles. These capabilities will enable tactical aircraft to

operate routinely in airspace below 20,000 feet by providing self-protection against current and advanced IR guided missile threats.

(U) For Surface Ships A Shipboard EO/IR Closed Loop Self Protection project will be developed to demonstrate an integrated threat detection, classification, and closed loop laser jamming system to counter EO/IR/Laser guided anti-ship missiles. This will be done by using a multi-line high power laser system operating in the visible to longwave IR spectral band; a rangefinder that will range passive targets out to 20km; and a transceiver and signal processor that will classify a target in less than 3 seconds.

(U) For Small Platforms, EO/IR self-protection for Small Surface Vehicles, part of the Electronic Warfare Integrated System for Small Platforms (EWISSP) project, was initiated to provide a small platform with automatic response self and local area protection against IR guided and laser designated missiles and munitions. This will be accomplished with an integrated system capable of detecting and localizing laser designators and providing missile launch indication at a range of 4 km. The EWISSP effort will be continued under PE0602235N in FY03.

(U) For Marine Corps, the End User Terminal (EUT) project, structured to develop improved personal communications, situational awareness and sniper detection for ground troops that use less power, provide greater range and ease of use, was initiated and will use a central processing unit that delivers the performance similar to the 550 MHz Pentium III but at ¼ the power level. The daylight readable low power display will provide a minimum of 256 colors and an 80% power reduction over existing units.

Completed:

(U) For Surface Ships, the Shipboard Laser Acquisition System (SBLAS) project will complete fabrication and characterization of an off-axis laser detection system and a decoy subsystem that will become part of the EWISSP project.

(U) For Naval Aircraft, the Electrical IR Decoy Launcher is developing the capability for multiple decoy shots and investigating components and designs for a non- foreign object damage (FOD) less cartridge.

(U) ($33,467) MISSILE DEFENSE

Initiate:

(U) As part of the Missile Defense Future Naval Capability: The Infrared Sensors project will initiate requirements analysis and technical assessment of alternatives for advanced IRST for airborne detection of Theater Ballistic Missile (TBM) events. The Littoral Affordability project will develop affordable elements of multi-spectral sensor and combat systems for the purpose of early detect-through-engage functions over-the-horizon from firing ships.

(U) The following Discovery and Invention will commence: The Directed Energy project will build upon free electron laser technology to conduct design studies and component development for a 100kw Free Electron Laser for potential naval use. The Advanced Energetics project will be the Navy component of the Defense Threat Reduction Agency led Thermobaric Warhead Explosive Fill ACTD. This work will include composition synthesis and process development for this explosive fill. Using as a basis the Army Developed Tactical Cruise Missile System (TACMS), feasibility and design efforts will be conducted for adaptation of this system to a submarine launched TACMS, TACMS-P, for a wide range of precision strike targets.

Continue:

(U) As part of the Missile Defense Future Naval Capability: The Distributed Weapons Coordination (DWC) project, an evolution from Composite Threat Evaluation / Weapon Assignment (TEWA), will develop algorithms (compatible with an open-architecture combat system) for the purpose of collating theater-wide sensor use and weapons status for common threat evaluation (CTE) and Preferred Shooter Recommendation (PSR) functions. The DWC project will develop and demonstrate Navy Area TBM Defense CTE and PSR functionality at a laboratory simulation facility.

(U) ($10,185) AIRCRAFT TECHNOLOGY

(U) Naval Air Vehicle Technology (includes Integrated Avionics):

Initiate

(U) Technology demonstration of an all-composite replacement for dynamically loaded control surfaces for tactical aircraft.

(U) Technology demonstration of an innovative composite structural configuration of dynamically loaded rotary components.

(U) Real-time CFD modeling of ship airwake flows to provide higher fidelity simulations, enhancing safety.

(U) Laboratory validation of a new, innovative design concept for dynamically loaded rotary components for the Maximizing Usable Service Times (MUST) Program.

(U) Development of two full-scale demonstrations of the innovative design concept for dynamically loaded rotary components for the MUST Program.

Continued:

(U) Abrupt Wing Stall) figures of merit development and verification, CFD validation, and wind tunnel test techniques to mitigate/eliminate AWS on current/future fighter/aircraft aircraft.

(U) Development and simulation of advanced control laws for ship-board auto-land of unconventional vehicles.

(U) Development and simulation of automated maneuvering algorithms to improve lethality, safety, and survivability for Naval Mission tasks.

(U) Development of Advanced optics and head tracker of a multi-mode helmet vision system.

Complete:

(U) Flight-testing with DARPA and Boeing of a UAV to demonstrate conversion from rotary-wing to fixed-wing flight using a canard/rotor wing concept.

(U) Piloted simulation of intelligent flight control prognostics and reconfiguration algorithms to improve safety, survivability, and affordability of flight control systems.

(U) Classified program.

BUDGET ACTIVITY: 2 PROGRAM ELEMENT: 0602123N
PROGRAM ELEMENT TITLE: Force Protection Applied Research

(U) ($2,612) UNDERWATER PLATFORM SELF DEFENSE

- (U) Underwater Platform Self Defense:

Initiate:
(U) Development of technology for a Next Generation Countermeasure (NGCM)
Continue
(U) Development of ATT component technology in propulsion, MicroElectroMechanical Systems (MEMS), and Guidance and Control (G&C)

(U) FY 2002 Congressional Plus-Ups:

- (U) ($991) American Underpressure System (AUPS): Complete the test program of the AUPS including the control system design. The project will develop control simulation data to verify performance and safety of the system in order to fully respond to the United States Coast Guard stated requirements and permit rulemaking changes.
- (U) ($857)Battery Charging Technology: Provide applied research efforts to the development of improved battery charging technology.
- (U) ($3,568) Center for Advanced Transportation Technology: Provide applied research support to the Center for Advanced Power Systems (CAPS).
- (U) ($991) Endeavor: Develop a software environment for advanced marine vehicles and operations research, with an emphasis on physics based modeling.
- (U) ($4,460) Fusion of Hyperspectral and Panchromatic Data: Research to develop a real-time airborne fusion processor and algorithms for the Navy Hyperspectral/Imaging for Surveillance and Targeting (HISTAR) program. Establish proposal for HISTAR. Research to support development of a hyperspectral sensor and signal processing for the Shared Reconnaissance Pod (SHARP) on the F/A-18 aircraft for real-time detection and classification of threat targets.
- (U) ($1,487) Modular Advanced Hull Form: Research structural issues associated joining steel and composite materials, as well as investigating concepts of generic hybrid composite Naval ship hull construction.
- (U) ($2,478) Three Dimensional Printing (3DP) Metal Working Technology: … Provide applied research to the technique of three dimensional printing (3DP) metal working.

3. (U) FY 2003 PLANS:

(U) ($45,990) SURFACE SHIP & SUBMARINE HM&E

- (U) Signature Reduction:

Initiate:

(U) For Surface Ships – Initiate surface ship acoustic hull radiation model development. Initiate flow noise model development for surface ships. Development of next generation IR scene model.

Continue:

(U) For Submarines - Algorithm/finite element model validation for submarine advanced degaussing/deamping. Development of advanced numerical acoustic codes and gridding methods. Continue development of analytical models to further define modular submarine hull concepts. For Surface Ships - Antenna isolation measurement for both high band and low arrays integrated into topside structures. Demonstration of technology options for electromagnetic, thermal, electro-optical and visual signature reduction of Low-Observable Integrated Deckhouse (LID). Development of physics based numerical model for electromagnetic scattering of hydrodynamic disturbances.

Complete:

(U) For Submarines- Assessment of internal foundation structure impact to hull response to excitation/propulsion drive types. For Surface Ships – Tank test for surface ship acoustic behavior validation. Assessment of susceptibility of surface ships electrical fields causing mines to trigger for Near Field Deamping program. Experimental and analytical assessment EM scattering from droplets and sprays and the preliminary version of Next Generation IR Code for Verification and Validation.

- (U) Hull Life Assurance:

Continue:

(U) Definition of composite hull structural failure modes and mechanisms, development of design concepts and design guidance for composite structural details. Design tool for integrated antenna and composite topside.

Complete:

(U) Component design for dynamic magazine protection. Study on Advanced Design Hardening Methods for hull structure design for SSADH, Composite Hybrid Hull and other hull forms.

- (U) Hydromechanics:

Initiate:

(U) For Submarines: Model testing of a looped-blade propeller with a full stern to characterize powering, cavitation, acoustic, and maneuvering performance.

Continue:

(U) For Submarines: Improved maneuvering simulation capability. Investigation of flow conditions and hull propeller interaction of fine and full sterns during maneuvering. Develop experimental methods to control/eliminate the cavitation and apply to model-scale propellers. For Surface Ships: Development, validation, and application of numerical codes to integrated propulsor/hull for advanced surface ship configurations.

Complete:

(U) For Surface Ships: Numerical prediction of hydrodynamic disturbances generated by surface ships. Cavitation prediction of variable pitch propeller by numerical methods.

- (U) Distributed Intelligence for Automated Survivability:

Continue:
(U) Assessment of explosion mitigation through preemptive use of water mist for advanced damage countermeasures. Investigation of fire and smoke spread modeling for damage control.

- (U) Advanced Electrical Power Systems:

Continue:
(U) Development of technology basis for a family of electromechanical actuators. Advanced thermal management concepts and components. Development of compact high-powered solid state switching technology for the Electromagnetic Aircraft Launch System (EMALS) and other pulsed and steady state applications. Development of advanced power system and control architectures for operation and reconfiguration of future all-electric ships. Support of power & energy research infrastructure, including major test and instrumentation needs, for such things as advanced prototype testing, Superconducting Magnetic Energy Storage (SMES), and other applications of superconductivity, as well as, power and control systems.
Complete:
(U) Transition of demonstration Hardware, Application, and System Managers to advanced EMALS program Commercial PEBB-based utility products available for Navy application.

(U) ($10,400) SENSOR & ASSOCIATED PROCESSING:

- (U) Distributive Aperture System:

Initiated:
(U) For the Naval Aircraft, the Integrated Defensive Electronic Countermeasures (IDECM) project will add additional capability to the radio frequency countermeasures (RFCM) system for F/A-18 E/F self-protection. This consists of developing a RF decoy towline capable of operating intermittently for 30 seconds at 650 degrees centigrade for 3 minutes total exposure time and applying Gallium Arsenide technology to design a prototype solid-state transmitter for the fiber optic towed decoy.
Continued:
(U) For Surface Ships, the Navy will continue developing DAS technologies and associated processing with the International Partners. Work schedule for FY03, 04 and 05 will seek to examine and integrate the sensor modules into a single system design to support shipboard combat operations. A high-speed processor and associated algorithms, ported to middleware, will be examined for real-time application. Technologies will be tested and verified in laboratories prior to shipboard DAS demonstration. The DAS program will deliver a three-sensor package with associated processing and high-speed central processor for integration into surface combatants. International partners will mirror the U.S. effort and help to explore, examine, and evaluate the DAS sensor, signal processing algorithms, and high-speed processor technologies to support a FY05/06 demonstration.
(U)For Marine Corps, the EUT project will examine techniques to inject advanced-scope information into its network and commence integration of the RF module and the vest/garment. Enhanced RF transmitters will be

developed using Gallium Nitride on Silicon Carbide transistor technology. The goal is a factor of 3 improvement in efficiency vs. current man wearable transmitters being used by the Marine Corps Warfighting Laboratory.
(U) For Naval Aircraft, the EO/IR laser jammer for Tactical Air (TACAIR) project continues to examine two-color (low operating temperature) Focal Plane Arrays for common optics.
(U) For Naval Aircraft, the MWS project will undertake improved time-to-go (TTG) accuracy testing, attend live fire demonstrations and tests as well as continue to test high temperature focal plane arrays.
(U) For Surface Ships The Shipboard EO/IR closed loop self-protection project will complete the development of the optical train design and continue development of the data processor and optical augmentation software algorithms for threat classification. The repackaging of the mid-wave IR laser will be completed in preparation for a future functional field demonstration.

(U) ($21,500) MISSILE DEFENSE
Continue:
(U) As part of the Missile Defense Future Naval Capability: The Infrared Sensors project will validate sensor design for E-2C aircraft-compatible IRST sensor, capable of detecting TBM events and cueing radio frequency (RF) sensors at meaningful ranges as well as conduct critical component tests. The Distributed Weapons Coordination (DWC) project will continue development of algorithms for the AEGIS Combat System, CTE and PSR functions. It will also demonstrate Navy Anti-Air Warfare (AAW) combined with terminal TBM defense functionality in a laboratory simulation facility. The Littoral Affordability effort will develop affordable elements of multi-spectral sensor and combat systems for the purpose of early detect-through-engage functions over-the-horizon from firing ships.
(U) As part of Discovery and Invention: The advanced energetics project which includes composition synthesis and process development for the Thermobaric Warhead Explosive Fill ACTD will continue.

(U) ($10,000) AIRCRAFT TECHNOLOGY
- (U) Naval Air Vehicle Technology (includes Integrated Avionics):

Initiate:
(U) Technology demonstration of an all-composite replacement for dynamically loaded control surfaces for tactical aircraft.
(U) Technology demonstration of an innovative composite structural configuration of dynamically loaded rotary components.
(U) Real-time CFD modeling of ship airwake flows to provide higher fidelity simulations, enhancing safety.
(U) Laboratory validation of a new, innovative design concept for dynamically loaded rotary components for the MUST Program.
(U) Development of two full-scale demonstrations of the innovative design concept for dynamically loaded rotary components for the MUST Program.

Continue:
(U) Abrupt Wing Stall figures of merit development and verification, CFD validation, and wind tunnel test techniques to mitigate/eliminate AWS on current/future fighter/aircraft aircraft.
(U) Development and simulation of advanced control laws for shipboard auto-land of unconventional vehicles.
(U) Development and simulation of automated maneuvering algorithms to improve lethality, safety, and survivability for Naval Mission tasks.
(U) Development of Advanced optics and head tracker of a multi-mode helmet vision system.
Commplete:
(U) Piloted simulation of intelligent flight control prognostics and reconfiguration algorithms to improve safety, survivability, and affordability of flight control systems.
(U) Flight-testing with DARPA and Boeing of a UAV to demonstrate conversion from rotary-wing to fixed-wing flight using a canard/rotor wing concept.

(U) Classified program.

(U) ($1500K) UNDERWATER PLATFORM SELF DEFENSE

- (U) Underwater Platform Self Defense:

Continue:
(U) Development of technology for a NGCM. Continue development of ATT component technology in propulsion, MEMS, and G&C.

C. (U) PROGRAM CHANGE SUMMARY:

	FY 2001	FY 2002	FY 2003
FY 2002 President's Budget	**	117,072	
Adjustments from FY 2002 President's Budget:			
Section 8123 Mgmt Reform Initiative		-1,167	
Congressional Plus-Ups		14,965	
FY 2003 President’s Budget Submission	**	130,870	89,390

** The Science and Technology PEs were restructured in FY 2002. FY 2001 efforts were funded in PE(s) 0602121N, 0602122N. 0602232N, 0602270N, 0602633N.

BUDGET ACTIVITY: 2 PROGRAM ELEMENT: 0602123N
PROGRAM ELEMENT TITLE: Force Protection Applied Research

(U) CHANGE SUMMARY EXPLANATION:

Schedule: Not Applicable.
Technical: Not Applicable.

D. (U) OTHER PROGRAM FUNDING SUMMARY:

(U) RELATED RDT&E: The aircraft technology program adheres to Defense S&T Reliance Agreements on Air Platforms (Fixed Wing, Rotary Wing, Integrated High Performance Turbine Engine Technology (IHPTET), and Aircraft Power), Sensors, Electronics & Electronic Warfare (Integrated Platform Electronics), Human Systems, and Materials/Processes.

(U) NAVY RELATED RDT&E:
- (U) PE 0601153N (Defense Research Sciences)
- (U) PE 0602271N (RF Systems Applied Research)
- (U) PE 0602235N (Common Picture Applied Research)
- (U) PE 0603235N (Common Picture Advanced Technology)
- (U) PE 0603271N (RF Systems Advanced Technology)
- (U) PE 0603123N (Force Protection Advanced Technology)
- (U) PE 0603502N (Surface and Shallow Water Mine Countermeasures (MCM))
- (U) PE 0603513N (Shipboard System Component Development)
- (U) PE 0603553N (Surface Anti-Submarine Warfare)
- (U) PE 0603561N (Advanced Submarine Systems Development)
- (U) PE 0603573N (Advanced Surface Machinery Systems)
- (U) PE 0603609N (Conventional Munitions)
- (U) PE 0604307N (Surface Combatant Combat System Engineering)
- (U) PE 0604558N (New Design SSN Development)
- (U) PE 0604561N (SSN-21 Development Program)
- (U) PE 0204152N (E-2 Squadrons)
- (U) PE 0205601N (HARM Improvement)
- (U) PE 0602131M (Marine Corps Landing Force Technology)
- (U) PE 0603640M (Marine Corps Advanced Technology Demonstrations)

(U) NON NAVY RELATED RDT&E:
- (U) PE 0602270A (Electronic Warfare Technology)
- (U) PE 0602204F (Aerospace Sensors)

E. (U) SCHEDULE PROFILE: Not applicable.

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602131M

PROGRAM ELEMENT TITLE: Marine Corps Landing Force Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
Marine Corps Landing Force Technology	12,144	30,961	30,274	32,499	36,341	39,798	39,186	CONT.	CONT.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The Marine Corps is tasked to develop, in conjunction with the Navy, Army, and Air Force, those phases of amphibious operations that pertain to tactics, techniques, and equipment used by the landing force. It is organized into five amphibious expeditionary warfighting capability areas. These are; Mobility; Weapons; Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR); Logistics; and Training and Education. Mobility and Weapons programs develop advanced technologies for application on current and future Marine Corps expeditionary weapons and vehicle systems. Emerging capability requirements for future armored vehicles include improved mobility, survivability, and lethality over legacy systems. Weapon systems for the individual Marine include advanced small arms development, non-lethal systems, and improved anti-armor weapons. C4ISR supports Expeditionary Maneuver Warfare by providing secure, robust, self-forming, mobile communications networks; distributed computing to support information dissemination to all echelons; and sensors, software, and data processing to support formation of the user-appropriate common picture. The Logistics programs are structured to meet emerging Marine Corps Warfighting Concepts Expeditionary Maneuver Warfare and Sea Based Logistics. Logistic program areas to meet these emerging concepts include improved distribution capabilities, Logistics Command and Control (C2) Systems, and reduced energy demand. The Training and Education program areas invests in technologies to enhance the performance of the warfighter that relate to the neural and cognitive part of human performance.

(U) The primary objective of this Program Element (PE) is to develop and demonstrate the technologies needed to meet the Marine Corps' unique responsibility for amphibious warfare and subsequent operations ashore. This PE provides the knowledge base to support Advanced Technology (6.3) and is the technology base for future amphibious/expeditionary warfare capabilities. This PE supports the Concept Based Requirements System of the Marine Corps Combat Development

Command and responds directly to the Marine Corps science and technology process. The Future Naval Capabilities (FNC) process is supported and funds are programmed accordingly. The core program also supports discovery and invention. Due to the number of efforts in this PE, the programs described are representative of the work included in this PE.

JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the APPLIED RESEARCH Budget Activity because it investigates technological advances with possible applications toward the solution of specific Naval problems, short of a major development effort.

B. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 2001 ACCOMPLISHMENTS:

- (U)($2,974) Mobility Thrust: Transitioned data to Coastal Offshore Battlefield Reconnaissance and Analysis (COBRA) program/Mine Countermeasures Future Naval Capabilities (FNC). Tested Tunable Filter Multi-spectral Camera in flight. Conducted studies and utilized urban terrain modeling to evaluate payoffs in vehicle hardening, signature management and vehicle configuration to exploit the current state of the art in materials and protection systems as they pertain to the littoral environment.

- (U)($336) Weapons Thrust: Conducted air bursting munitions effectiveness study. Conducted lethality modeling and simulation for Objective Crew Served Weapon.

- (U)($2,549) C4ISR: Continued devising Joint Tactical Radio System (JTRS) Software Communications Architecture version 1.0 Standard. Injected Marine Corps specific requirements into and performed network modeling of proposed JTRS wide-band network waveforms (WNW); began JTRS WNW standardization process. Developed and prototyped JTRS wide-band wearable antennas. Completed Mobile Direction Finding development of signal characterization software and completed location, orientation and timing card design. Moved effort to 0603640M program for prototype development in FY2002. Initiated and continued development of a black and white, still-frame imaging capability with infrared payload for the Infantry Reconnaissance Round.

- (U)($2,173) Logistics: Expeditionary packaging technologies for biodegradable and non-expendable materials explored. Light Weight Water Purifier evaluated for modification to meet USMC requirements – man portable, High Mobility Multi-purpose Wheeled Vehicle (HMMWV) transportable. Military assessment of Small Unit Logistics system conducted. Continued development of Onboard vehicle Refueler Communication system. Corrosion study completed.

- (U)($1,699) Training & Education Thrust: Transitioned Advanced Amphibious Assault Vehicle (AAAV) modeling and simulation products developed as part of the Small Unit Tactics Trainer (SUTT) program to the Capable Manpower (CM) Future Naval Capabilities (FNC) program. Completed Fire Team Cognitive Skills Trainer Demonstration (FTCSTD) report. This report evaluated the ability of a Commercial Off The Shelf (COTS) computer game to perform as a Tactical Decision Game (TDG) for accomplishing Marine Infantry and Combat Arms required skills training. Transitioned the FTCSTD products to the Deployable Virtual Training Environment (DVTE) program. Completed Marine Air Ground Task Force (MAGTF) Federation Object Model (FOM) prototype development and testing in an integrated simulator network. Transitioned the MAGTF FOM products to the DVTE program.

(U) FY 2001 CONGRESSIONAL PLUS-UP:

- (U)($2,413) Center for Emerging Threats and Opportunities (Non-Traditional Warfare Initiatives): Conducted Military Operations in Urban Terrain (MOUT) Experimentation at the Strategic, Operational, and Tactical levels of war. Conducted 2 major strategic level war games, 2 operational level war games, and 3 limited objective field experiments concentrating on technological enhancements in the areas of robotics, micro-UAVs, and directed energy non-lethal weapons. Products included a Reconnaissance/Surveillance/Target acquisition (RSTA) Tactics/Techniques/Procedures (TT&P) document, Directed Energy TT&P document, and a joint Urban Operating concept draft document. A prototype shipboard was developed in port defense course for the US Navy in the wake of the U.S.S. Cole attack. This included a Navy version of the Combat Decision Range and completed a major study on Ships to Objective Maneuver (STOM) capabilities to include identification.

2. (U) FY 2002 PLAN:

- (U)($5,435) Mobility Thrust: Evaluate alternate power sources for advanced hybrid electrical systems and improvements in high efficiency and high energy density vehicle power sources compatible with Operational Maneuver From The Sea (OMFTS) and Ship To Objective Maneuver (STOM) operating concepts, e.g. fuel cells, micro turbines and power management systems. Evaluate active suspension systems, integration of novel shock and strut systems for Marine Corps future vehicles. Develop lightweight armor/structural materials. Develop unmanned ground vehicle (UGV) technology. Complete studies of urban terrain issues, visibility, rubble, and trafficability. Assess UGV technology for the mission payload package; sensors, self-protection and effects, in order to complete input into the UGV Operational Requirements Document.

- (U)($3,436) Weapons Thrust: Develop sensor fusion/fire control technologies, e.g. advanced ground weapon fire control systems fusing multiple sensor inputs (thermal, visual, acoustic) into a single display. Conduct Marine Air Ground Task Force (MAGTF) Expeditionary Family of Fighting Vehicles (MEFFV) lethality modeling and simulation. Develop non-lethal weapons technology, e. g. neuro-muscular disruption systems to deliver shock or trauma to multiple targets at greater than contact weapons ranges. Complete air burst munitions study of alternative methods of integrating low cost mobile sensor and missile system components into advanced combat systems.

- (U)($2,315) C4ISR: Initiating high-density data storage (rugged, no moving parts) applied research program. Developing chip-manufacturing processes for emerging test prototype device. Initiating Command and Control testbed for testing interoperability, usability and military suitability of developmental software. Initiating conformal antenna development effort for very-high frequency and ultra-high frequency radio vehicle applications. Completing JTRS architecture and standard development work for transfer to the JTRS Joint Program Office. Selecting WNW

Standard Version 1. Completing wearable JTRS vest antenna work (human effects, ruggedness, prototype development) for transition to acquisition command. Testing and completion of development for technology maturity of a black and white, still-frame imaging capability with infrared payload for the Infantry Reconnaissance Round.

• (U)($1,470) Logistics: Investigate water filtration technologies by completing evaluation of Lightweight Water Purifier and development of Nuclear Biological and Chemical (NBC) water packaging compatible with Modular Load Bearing Equipment (MOLLE) modular lightweight load bearing system. Investigate fuel quality sensing technology to include pressure transducer sensors to provide fuel asset visibility. Continue to refine Expeditionary Packaging technologies for biodegradable and non-expendable materials. Continue development of Small Unit Logistics ground logistics C2 program.

• (U)($3,305) Training & Education Thrust: Evaluate technologies available for the development of a Portable Synthetic Environment Generation capability. This system will be capable of automatically producing a three dimensional synthetic database from a video stream of real world terrain and cultural features in a 'common' database format suitable for Close Quarter Battle (CQB) and Military Operations in Urban Terrain (MOUT) training. Evaluate technologies available for enhancing situational awareness in CQB and MOUT training. This technology must be capable of tracking all aspects of individual movement in real time. Center for Emerging Threats and Opportunities (CETO) Thrust-Evaluate and develop technologies for application to Force Protection of Marine units deployed to high risk environments and for Anti-Terrorism operations to be conducted by the Fourth Marine Expeditionary Brigade. These technologies will be evaluated in the context of operational experiments to determine feasibility and utility for rapidly emerging asymmetric warfare environments.

• (U)($1,000) Littoral Combat and Power Projection FNC: Initiate program planning to include the development of Enabling Capabilities, Technology Products, Metrics, Exit Criteria, Technology Risk, and Demonstration planning. Identify and fund technologies that can be demonstrated meeting specific exit criteria for transition to acquisition.

• (U)($1,000) Littoral Combat and Power Projection FNC: Conduct Expeditionary Maneuver Warfare (EMW) wargame to determine critical capability gaps that are particularly well suited to be resolved by innovative science and technology solutions in support of the new USMC capstone concept. Several specific expeditionary vignettes encompassing a high-end forcible entry scenario, a high-end forward operations scenario, and a low-end “three block war” scenario will drive the game.

• (U)($5,000) Littoral Combat and Power Projection FNC: Initiate Expeditionary Fires Technology Program to develop a system with self-contained survey, networked, real-time geospatial fire control, communications and automatic aiming subsystems.

• (U)($2,000) Littoral Combat and Power Projection FNC: Determine the level of increased operational capability that is provided to a "First In" USMC Command Post (oftentimes referred to as a Jump CP) through the development and or integration of a Ku band SATCOM reachback capability with TACSAT and line of sight communication, that includes wireless command post extension, SIPR/NIPRNET, tactical cell phone, and video teleconference capability.

• (U)($1,500) Littoral Combat and Power Projection FNC: Complete development of Dragon Eye, small unit unmanned aerial vehicle designed for one-hour flight at 40-mph airspeed. Transition to Marine Corps Systems Command.

• (U)($1,000) Littoral Combat and Power Projection FNC: Initiate development of portable/deployable Tactical Decision Games that provide the capability for virtual force-on-force interaction and virtual live fire training to include heterogeneous "plug and play" virtual environments (especially for individual and small unit training). Initiate development of precision location indicator devices to be integrated with constructive simulation for live fire training and range safety purposes.

• (U)($3,500) Develop innovative technology solutions in the capability gap areas that emerged from the insights gained from the EMW wargame. Gap technology areas will include C4ISR, Expeditionary Fires, and Maneuver. Initiate and release Broad Agency Announcements.

3. (U) FY 2003 PLAN:

- (U)($4,422) Mobility Thrust: Initiate hybrid electric mobility platform test bed for MEFFV. Develop lightweight armor/structural materials. Develop lightweight vehicle power technologies. Develop advanced vehicle mobility technologies. Develop UGV technology.

- (U)($2,312) Weapons Thrust: Develop MEFFV requirements excursions, e.g. unique Marine Corps differences from the Army Future Combat Systems (FCS) lethality programs, multi-role cannon, compact kinetic energy missile and directed energy. Develop sensor fusion/ fire control technologies for USMC ground weapons. Develop MEFFV lethality study/ modeling and simulation for future USMC fighting vehicles that meet requirements for OMFTS/STOM which are different from the Army FCS concept. Develop non-lethal weapons technology for transition to Marine Program Manager for Non-lethal Weapons.

- (U)($2,420) C4ISR: Initiate development of low-probability of interception, low-probability of detection ultra-wide band communications (from 6.1). Initiate development of network management capabilities for the low-bandwidth, heterogeneous communications environment. Initiate development of information management technologies for low-bandwidth distributed environments. Continue development of high-density, solid-state data storage devices. Continue development of command and control testbed capability. Continue development of vehicular conformal antenna technology.

- (U)($1,634) Logistics: Investigate expeditionary energy technologies to include fuel cells and technologies associated with reducing fossil fuel consumption. Continued development of water filtration technologies to include water packaging compatible with MOLLE modular lightweight load bearing system. Continued development of Sensor technologies to expand to other areas of Supply beyond fuel to include Water, ammo, etc. Continue to refine Expeditionary Packaging technologies biodegradable and non-expendable materials. Continue development of Small Unit Logistics ground logistics C2 program with emphasis in Autonomic Logistics, sensor technologies to improve readiness of USMC ground equipment.

- (U)($4,162) Training and Education Thrust: Complete evaluation of technologies available for the development of a Portable Synthetic Environment Generation capability. Commence design of a systems that will be capable of automatically producing a three dimensional synthetic database from a video stream of real world terrain and cultural features in a ‘common’ database format suitable for Close Quarter Battle (CQB) and Military Operations in Urban Terrain (MOUT) training. Demonstrate feasibility of technologies applicable to enhancing situational awareness in CQB, MOUT, and other warrior training applications. Center for Emerging Threat and Opportunities (CETO) Thrust: Continue to evaluate, develop, and test technologies in operational experiments for applications to Force Protection and Anti-Terrorism. Technologies will include, but not be limited to: surveillance/counter-surveillance; chemical/biological incident response; near-real-time subject matter expert reach-back; intelligent agent symbiosis for modeling incident precursors; modeling and simulation of optimized multi-agency command and control processes.

- (U)($2,500) Littoral Combat and Power Projection FNC: Develop prototype Command and Control technologies for Amphibious Task Force (ATF).

- (U)($5,000) Littoral Combat and Power Projection FNC: Develop prototype Expeditionary Fires technologies to include platform and weapon stabilization techniques to enable firing on the move.

- (U)($5,000) Littoral Combat and Power Projection FNC: Develop prototype technologies for MAGTF Maneuver in the Littorals.

- (U)($2,824) Littoral Combat and Power Projection FNC: Develop prototype Intelligence, Surveillance, and Reconnaissance technologies for the ATF.

C. (U) PROGRAM CHANGE SUMMARY:

	FY 2001	FY 2002	FY 2003
FY 2002 President's Submission	12,180	31,248	
Execution Adjustment	+232		

BUDGET ACTIVITY: 2 PROGRAM ELEMENT: 0602131M
PROGRAM ELEMENT TITLE: Marine Corps Landing Force Technology

SBIR	-268		
Section 8123: Management Reform Initiative		-276	
FFRDC Reduction		-11	
FY 2003 President's Submission	12,144	30,961	30,274

(U) CHANGE SUMMARY EXPLANATION:

(U) Funding: Not Applicable.
(U) Schedule: Not Applicable.

D. (U) OTHER PROGRAM FUNDING SUMMARY: The Navy's 6.1 program contributes to this effort.

(U) NAVY RELATED RDT&E:

(U) This program adheres to Tri-Service Reliance Agreements in Chemical/Biological Defense; Command, Control and Communications; Conventional Air/Surface Weaponry; Electronic Devices; Ground Vehicles; Ships and Watercraft; Manpower and Personnel; and Training Systems.

(U) PE 0601152N (In-House Laboratory Independent Research)
(U) PE 0601153N (Defense Research Sciences)
(U) PE 0204163N (Fleet Communications-Tactical)
(U) PE 0602235N (Common Picture Applied Research)
(U) PE 0602782N (Mine and Expeditionary Warfare Applied Research)
(U) PE 0603782N (Mine and Expeditionary Warfare Advanced Technology)
(U) PE 0603235N (Common Picture Advanced Technology)
(U) PE 0206623M (Marine Corps Ground/Supporting Arms Systems)
(U) PE 0603640M (Marine Corps Advanced Technology Demonstrations)

(U) PE 0603612M (Marine Corps Mine/Countermeasures)
(U) PE 0603635M (Marine Corps Ground Combat/Support System)
(U) PE 0206313M (Marine Corps Communications Systems)
(U) PE 0603236N (Warfighter Sustainment Advanced Technology)

(U) NON NAVY RELATED RDT&E:
(U) PE 0603004A (Weapons and Munitions Advanced Technology)
(U) PE 0603005A (Combat Vehicle and Automotive Advanced Technology)
(U) PE 0603606A (Landmine Warfare and Barrier Advanced Technology)
(U) PE 0603607A (Joint Service Small Arms Programs)
(U) PE 0603619A (Landmine Warfare and Barrier Advanced Development)
(U) PE 0603772A (Advanced Tactical Computer Science and Sensor Technology)

(U) PE 0604710A (Night Vision Systems-Engineering Development)
(U) PE 0604808A (Landmine Warfare/Barrier Engineering Development)
(U) PE 0602301E (Computing Systems and Communications Technology)
(U) PE 0602702E (Tactical Technology)

E. (U) SCHEDULE PROFILE: Not applicable.

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602232N
PROGRAM ELEMENT TITLE: Communications, Command, Control, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR)

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE
Communications, Command, Control, Computers, Intelligence, Surveillance and Reconnaissance		
	113,270	*

*This PE was restructured in FY 2002. FY 2001 efforts are described in PEs 0602114N, 0602123N, 0602235N, and 0602271N.

Congressional Plus-ups appropriated in this PE are described under the following restructured program elements:

TITLE	PROGRAM ELEMENT	FY 2001
Cooperative Engagement Capability Preplanned Product Improvement	0602235N	$ 9,659
Hyperspectral Research	0602114N	$ 2,899
Optoelectric High Definition Camera Prototypes	0602235N	$ 1,932
Tactical Component Network Demonstration	0602235N	$ 9,659
UESA Signal Processing Support	0602271N	$ 9,659

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602233N
PROGRAM ELEMENT TITLE: Human Systems Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE
Human Systems Technology		
	40,994	2,577

This PE was restructured in FY 2002. FY 2001 efforts are described in PEs 0602235N, 0602236N and 0602271N.

Congressional Plus-ups appropriated in this PE are described under the following restructured program elements:

TITLE	RESTRUCTURED PROGRAM ELEMENT	FY 2001	FY 2002
Biological Hazard Detection System	0602236N	3,377	
Cognitive Research	0602236N	1,931	
Marine Fire Training Center At MERTS	0602236N	1,931	
Marine Fire Training/Berbers Point	0602236N	1,931	2,577

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602234N
PROGRAM ELEMENT TITLE: Materials, Electronics & Computer Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE
Materials and Radio Frequency/Electro-Optics/Infrared Electronics Technology		
	100,177	19,129

This PE was restructured in FY 2002. FY 2001 efforts are described in PEs 0602236N and 0602271N.

Congressional Plus-ups appropriated in this PE are described under the following restructured program elements:

TITLE	PROGRAM ELEMENT	FY 2001	FY 2002
ADPICAS	0602236N		$1,289
Advanced Materials Innovative Communications Materials	0602271N	$1,448	
Advanced Materials Processing Center	0602236N	$4,837	
Aerospace Materials Technology Consortium	0602236N	$2,906	
Anti-Corrosion Coatings	0602236N		$3,469
Battlespace Information Display Tech Initiative Devopment Demo	0602235N	$2,898	
Carbon Foam for Navy Applications	0602236N		$2,577
Ceramic and Carbon Based Composites	0602236N	$1,939	
Composite Storage Module	0602236N	$2,906	
Development of Magnetic Random Access Memory	0602271N		$ 991
Environmentally Sound Ship Program	0602236N	$1,207	
High Brightness Electron Source Program	0602271N		$1,481
Hybrid Fiberoptic Wireless Communications	0602235N	$1,932	
Innovative Communications Material	0602271N	$1,932	
Intermediate Modulus Carbon Fiber Qualification	0602236N	$1,966	

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 2 PROGRAM ELEMENT: 0602234N
PROGRAM ELEMENT TITLE: Materials, Electronics & Computer Technology

Materials, Electronics & Computer Technology	0602271N	$1,448	
Materials Micronization Technology	0602236N	$ 971	$3,469

TITLE	PROGRAM ELEMENT	FY 2001	FY 2002
MicroArray Technology	0602271N		$3,469
Nanoscale S&T Sensor Research	0602271N	$2,414	
Silicon Carbide Semiconductor Material for Microwave Applications	0602271N	$3,865	$1,388
Thick Film Ferrite Magnetic Material	0602271N		$ 991
Virtual Company Link	0602235N	$1,931	
Wood Composite Technology	0602236N	$1,941	

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602235N

PROGRAM ELEMENT TITLE: Common Picture Applied Research

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
	Common Picture Applied Research								
	**	124,370	75,594	74,106	69,800	81,232	84,589	CONT.	CONT.

**The Science and Technology (S&T) Program Elements (PEs) were restructured in FY 2002. FY 2001 efforts were funded in PEs 0602232N, 0602233N, and 0602270N.

A (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION:

The Common Picture Applied Research Technology Program addresses technology deficiencies associated with the Navy's Twenty-First Century Network Centric Warfare need for developing information as a resource, weapon and target. The need is to develop a high performance network to interconnect geographical distributed surface, subsurface (including electric warship) and air platforms into a unified Naval Force. The Program emphasizes the development of technology supporting real-time planning and execution of Naval Warfare mission ranging from land attack (including expeditionary and littoral warfare) to Joint Theater Operations. These technology developments involve building new embedded capabilities within the Fleet to: 1) locate, extract and integrate relevant, time sensitive, critical information; 2) distribute information tailored to user needs; 3) manage and portray knowledge to the warfighter; 4) enable collaborative decision making among geographically disbursed warfighters; and 5) provide interoperable secure networking among Navy platforms. This program's technology developments directly support Future Naval Capabilities (FNCs) in Knowledge Superiority and Assurance (KSA), Missile Defense, Littoral Anti-Submarine Warfare (LASW) and Platform Protection (PP). The goal is to increase combat power via robust networking of information among distributed naval forces.

(U) Due to the number of efforts in this PE, the programs described are representative of the work included in this PE.

BUDGET ACTIVITY: 2 PROGRAM ELEMENT: 0602235N
PROGRAM ELEMENT TITLE: Common Picture Applied Research

JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the APPLIED RESEARCH Budget Activity because it investigates technological advances with possible applications toward solution of specific naval problems, short of a major development effort.

B. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 2001 ACCOMPLISHMENTS:

- (U) ($2,400) DECISION SUPPORT SYSTEMS: Decision Support System supports the Knowledge Superiority and Assurance Future Naval Capability specifically in the area of Decision Support Systems. The emphasis is on developing information and knowledge management capabilities and decision aids to build and maintain a timely operational/tactical picture of the total battlespace across all Command echelons from the Commander in Chief (CINC) to tactical units afloat as well as warfighters ashore. In FY01, delivered geospatial visualization and knowledge management services based on extensible Markup Language (XML) data tagging: allowing interoperability and reuse across multiple data bases. (FY01 accomplishments were funded under PE 0602232N.)

- (U) ($1,912) PLATFORM AWARENESS AND PROTECTION/ELECTRONIC WARFARE SYSTEMS: This Thrust supports the Platform Protection FNC. Current small platforms (both surface and airborne) have little to no situational awareness (SA) or self-protection against threat missile systems. The focus of this effort is to develop technologies that could provide these platforms the capability to achieve very accurate hemispheric direction-finding (DF) of radio frequency (RF) signals and deny the enemy their effective use or exploit their weaknesses. This capability, when integrated with emitter identification and Low Probability of Intercept (LPI) detection systems, will provide netted targeting information and cueing that allows for platform self protection against various threat systems. Developments included the use of small compact digital electronics, integrated circuits and digital synthesis technology. The following are examples of projects in this area: the Shipboard Laser Acquisition System (SBLAS), a common laser warning solution for all naval surface vessels that can detect and locate tactical laser threats by indirect scattering as well as direct illumination, successful proof of concept demonstration of single sensor laser-threat warning for large ships and wide area protection for amphibious assault vehicles. SBLAS Critical Design Review (CDR) was successfully conducted and long-lead procurement initiated for system fabrication, delivery and testing under the Platform Protection FNC Electronic Warfare (EW) Integrated System for Small Platforms (EWISSP) program commencing in FY02. The following projects developed EW related technologies that support EW RF and EW Mission Support thrust areas as coordinated by the Defense Reliance Tri-Service Technical Panel for EW S&T. The Tactical Reactive Command & Control Warfare (C2W)/Electronic Attack (EA) Network project develops a self-adapting, spatially distributed EA network for C2W capable of electromagnetic (EM) battlefield dominance through target denial, obscuration and signature alteration. In FY01, the project assembled and tested a C2W Net Emulator, integrated a network C2W/EA concept and completed first field testing. The Adaptive Mixed-Mode Very Large Scale Integration (VLSI) Sensors for Micro Air Vehicles (MAV) project emphasizes development of integrated monolithic or multi-chip module sensors to allow a MAV to autonomously detect, classify and navigate towards selected emitters and deliver countermeasures or payloads. FY01 saw the development of receiver systems and refined optic flow sensors in preparation for further fabrication and demonstration. The Personal Communications Systems (PCS) Exploitation project, which develops and evaluates technology to exploit and counter (from Navy platforms) modern PCS, conducted a survey of commercial off-the-shelf PCS and Digital Signal Processing (DSP) technology. The Battlefield Ordnance Network Centric Employment project develops and integrates electro-optical infrared (EO/IR) sensor and countermeasures (CM) technology into low cost, light weight unmanned aerial vehicle (UAV) systems to locate and direct counterfire against enemy gunfire, mortars, large caliber weapons, and missiles, and provides real-time imagery with symbology for Network Centric Warfare. In FY01 this project initiated development of coordinated counter-Surveillance/Targeting/Terminal EA techniques to achieve battleforce defense (with available EA assets), continued development of the fuzzy resource manager and an EW architecture that produces self-adaptive force behavior (“Plug-and-fight”) as well as measures of effectiveness (MOEs) for same. The Force Level Simulation project develops, tests and demonstrates concepts for distributed force level simulations over wide area networks. FY01 accomplishments include demonstration of a prototype High Level Architecture (HLA) capable Anti-Ship Cruise Missile (ASCM) simulation and completed prototype of Run Time Interface (RTI) middleware using Object Model Agility design implemented with Defense Modeling and Simulation Office (DMSO) RTI V1.3 implementation. (FY01 accomplishments were funded in PE 0602270N.)

- (U) ($8,916) MULTI-SOURCE INTEGRATION AND COMBAT IDENTIFICATION: (FORMERLY TITLED Multi-Source Technology): This thrust focuses on development of technology addressing the Navy’s Surface & Aerospace needs for multi-source integration (MSI), fusion, systems architecture, automated sensor management and algorithms to fuse, filter and correlate on-board sensor and off-board battlespace information from tactical data links, satellite communications and interoperable cooperative engagement networks. In FY 2001, the program initiated development of Affordable Ground Based Radar technology in response to Marine Corps needs for advanced multi-functional radar capability in Littoral operations. Joint development discussions were initiated and are underway with the Army. Development of System Resource Manager technology was initiated to maximize AEGIS radar (AN/SPY-1D) operational efficiencies in Missile Defense operations. A Joint United States/United Kingdom (US/UK) data fusion technology development addressing interoperability deficiencies was initiated. The program continued the development of platform (E-2C) Multi-Source Integration technology supporting the Missile Defense MSI program. In FY 2001 satellite communications (SATCOM) Input/Output Functionality and Fusion Engine Development was studied and lab demos performed. Electronic Support Measures (ESM) Correlation Algorithm and Human Machine Interface functionality was studied and lab demonstrated. Also continued was the development of Advanced Sensor Networking Technology (ASNT) to enable Cooperative Engagement Capability (CEC)-like networks to add new sensors and capabilities. The development of Composite Combat Identification (CCID) technologies continued with focus on acceleration of EP-3E Story Maker ID

Fusion, and the association of tracks with EP-3E Intelligence, Surveillance and Reconnaissance (ISR) data. (FY01 accomplishments in this thrust were funded in PE 0602232N.)

- (U) ($4,413) COMMUNICATION AND NETWORKS: This area supports the development of key wireless communications network technologies for air, ship, submarine and land platforms critical to the performance and robustness of Naval communications. In FY 01, work was initiated on tasks covering networking of phased arrays, interoperable networks for secure communication and mobility management for heterogeneous networks. The tactical phased array networking effort will support high data rates and future use of emerging phased array apertures to form a coordinated, dynamically adjusting network. This technology will enable richly connected, long-range, high capacity, littoral battlespace extensions for network centric warfare. In order to support mobile warfighters with connectivity across Naval and Marine Corps dissimilar networks, an effort on mobility management for heterogeneous networks was started. It focused on developing routing protocols for tactical, mobile ad hoc networks and also includes mobile internet protocol (IP) development to allow users to seamlessly move from one net to another and reconnect. In order to support allied interoperability over dissimilar networks, a multi-national effort focusing on interoperable networks for secure communications (INSC) was started. INSC is a collaborative research, development and demonstration project focused on internetworking technologies. A total of eight nations participate with their own funding in this effort on tasks dealing with information services, security, mobility, quality of service routing, network management and subnetworks. Within all of these networks it is important to provide a reliable multicast capability to specific groups of warfighters. Our effort on reliable multicast congestion control continued and focuses on increased resource utilization in terms of bandwidth and data rate. This technology will also reduce uncontrolled traffic lockout risks. The tactical data link dynamic networking effort completed in FY01. A Time Slot Reallocation (TSR) protocol was developed and targeted for the Link-16 network. This protocol will dramatically reduce the time for Link-16 participants to enter and exit the system as well as improve the overall throughput. This protocol and associated network management tools will be further developed under the Knowledge, Superiority and Assurance Future Naval Capability starting in FY02. (FY01 accomplishments were funded under PE 0602232N.)

- (U) ($19,583) NETWORKED COMMAND, CONTROL & COMBAT SYSTEMS: This Thrust supports the Navy's Network Centric Warfare concept by providing battle-space awareness through the management, distribution, and portrayal of information to geographically dispersed decision makers and war fighters. The following technical issues are addressed by this Thrust: 1) development of a seamless information management infrastructure and open architecture that is capable of processing and filtering large amounts of data; 2) the ability to conduct distributed collaborative planning and re-targeting of strike aircraft; 3) development of automated image registration techniques that provides global positioning system (GPS)-equivalent targeting coordinates (3 Meters); 4) development of software technology for advanced visualization systems from high end virtual reality systems (i.e. fully immersive and responsive virtual reality systems) to desktop personal computers (PCs), personal data assistant (PDAs) and see through goggles; and 5) development of software algorithms for combat systems that provide weapon-target pairing, target deconfliction and distributed weapons coordination among surface shooters. In FY01, work was completed on several technologies that have transitioned into FNC Projects beginning in FY02. Transition accomplishments included: 1) the Real-time Execution Decision Support (REDS) strike mission planning/re-targeting system that is designed to reduce average planning time to less than two hours through use of an open systems architecture and software tools that provide a capability for collaborative planning, real-time situational assessment, plan monitoring/execution and re-targeting of aircraft; 2) image processing and exploitation algorithm that provide geo-registration of multi-channel/multi-resolution images to less than 3 meters; and 3) an optimization algorithm for the Joint Tactical Tomahawk Weapons System (JTTWCS) for selecting an appropriate Tomahawk missile variant necessary to achieve high probability of target-kill. Other accomplishments in FY01 included the following: a successful field test and demonstration of augmented reality goggles with wearable computer that provides the Marines a capability to identify critical landmarks and target coordinates in urban environments; a laboratory test validating a design approach that creates a network-centric architecture for use by the Joint Task Force Commander allowing more effective coordination of Theatre level operations; software agents that retrieve and disseminate tailored information to end users; verification & validation of an end-to-end object model that supports mission critical scheduling with time constraints and quality of service (QoS) guarantees. The Navy payoff for technologies developed by this Thrust will improve speed of command (days to hours to seconds), provide major force multiplier effects and support achievement of self-synchronization of forces through networked information, decision support tools, advanced display technologies and advanced enterprise architectures that are specifically designed to seamlessly connect geographically dispersed war fighting elements in the execution of Naval missions. (FY01 accomplishments were funded under PE 0602232N.)

- (U) ($5,500) HUMAN COMPUTER INTERFACE: Work in this area focused on the improvement of human performance in platform, task force and battle group operations by developing human-centric decision support technology for incorporation into operational systems; by validating and investigating models of cognition, organization and decision making for improving human performance; and by testing algorithms and techniques for greater speed of command, reduced errors, and reduced fog of war in mission operations. General objectives cover: the development of models, algorithms, techniques and tools to enhance human performance effectiveness, the improvement of decision support and command decision-making and collaboration, the improvement of human-centered design and accelerated insertion of advanced Human Factors Engineering technology into existing and new weapons systems. In FY01, work was initiated in three areas: the development of improved tools for situation awareness; techniques of dealing with high information load such as knowledge visualization and attention management; and models, algorithms and techniques for improving organizational agility, situation awareness, and warfighting task performance. Work was continued on the techniques for improvement of situation awareness, angle of view judgment accuracy, organizational design and decision support for command and control, and improvement of usability and interpretation of tactical displays. Completed tasks include supervisory control tools for tactical task management, and intelligent agent modeling for tactical situation awareness, and the enhancement of user displays for tactical visualization. (FY01 accomplishments were funded under PE 0602233N.)

(U) FY 2001 Congressional Plus-ups:

- (U) ($2,898) BATTLESPACE INFORMATION DISPLAY TECHNOLOGY INITIATIVES DEVELOPMENT DEMONSTRATION (Funded in PE 0602234N): This effort focused on the development of a retinal scanning display for use by the individual warfighter by taking advantage of the size reductions and brightness enhancements that can be obtained by using a low-power laser to write an image directly onto the human eye. Navy/United States Marine Corps (USMC) applications include maintaining the common picture for the dismounted warfighter in urban warfare, aircraft carrier deck operations, and in-the-field maintenance and repair. Initial work is to (1) reduce the power consumption of the display by at least 40% (1700 mW to 1000mW or below) (2) develop a micro electronic mechanical system (MEMS) scanner at Extended Graphic Array (XGA) resolution quality (1024 X 768 diffraction-limited pixels), and (3) perform user evaluation studies to determine which display features (e.g., resolution, field-of-view, stereoscopic, color) are most important for the urban warfighting application.

- (U) ($9,659) Cooperative Engagement Capability Preplanned Product Improvement (CEC P3I) (Funded in PE 0602232N): Effort was directed to cost-effectively equip various fleet assets to determine the extensibility of the cooperative engagement capability (CEC). Specifically, work was performed to develop and demonstrate next generation CEC capability to various 7th Fleet assets, including Essex (LHD, CTF-76), Blue Ridge (LCC, CTF-76), and an AEGIS platform (CTF70) along with ground units from the Marine Corps (CTF-79). Effort at the Pacific Missile Range Facility (PMRF) was to develop next generation CEC units for integration into fleet assets as well as facilitating demonstrations for Theatre Ballistic Missile Defense (TBMD).

- (U) ($1,932) HYBRID FIBER OPTIC WIRELESS COMMUNICATIONS (Funded in PE 0602234N): The program is developing a versatile, mobile, secure communication that represents a marriage between fiber optic and wireless communications. The hybrid communication package incorporates the most desirable features of these two technologies. The specific goal was to develop and prove communications over an aggregate bandwidth of 40 Gb/s using a selectable number of channels. The proposed hybrid optical and wireless communications will provide the military with low-cost, high-capacity, high-speed communications that can simultaneously provide security and mobility. This wideband communication capability supports a full range of database services, shared computing services, network computing, and shared collaboration.

- (U) ($1,932) OPTOELECTRIC HIGH DEFINITION CAMERA PROTOTYPE (Funded in PE 0602232N): The project is developing a high definition camera for high definition surveillance sensors. Forced Air Unit is developing the camera. The camera will use 4 million gate field programmable gate arrays (FPGAs), and scan progressively at 60 frames a second. It will have over 12 times the number of pixels at twice the frame rate as current camera for video surveillance. The camera’s resolution, field of view, color rendition, spectral sensitivity, and frame rate to discriminate targets will meet projected military needs. It will transition to Enhanced Optical Networking (EON) surveillance packages used in ships, drone aircraft and autonomous undersea vehicles.

- (U) ($9,659) TACTICAL COMPONENT NETWORK (TCN) DEMONSTRATION (Funded in PE 0602232N): This project is integrating Tactical Component Network (TCN) at the Pacific Missile Range Facility (PMRF) to support networking for the Navy's cooperative engagement capability demonstrations. The funds are being used to develop integrated modular command posts for various sites at PMRF and integrate both the range sensors with advanced sensors in development using TCN software. This effort includes three tasks: 1) Integration of TCN network capability at PMRF and using 3rd fleet assets to further demonstrate single integrated Picture; 2) Continuation of the 7th fleet ESSEX ARG installation and demonstration through Cobra Gold (this also includes development of training modules for the fleet); and 3) Assist in the TCN cooperative engagement capability of evaluation in support of Program Executive Office (PEO) Theater Surface Combatants (TSC).

- (U) ($1,926) VIRTUAL COMPANY LINK (Funded in PE 0602234N): This effort supports the "Virtual Company LINK" a proprietary trademark of the West Virginia High-Technology Consortium Foundation. The purpose of the work is research to establish a network of commercial businesses in the greater West Virginia economic region that are linked by updated, interoperable computer networks and databases, and supported through partnerships with government agencies and private suppliers and buyers of technology. This network will facilitate the flow of new technology among naval, other government, and commercial applications, and thereby foster robust businesses in the region. One of the Department of the Navy's goals is to reduce the total ownership cost of naval systems by increasing the availability of affordable new technologies through increased commercial activity and use of technologies developed primarily for the commercial marketplace. The work in FY 2001 focused on research toward business portals, webcrawling and websearch engines, database access tools, and intercompany partnerships. This program complements similar efforts in other regions, including the DuPage Technology Research Education and Commercialization Center in Illinois, a plus-up of the Defense University Research Initiative.

2. (U) FY 2002 PLANS:

- (U) ($26,691) DECISION SUPPORT SYSTEMS: This effort supports technology developments in support of the Knowledge Superiority and Assurance (KSA) Future Naval Capability (FNC) program. The objective of the KSA FNC is to provide the warfighter with the capability to plan and execute operations that are coordinated across organizations and command echelon, including coalition partners. The Decision Support Systems applied research thrust addresses these KSA needs by technology developments that include a) 21st Century Command, b) Common Picture, and c) Time Sensitive Decision Making. The first addresses operational and theater common picture Naval mission needs by developing knowledge engineering to enable high-intensity joint and naval staffs to effectively acquire, manage, and use large volumes of information in diverse formats. The second focus area (Common Picture) addresses operational and tactical needs of operating forces specifically application of common picture information to the planning, monitoring, and re-planning cycle of operational and tactical force employment. The third area (Time Sensitive Decision Making) supports tactical operations where the timeliness and accuracy of decisions is crucial to the successful and efficient application of available forces. The goal of this thrust is greater speed of command and increased combat power. In FY02, the emphasis continues with the development of information and knowledge management technologies such as: Cryptologic Management and Analysis Support System; Environmental Visualization; Tactical Tomahawk Weapon Control System, Land Attack Missile Fire Control, and Naval Fire Control System Decision Support Capability; and Integrated Decision Support System Product Suite.

- (U) ($1,500) PLATFORM AWARENESS AND PROTECTION/ELECTRONIC WARFARE SYSTEMS: Supports the Platform Protection FNC. Current small platforms (both surface and airborne) have little to no situation awareness (SA) or self-protection against threat missile systems. The focus of this effort is on developing technologies that can provide these platforms the capability to achieve very accurate hemispheric direction finding (DF) of radio frequency (RF) signals and deny the enemy their effective use or exploit their weaknesses. This capability, when integrated with emitter identification and low probability of Intercept (LPI) detection systems, provides netted targeting information and cueing that allows for platform self protection against various threat systems. Developments include the use of small compact digital electronics, integrated circuits and digital synthesis technology. The EWISSP program addresses electronic attack (EA)/situation awareness (SA) subsystem integration and employment technologies for small surface platforms and will be executed in four phases. After applicable EA/SA technologies and solutions are developed and validated under this PE, proof-of-concept hardware and software will transition to PE 0603235N for further integration into systems suitable for capability demonstration under Naval environments and tactical conditions. The technology developments for Compact Small Platform EA and Compact Small Platform SA projects within the EWISSP program are addressed under this PE. During phase I the threat to small Navy and Marine combat platforms is being defined and the platforms' Concept of Employment (COE) is being reviewed. Trade-offs leading to the definition of performance requirements for an affordable EW system capable of providing substantially increased platform survivability are being conducted. The following subsystems will be developed in parallel: SA, EA, EO/IR and Hybrid radio frequency (RF)/IR Sensor and Countermeasures Decoy Subsystems. The following projects are developing EW related technologies that support EW RF and EW Mission Support thrust areas as coordinated by the Defense Reliance Tri-Service Technical Panel for EW (TPEW) S&T. The PCS Exploitation project is conducting hardware laboratory and flight tests, PCS countermeasure analysis and 2nd generation Specific Emitter Identification (SEI) laboratory measurements. The Battlefield Ordnance Network Centric Employment project is developing an Artificial Intelligence (AI) adaptive controller and testing new multi-platform EA techniques via lab and field experiments. The Adaptive Mixed-Mode VLSI Sensors for Micro Air Vehicles (MAVs) is verifying performance of custom developed Application Specific Integrated Circuits (ASICs) and integrating receivers prior to demonstrating a proof-of-concept sensor. The Tactical Reactive C2W/EA Network project will optimize the C2W/EA network, perform laboratory tests of the developed network and complete the 2nd field test.

- (U) ($8,200) MULTI-SOURCE INTEGRATION AND COMBAT IDENTIFICATION (CID): This thrust is focused on development of technology addressing the Navy's Surface & Aerospace needs for multi-source integration (MSI), fusion, systems architecture, automated sensor management and algorithms to fuse, filter and correlate on-board sensor and off-board battlespace information from tactical data links, satellite communications and interoperable cooperative engagement networks. In FY 2002, the program continued development of risk reduction technology for the Affordable Ground Based Radar. This multi-mode, multi-functional radar is being developed on an accelerated schedule for USMC, which needs an advanced multi-functional mobile radar capability for Expeditionary Littoral operations. Data streams from multiple radars operating simultaneously must be integrated. Joint development discussions are underway with U.S. Army. (This project will move to PE 0603271N in FY 2003.) The development of the Joint US/UK data fusion technology, which addresses multiple radar fusions and US/UK interoperability deficiencies was canceled for lack of funds. The development of risk reducing technology for application to the platform (E-2C) Multi-Source Integration continues. The program supports the larger effort to improve the E-2C aircraft combat system efficiencies by developing the E-2C MSI. This thrust program has initially investigated the SATCOM Input/Output Functionality problem, the Fusion Engine problem and ESM Correlation problem all related to the Human Machine Interface problem. In FY2002 SATCOM ESM Correlation, algorithms and Human Machine Interface are formally correlated and will be demonstrated in test aircraft. The development of the Advanced Sensor Networking Technology (ASNT) to enable CEC-like networks to add new sensors and capabilities is continued. The development of risk reducing technologies for application to the Composite Combat Identification (CCID) effort continues. Focus is on association of CEC

Networked ESM Classification data with Intelligence, Surveillance and Reconnaissance (ISR) data and the implementation of Joint Tactical Information Distribution System (JTIDS) EW Message for CID Dissemination.

- (U) ($10,580) COMMUNICATION AND NETWORKS: This area supports developing key wireless communications network technologies for air, ship, submarine and land platforms critical to the performance and robustness of Naval communications. Technology developments include QoS protocols, bandwidth and network management techniques for robust highly dynamic environments, interoperable wireless networks for secure communications, and protocols, bandwidth and network management techniques that can effectively manage and allocate bandwidth across tactical and theater levels in support of wireless network centric operations. In FY 02, work is being initiated on tasks covering dynamic reconfiguration of Link-16, asymmetric secure network access for vulnerable assets, submarine satellite communications (SATCOM) medium access protocol and dynamic access for satellite-based networks. Under the dynamic reconfiguration for Link-16 effort, which is part of the Knowledge, Superiority and Assurance Future Naval Capability, both a dynamic network management tool and a new time slot allocation protocol are being developed. The protocol technologies include a generalized protocol that extends time slot reallocation (TSR) from a single Network Participation Group (NPG) to the entire network and the Stochastic Unified Multiple Access (SHUMA) protocol technology. The potential payoff is a dramatically reduced time to reconfigure the network to allow for entry and exit of network participants (eliminating the two week preplanning process) and to achieve a five-fold throughput improvement by accessing all available time slots instead of leaving them dedicated to network participants that are not present. Our effort under the asymmetric secure network access project focuses on integrating low probability of intercept/detection technology with a secure wireless local area network (WLAN) in order to provide a bi-directional, secure, wireless network access device. This device could potentially be used by Marine Corps vulnerable assets such as special operations forces and unattended ground sensors. This technology will also be provided to the Joint Service Tactical Radio System Project Office as a possible candidate for a handheld tactical radio. In order to improve our submarine communications capability an effort was started to develop a satellite medium access control protocol that would allow three submarines to effectively share a common ultra high frequency (UHF) channel in support of internet protocol (IP) communications. This effort will result in efficient bandwidth management and supports the Chief of Naval Operations (OPNAV) code N6 mandated submarine transition to IP based communications. A project was initiated to provide dynamic access for satellite-based networks on board ships. This effort focuses on bandwidth management for Navy ship SATCOM networks. Networking and bandwidth management technologies are being investigated in order to increase the total information throughput in satellite-based Naval networks and provide critical prioritization and quality of service to warfighters. Our work covering networking of phased arrays, interoperable networks for secure communication and mobility management for heterogeneous networks has continued. The tactical phased array networking effort will support high data rates and future use of emerging phased array apertures to form a coordinated, dynamically adjusting network. Automated, distributed algorithms to coordinate routing and beam scheduling are being developed. This technology will enable richly connected, long-range, high capacity, littoral battlespace extensions for network centric warfare. Our continuing effort on mobility management for heterogeneous networks supports mobile warfighters with connectivity across Naval and Marine Corps dissimilar networks. It focuses on developing routing protocols for tactical, mobile ad hoc networks and also includes mobile IP protocol development to allow users to seamlessly move from one net to another and reconnect. Simulations of specific routing protocols are being conducted. In order to support allied interoperability over dissimilar networks, our multi-national effort focused on interoperable networks for secure communications (INSC) is continuing. INSC is a collaborative research, development and demonstration project focused on internetworking technologies. A total of eight nations participate with their own funding in this effort on tasks dealing with information services, security, mobility, quality of service routing, network management and subnetworks. Some preliminary simulations and laboratory demonstrations of mobility routing are being conducted. Within these networks it is important to provide a reliable multicast capability to specific groups of warfighters. Our effort on reliable multicast congestion control will complete this fiscal year and focuses on increased resource utilization in terms of bandwidth and data rate. This technology will also reduce uncontrolled traffic lockout risks. Simulations of congestion control algorithms are being developed for a reliable multicast protocol.

- (U) ($24,377) NETWORKED COMMAND, CONTROL & COMBAT SYSTEMS: FY02 plans call for the development of command, control and combat systems technologies that directly support and are critical to the Navy’s network centric warfare concept. The following technical issues are being addressed by this Thrust: the management, extraction, distribution and portrayal of information to decision makers and war fighters; development of advanced multi-resolution images for target identification; near real time and real time mission QoS constraints; a seamless collaborative computing framework capable of supporting operational, systems and technical level collaboration while operating under limited bandwidth, system latencies and unpredictable system interrupts; and software and middle-ware interface requirements for achieving seamless interoperability between command and control and combat systems platforms. In FY02 technology efforts include: 1) the development of “event-condition-alert” rule based algorithms and templates that provide a capability to automatically extract and distribute information to end-users from multiple data sources (i.e. tailored information-push); 2) development of an automated process for creating, disseminating and displaying rules of engagement (ROE) to decision makers and operators; 3) the design, development and prototyping of software algorithms that optimizes tasking-to-platform and weapons-to-target selections for land attack missions; 4) testing and experimentation of an architectural framework and software to provide seamless interoperability and collaboration between theatre level command and control (C2) and combat systems platforms; 5) a joint Defense Advanced Research Projects Agency (DARPA)-Fleet-ONR effort to develop a concept of operations (CONOPS) that utilizes an airborne platform for controlling and managing strike aircraft in the execution of land attack missions. The concept designates the use of an E-2 to perform airborne battle management functions, receive and process target imagery, and provide en-route strike aircraft GPS-equivalent targeting coordinates. This effort is being coordinated with the Naval Fires Network (NFN) Program Office, Fleet operators and appropriate Program Management offices at Naval Air Systems Command (NAVAIR); 6) development of a computer model and software algorithms capable of estimating mobile target locations during emitting and non-emitting periods; 7) the development of a computer-collaborative framework that supports collaboration among Naval enclaves whether they use legacy client-server architectures or more advanced peer-to-peer processing framework; 8) interoperable protocols and human-computer interface techniques to provide a capability for sharing a common picture and situational awareness among high-end 3D virtual reality systems, PCs, laptops, or a low end hand held displays; and 9) research to define the underlying data structures that will enable statistical information to be rendered graphically for visualizing data uncertainty. Major payoffs from this work will provide: a network centric framework and infrastructure that seamlessly connects war fighters to decision makers with data, information, and a shared situational awareness, thereby achieving a major force multiplier effect through collaboration, coordination and optimization of resources; a substantial increase in the speed of command to near real time; and support for synchronization of Naval forces in the execution of network centric operations.

- (U) ($9,513) HUMAN COMPUTER INTERFACE: Work in this area focuses on the improvement of human performance in platform, task force and battle group operations by developing human-centric decision support technology for incorporation into operational systems; by validating and investigating models of cognition, organization and decision making for improving human performance; and by testing algorithms and techniques for greater speed of command, reduced errors, and reduced fog of war in mission operations. General objectives cover: the development of models, algorithms, techniques and tools to enhance human performance effectiveness, the improvement of decision support and command decision-making and collaboration, the improvement of human-centered design and accelerated insertion of advanced Human Factors Engineering technology into existing and new weapons systems. In FY02, work is being initiated in generative decision support architecture, in knowledge visualization, cognitive models of military decision making domains to improve engineering of decision support tools, and in effects based models for enhancement of surveillance systems. Work will continue in three areas: the development of improved intelligent agents and decision support tools; techniques of dealing with high information load such as knowledge visualization and attention management; and models, algorithms and techniques for improving organizational agility, situation awareness, and warfighting task performance. These areas will improve command and control, speed critical decision making, and improve human performance in intense, high-tempo and dynamic warfare environments by focusing on the human dimension in the human-computer collaboration, so that warfighters can develop and maintain increased levels of situation awareness and decision making agility through manageable, human-tailored systems that meet their needs in mission critical operations. Work to be completed includes the evaluation of the usability of perspective views in tactical displays and usability of virtual environment interfaces in comparison with traditional display technology.

(U) FY 2002 Congressional Plus-ups:

- (U) ($2,081) BATTLESPACE INFORMATION DISPLAY TECHNOLOGY: The Dominant Battlespace Command project established a state-of-the-art battlespace visualization environment to advance Joint Vision 2020 objectives and the United States Navy’s “Forward from the Sea” strategy. Dominant Battlespace Command integrates commercial technologies with emerging Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) capabilities, specifically for Navy and Marine Corps battlefield commanders and their staffs. In the absence of proven data correlation and information fusion algorithms, Dominant Battlespace Command visually represented the positions and tracks of ships, aircraft, and ground-based units, along with threat envelopes - in a whole earth, scalable, multi-resolution virtual display linked to intelligence and operational databases. Therefore, Dominant Battlespace Command presented the commander with the battlespace that closely approximates what one sees in their “mind’s eye.” This realization of the mind’s-eye view is expected to result in intuitive actions that transform the 2-D battlespace into a 4-D battlespace so that the warfighter can view events in near-real time and fold in operational aspects associated with time - the 4th dimension. In 2002, demonstrate a Dominate Battlespace Command prototype system enhanced with the capability to visualize the common undersea picture during Fleet Battle Experiment Juliet (FBE-J). Additionally, conduct experiments to collect user information from the Navy, Army, Air Force and USCENTCOM.

- (U) ($1,982) COMMON SENSOR MODULE: Development of small common sensor modules for ground forces. These sensors will be networked to provide total situational awareness for the ground forces and to extend the integrated picture to the rest of the forces. This will develop prototype modules and conduct limited demonstrations

- (U) ($35,184) TACTICAL COMPONENT NETWORK (TCN) Demonstration: Integrate Tactical Component Network (TCN) at the Pacific Missile Range Facility (PMRF) to support networking for the Navy's cooperative engagement capability demonstrations. Develop integrated modular command posts for various sites at PMRF and integrate both the range sensors with advanced sensors in development using TCN software. This effort includes three tasks: 1) integration of TCN network capability at PMRF and use 3rd fleet assets to further demonstrate a single integrated picture; 2) continuation of the 7th fleet ESSEX ARG installation and demonstration through Cobra Gold (this also includes development of training modules for the fleet); 3) assist in the TCN evaluation in support of PEO (TSC) to consider the applicability of an cooperative engagement capability.

- (U) ($4,262) THEATER UNDERSEA WARFARE (TUSW) INITIATIVE: Using Web Centric ASW as the backbone technology, TUSW will work with the Maui High Performance Computing Center and PMRF to integrate the undersea picture to the single integrated picture.

3. (U) FY 2003 PLANS:

- (U) ($25,800) KNOWLEDGE SUPERIORITY AND ASSURANCE (KSA)(FORMALLY TITLED Decision Support Systems). This thrust supports the technology development needs of the Knowledge Superiority and Assurance (KSA) Future Naval Capability (FNC) program. Technology activities include: middleware to enable innovative applications and algorithms to be quickly and cheaply integrated with the Department of Defense Information Infrastructure's Common Operating Environment (COE) software, data management frameworks, specifications for software plug-in of applications and correlators, automated reasoning capability applied to meteorological and oceanographic support for mission planning and execution, and course of action simulation, projection, and assessment, optimization algorithms. The feasibility of these technologies will be evaluated to determine their risk and maturity. Environmental Visualization, Extensible C4I Framework, and Middleware and COE Interoperability will be prototyped and feasibility demonstrations conducted. Investigate for Navy application such as: the application of automated reasoning to surface and sub-surface common picture maintenance; cognitive model-based decision support of mobile time sensitive targets in the amphibious warfare and joint fires support mission context; and adaptive automation to enhance the effective use of scarce assets (such as aircraft and crews) in a joint air mission context. Specific projects planned for FY03 include: Sea Combat Commanders’ Module for Embarked Staff, Common Undersea Picture Architecture, Course of Action Analysis Tool for Identifying Mobile Time Sensitive Targets, and Comprehensive, Analytic, Real-Time Execution in Joint Air Operations.

- (U) ($2,000) PLATFORM AWARENESS AND PROTECTION/ELECTRONIC WARFARE SYSTEMS: Platform Awareness and Protection supports the Platform Protection FNC. Current small platforms (both surface and airborne) have little to no SA or EA self-protection against threat missile systems. The focus of this effort will be to develop technologies that can provide these platforms the capability to achieve very accurate hemispheric DF of RF signals and deny the enemy their effective use or exploit their weaknesses. This capability, when integrated with emitter identification and LPI detection systems, provides netted targeting information and cueing that allows for platform self protection against various threat systems. Developments include the use of small compact digital electronics, integrated circuits and digital synthesis technology. The Compact Small Platform EA and Compact Small Platform SA projects continue and will, among other things, provide the flexibility and capability to generate required EA technique waveforms against both non-coherent and coherent radar threat systems to conceal the radar return produced by small craft, such as the Advanced Amphibious Assault Vehicle (AAAV). They will also provide both autonomous and netted targeting information and cueing to support SA and combat weapon systems. The EWISSP program addresses EA/SA subsystem integration and employment technologies for small surface platforms and is being executed in four phases. EA and SA aspects are addressed under this PE. EWISSP Phase II will commence in FY03. During this phase, detailed EWISSP subsystem designs will be developed and implemented physically. Although the subsystems may be designed and developed separately, they must provide for compatible integration and platform interface in Phase III (system integration), which is planned to commence in FY05. Subsystem hardware and software performance will be successfully demonstrated to defined levels in a laboratory/field environment at the end of this phase as well as compatibility with existing and/or planned basic physical and electrical designs and features of host platforms. The Battlefield Ordnance Network Centric Employment project will evaluate data compression and transmission schemes and complete development of the detection algorithm framework and realtime processor. The Tactical Reactive Command and Control Warfare (C2W)/EA project will analyze and optimize hardware for the 3rd field test (proof-of-concept demonstration) and identify concept performance and enabling technology factors. Receiver systems and refined optic flow sensors will be developed under the Adaptive Mixed-Mode VLSI Sensors for MAVs. The PCS Exploitation project will complete and test all hardware and CM techniques.

- (U) ($7,900) MULTI-SOURCE INTEGRATION AND COMBAT IDENTIFICATION (CID): This thrust focused on development of technology addressing the Navy’s Surface & Aerospace needs for multi-source integration (MSI), fusion, systems architecture, automated sensor management and algorithms to fuse, filter and correlate on-board sensor and off-board battlespace information from tactical data links, satellite communications and interoperable cooperative engagement networks. In FY 2003, the program will continue development in the risk reducing technologies to support the platform (E-2C) Multi-Source Integration effort. This is a software development effort. In FY 2003, a phased plan provides for support for near-term fleet benefits in this fiscal year and later out years. This thrust program will support this plan with development of risk reducing software technology. The development of the Advanced Sensor Networking Technology (ASNT) to enable CEC-like networks to add new sensors and capabilities will continue. The development of risk reducing technology supporting the Composite Combat Identification (CCID) will continue. Emerging technologies potentially superior to the Cooperative ID and Non Cooperative ID presently integrated into the CCID program will be pursued.

  - (U) ($1,600) LITTORAL ANTI-SUBMARINE WARFARE (ASW): This Littoral ASW Discovery and Invention (D&I) program supports the Littoral ASW FNC. The emphasis is on developing a common ASW tactical and environmental picture to improve detecting, tracking, and classifying subsurface platforms. This project will develop technology to support cross platform Command & Control and Tactical level data fusion, decision aids and display for ASW and thereby improve input to and construction of the common tactical and environmental ASW picture. Network-centric warfare is recognized by many studies as the future of US defense forces. Network-centric ASW is difficult to implement because of restricted connectivity to submarine platforms and bottom-deployed systems. Advances in data fusion, decision aid, and display technology are needed to fully achieve ASW network-centric warfare. The project will be initiated in FY03. The initial task of the effort will be a system requirement analysis that will set system goals for technology development. In addition, a technology assessment will also be initiated to define high payoff technologies for further development. Planning for data collections to support algorithm development will begin with a data collection event occurring in the first part of FY04.

• (U) ($7,000) COMMUNICATION AND NETWORKS: This area will support development of key wireless communications network technologies for air, ship, submarine and land platforms that are critical to the performance and robustness of Naval communications. Technology developments include Quality of Service (QoS) protocols, bandwidth and network management techniques for robust highly dynamic environments, interoperable wireless networks for secure communications, protocols, and bandwidth and network management techniques for managing and allocating bandwidth across wireless tactical networks. In FY03, work will continue on tasks covering networking of phased arrays and multi-national virtual operation capability. The tactical phased array networking effort will support high data rates and future use of emerging phased array apertures to form a coordinated, dynamically adjusting network. The emphasis is on developing automated, distributed algorithms to coordinate routing and beam. This technology will enable richly connected, long-range, high capacity, littoral battlespace extensions for network centric warfare. The Virtual Operations Network (VON) continues and seeks to develop and experiment with the required technologies to provide Maritime multinational coalition forces with the capability to conduct timely and relevant information exchanges over IP networks at sea. Security technology development under this effort will be integrated with related ONR, DARPA, other service, or multinational partner network technology developments in order to continue to enhance multinational network interconnects and minimize network infrastructure required to allow multi-level networking. VON is coordinated with and supports the Chief of Naval Operations Allied Interoperability Strategy, the maritime component of the multinational Combined Communications Electronics Board (AUSCANNZUKUS), North Atlantic Treaty Organization (NATO) Command, Control and Communications (C3) Agency, DARPA Dynamic Coalitions program, CINCPACFLT, and is conducted jointly with the UK MoD. Our work covering dynamic reconfiguration of Link-16, asymmetric secure network access for vulnerable assets, submarine satcom medium access protocol, dynamic access for satellite-based network, and mobility management for heterogeneous networks will complete during FY03. A dynamic network management tool and a new time slot allocation protocol will be completed and simulated for Link-16. The goal is to reduce time to reconfigure the network to allow for entry and exit of network participants and to improve throughput by accessing all available time slots. Our effort under the asymmetric secure network access project will focus on integrating low probability of intercept/detection technology with a secure wireless local area network (WLAN) in order to provide a bi-directional, secure, wireless network access device. In FY03, Marine Corps vulnerable assets such as special operations forces and unattended ground sensors could potentially use this device. This technology will also be provided to the Joint Services Joint Tactical Radio System Joint Project Office as a possible candidate for a handheld tactical radio. Work will be completed on development of a satellite medium access control protocol that would allow three submarines to share a common UHF channel in support of Internet protocol (IP) communications. This effort will result in efficient bandwidth management and supports the OPNAV N6 mandated submarine transition to IP based communications. A project to provide dynamic access for satellite-based networks on board ships will be completed. This effort will focus on bandwidth management for Navy ship SATCOM networks. Networking and bandwidth management technologies will be investigated in order to increase the total information throughput in satellite-based naval networks and provide critical prioritization and quality of service to warfighters. Our effort on mobility management for heterogeneous networks will be completed in FY04 and supports mobile warfighters with connectivity across Naval and Marine Corps dissimilar networks. It will focus on developing routing protocols for tactical, mobile ad hoc networks and includes mobile IP protocol development to allow users to seamlessly move from one net to another and reconnect. Simulations of specific routing protocols will be completed.

(U) ($24,723) NETWORKED COMMAND, CONTROL & COMBAT SYSTEMS: This Discovery and Invention thrust in FY03 will continue to develop software technologies and modify commercial of the shelf (COTS) products for military application that provide: improved enhanced situational awareness; sharing of a common picture among command echelons; seamless interoperability among computing platforms, systems and geographically dispersed war fighters; and automated decision aids that optimizes the use of resources and further reduces planning cycle time. FY03 plans will emphasize developments of software algorithms and security techniques that will provide high assurance computing and dependable information, real time middle-ware for dynamic and timely scheduling of resources with enforced operational constraints, enhanced image processing algorithms for target identification, protocols for secure interoperable data exchange among coalition forces, completion of the rule-based (event-condition-alert) algorithms for actively pushing tailored information to users, and assessing the value-added of using 2D versus 3D display systems on board submarine platforms. Additionally, work will continue on tasks covering theater battle management for command and control, battle-space decision aids such as rules of engagement and land attack pre-designation weapons optimization, and development of advanced visualization technologies such as auto-stereoscopic 3D displays that can be viewed without the use of goggles. Further, a new initiative with the Naval Warfare Development Command (NWDC) will be pursued to investigate the utility and benefits of using existing networks such as Defense Research and Engineering Network (DREN) to conduct collaborative experiments among performing activities. Experiments will be specifically designed to test and evaluate technologies developed for network centric applications. The effort is intended to define MOEs and performance (MOPs), identify experimental objectives and integrate and test maturing technologies into enterprise architectures designed for network centric operations. The payoff for the Navy will be a marked improvement in speed of command and self synchronization of forces in the execution of Naval missions.

- (U) ($6,571) HUMAN COMPUTER INTERFACE: Work in this area will focus on the improvement of human performance in platform, task force and battle group operations by developing human-centric decision support technology for incorporation into operational systems; by validating and investigating models of cognition, organization and decision making for improving human performance; and by testing algorithms and techniques for greater speed of command, reduced errors, and reduced fog of war in mission operations. General objectives cover: the development of models, algorithms, techniques and tools to enhance human performance effectiveness, the improvement of decision support and command decision-making and collaboration, the improvement of human-centered design and accelerated insertion of advanced Human Factors Engineering technology into existing and new weapons systems. In FY03, we will initiate work on the development of cognitive models for the prediction of user performance in different types of visual and audio display technologies. Work will continue on tasks in the development of improved tools for situation awareness; in effects based models for enhancement of surveillance systems techniques of dealing with high information load such as knowledge visualization and attention management; cognitive models of military decision making domains to improve engineering of decision support tools; and models, algorithms and techniques for improving organizational agility, situation awareness, and warfighting task performance.

C. (U) PROGRAM CHANGE SUMMARY EXPLANATION:

	FY 2001	FY 2002	FY 2003
(U) FY 2002 President's Budget	**	83,557	
(U) Adjustments from FY 02 PRESBUDG:			
Section 8123 Management Reform Initiative Reduction		-1,109	
Congressional Reduction for Transformation Priorities		-1,912	
FFRDC Reduction		-66	
Congressional Plus ups		43,900	
(U) FY 2003 President's Budget Request:		124,370	75,594

**The Science and Technology PEs were restructured in FY 2002. FY 2001 efforts were funded in PEs 0602232N, 0602233N, and 0602270N.

(U) PROGRAM CHANGE SUMMARY EXPLANATION:

(U) Schedule: Not Applicable
(U) Technical: Not Applicable

D. (U) OTHER PROGRAM FUNDING SUMMARY:

(U) RELATED RDT&E: The Navy's 6.1 program contributes to this effort.

(U) NAVY RELATED RDT&E:

(U) PE 0204152N (E-2 Squadrons)
(U) PE 0206313M (Marine Corps Communications System)
(U) PE 0601153N (Defense Research Sciences)
(U) PE 0602123N (Force Protection Applied Research)
(U) PE 0602271N (RF Systems Applied Research)
(U) PE 0602131M (Marine Corps Landing Force Technology)
(U) PE 0603114N (Power Projection Advanced Technology)
(U) PE 0603123N (Force Protection Advanced Technology)
(U) PE 0603235N (Common Picture Advanced Technology)
(U) PE 0603271N (RF Systems Advanced Technology)
(U) PE 0603609N (Conventional Munitions)
(U) PE 0603640M (Marine Corps Advanced Technology Demonstrations)
(U) PE 0603658N (Cooperative Engagement)
(U) PE 0604307N (Surface Combatant Combat System Engineering)
(U) PE 0604518N (Combat Information Center Conversion)

(U) NON NAVY RELATED RDT&E:
(U) PE 0602204F (Aerospace Sensors)
(U) PE 0602702F (Command, Control and Communications)
(U) PE 0602782A (Command, Control and Communications (C^3) Technology)

E. (U) SCHEDULE PROFILE: Not Applicable.

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 2 PROGRAM ELEMENT: 0602236N
PROGRAM ELEMENT TITLE: Warfighter Sustainment Applied Research

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
Warfighter Sustainment Applied Research	**	107,842	68,852	68,636	69,226	70,579	71,637	CONT.	CONT.

**The Science and Technology Program Elements (PEs) were restructured in FY 2002. The work described in FY 2001 was funded in PEs 0602121N, 0602233N, and 0602234N.

(U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This PE funds applied research supporting Future Naval Capabilities (FNC) (Capable Manpower, Expeditionary Logistics, Total Ownership Cost (TOC) Reduction, and Warfighter Protection) and innovation-based efforts that will provide technology options for future Navy and Marine Corps capabilities. Efforts focus on manpower, personnel, and human factors (HF); naval systems training; expeditionary logistics distribution and command/control; energy conversion; naval materials, maintenance reduction and TOC reduction; medical technologies; environmental quality, and biocentric technologies.

(U) Due to the number of efforts in this PE, the programs described are representative of the work included in this PE.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the APPLIED RESEARCH Budget Activity because it investigates technological advances with possible applications toward solution of specific naval problems, short of a major development effort.

(U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 2001 ACCOMPLISHMENTS:

- **(U)($2,878) Manpower, Personnel, and Human Factors:** (FY01 accomplishments were funded in PE 0602233N)

Initiated FY01

- (U) Initiated within the Chemical Sensing in the Marine Environment Program, efforts for locating the source of chemical plumes in very shallow waters using sensors stationed onboard autonomous underwater vehicles. This will provide the Navy with the capability to remotely identify unexploded ordnance in the littoral zone for salvage or neutralization purposes.
- (U) Efforts were initiated in the development of novel biosensors for underwater explosives detection applications. These novel biosensor systems are expected to provide sensitive, selective, and rapid detection of explosive signatures (such as trinitrotoluene (TNT)), a capability that is currently lacking but is needed to provide real-time data for swift decision making.

Continued FY01

- (U) Continued within the Chemical Sensing in the Marine Environment Program, efforts to characterize the source strengths of underwater unexploded ordnance (UXO). Distance from source and associated concentration profile data will drive the operational requirements necessary to guide the development of sensor systems for underwater UXO detection.
- (U) Continued within the Chemical Sensing in the Marine Environment Program, efforts to characterize chemical plume structure in very shallow water regime. Previous research indicates that the plume structure is quite variable and heavily dependent on environmental conditions and interactions. Mapping of plume structure under various environmental scenarios is necessary to guide the development of sensor systems for underwater UXO detection.
- (U) The development of bio-based materials was continued, specifically bulk fabrication of metallized lipid tubules, for radar absorbing and antenna isolation applications. These materials show potential as replacement for the existing systems, displaying competitive absorption properties but weighing approximately 60% less, a property important on smaller vehicles.
- (U) Investigation of bio-molecular barcodes for unique identification and tracing of materials was continued. These barcodes, or taggants, act as microscopic markers that can be used to trace and identify material of naval interests, e.g., military equipment and personnel.

- (U) The Student Value Model program that assigns a numerical value to training seats progressed. This effort calculated the added value to the Navy of training a sailor. Understanding the enhanced fleet readiness potential of providing specific training to a specific sailor helps planners determine the most effective use of scarce training resources.
- (U) In the E-Commerce Technologies for Personnel Distribution and Assignment program, constructed a robust prototype agent/marketing system using a web-based "intelligent personnel mall" construct (similar to "Amazon.com"). Conducted agent/market testing to examine actual versus predicted matching performance for both human detailers and a two-sided matching algorithm. Evaluated the algorithm's ability to conform to Navy policy.
- (U) Continued developing a probability loss model that uses data mining techniques to forecast enlisted sailor attrition. Continued developing a web view of statistical reports generated via extensible markup language. The effort focused on standardizing communications and data interchange to allow independent manpower models to exchange information across disparate platforms and communications media.
- (U) Continued the Integrated Personnel Simulation Techniques program to prototype a model allowing decision-makers to understand the impact of policy changes on functional areas (recruiting, training, promotion policy, retention, etc.).

Completed FY01

- (U) Acoustic characterization of elastomeric polypeptides for naval applications was completed. These biomaterials show promise as tunable acoustic absorption materials useful for platform protection.
- (U) Inverse algorithmic method development within Chemical Plume Tracing Program was completed. This effort developed a model using tracer concentration profiles coupled with various hydrodynamic measurements to inversely estimate the location of the tracer source. This work furthers the development of search strategies to be used on autonomous underwater vehicles to locate objects with a detectable chemical signature, such as unexploded ordnance (UXO).
- (U) Laboratory-scale green synthesis of explosives and related compounds using enzymatic catalysts was completed. The discovered synthetic schemes provide an environmentally benign mechanism for production of energetic materials without the use of hazardous reagents and generation of hazardous by-products.
- (U) Completed the Prediction of Submarine Service Disqualification program. The database allows comparison of screening tests for basic enlisted submarine school. Comparisons by rank, rate, type of submarine, and nuclear

training have been performed. Preliminary results suggest that anxiety and depression are higher in sailors on fast attack submarines than in sailors on Trident submarines. These normative data will be used for comparison of prospective submarine school candidates.

- (U) Applied research on the Selecting, Training Assigning and Retaining Sailors program was concluded. This work developed measures and methods necessary to track a cohort of incoming sailors through their first term. This system used outcome measures other than training success to identify points in the first enlistment term where problems arose.
- (U) Completed the development of decision making supervisory control tools for tactical task management in command and control environments.

• **(U)($10,930) Training**: (FY01 accomplishments were funded in PE 0602233N)

Initiated FY01

- (U) Initiated the application of Virtual Environment (VE) technology to provide training of spatial behavior relevant to expeditionary force combat vehicles including the Landing Craft, Air Cushion (LCAC) and the Advanced Amphibious Assault Vehicle (AAAV).
- (U) Started development of methods for measuring realism in Virtual Environments (VEs) and determining the relationship between realism and training effectiveness of VEs. Virtual Environment is a cost-effective training venue that can improve training effectiveness and enable improved capabilities in training for dynamic, high-tempo warfighting environments.
- (U) Began the development of multi-sensory, spatially distributed computer interfaces and the assessment of their impact on human learning and memory.
- (U) Initiated efforts to address human computer interaction issues relevant to the Close Quarters Battle for Military Operations in Urban Terrain (CQB for MOUT) simulator.

Continued FY01

- (U) Continued artificially intelligent tutoring in dynamic decision-making. Artificially intelligent tutors offer potential of supplying cost-effective, tailored instruction to the needs of individual students, increasing their rate of mastering complex materials.
- (U) Continued augmenting displays to enhance learning. The goal of this project is to document how differing augmentation technologies can facilitate knowledge acquisition for complex task training in distance learning environments such as the Advanced Distance Learning program.
- (U) Continued advancing applied cognitive task analysis.
- (U) Continued physics tutor (electricity and magnetism) development. This effort will improve training effectiveness, advance students' understanding, and improve students' ability to problem solve on their own in a required, complex, Navy-relevant course at the U.S. Naval Academy, as well as providing empirical data on the effectiveness of intelligent tutoring systems.
- (U) Continued instructional authoring tools. This effort improves the abilities of instructor to produce pedagogically sound computer-based training tailored for military settings and training needs.
- (U) Continued computer generated forces (CGF): CGF development of simulated team members to insert into team training and intelligent tutoring systems. This effort focuses on creation of more realistic simulated team members to achieve more realistic training for Navy personnel.

Completed FY01

- (U) Completed studies of the effective use of multi-media.
- (U) Completed program on Advanced Artificial Intelligence (AI) teaching technology for thermodynamics.
- (U) Completed program on Integrating Interactive Electronic Technical Manuals (IETMS), training, performance aiding.
- (U) Completed program on self-training teams.
- (U) Completed development of a test-bed to study large distributed teams.

- **(U)($6,950) Expeditionary Logistics:** (FY01 accomplishments were funded in PE 0602121N)

Initiated FY01

- (U) Developed metrics, demonstration plans, and a transition path for the Future Years Defense Plan (FYDP) investment cycle in technologies to support a tactical level Logistics Command and Control System. The FYDP investment will create a technology foundation for a tactical level logistics command and control system, which presently does not exist.
- (U) Initiated decision support technologies for Logistics Command and Control Course of Action generation. This investment will support the force deployment planning and execution at the tactical level, beginning with robust calculations for ground troop supportability estimates and tactical sustainment requirements determination.
- (U) Initiated logistics modeling and simulation, focused on simulation engines and user interfaces, to assist in doctrinal functions of mission planning and execution. This will allow a faster than real time projection of logistics support at the tactical level, and provide logistics calculations algorithms to be employed in joint war-game.

Completed FY01

- (U) Developed metrics, demonstration plans, and transition path for the FYDP investment cycle in technologies to support a tactical level Logistics Command and Control System.

• **(U)($28,796) Materials, Maintenance Reduction, and TOC:** (FY01 accomplishments were funded in PE 0602234N)

Initiated FY01

- (U) Initiated efforts on bristle brush processes for paint and corrosion product removal. This will provide the Navy with the ability to spot-repair aircraft paint coatings without having to repaint the whole aircraft, thereby reducing maintenance costs.
- (U) Initiated stress corrosion tests on friction stir welded advanced amphibious assault vehicle (AAAV) aluminum alloy. This will enable the Marine Corps to select lower cost joining technologies for the AAAV, which provide aluminum alloy microstructures not susceptible to stress-corrosion cracking.

- (U) Explored electro-chemical coating processes for cadmium replacement technologies. This will provide the Navy with an environmentally acceptable technology for preventing corrosion and hydrogen embrittlement in high strength steel aircraft components such as landing gear and wing boxes.
- (U) Initiated the development of new corrosion prevention technologies using an applique coatings approach. This will enable the Navy to save maintenance costs by employing easily replaceable stick-on coatings having both corrosion prevention and stealth properties.
- (U) Explored new thermal barrier technology using multiphase coatings for oxidation resistant molybdenum alloys, a likely candidate for the next generation of superalloys. These alloys will provide higher hot section operating temperatures for future naval gas turbine engines resulting in improved performance and decreased specific fuel consumption.
- (U) Initiated development of environmental barrier coatings for ceramics/composites to provide higher combustor operational temperatures and extended combustor life times for future naval gas turbine engines. This work is necessary to meet Industry Integrated High Performance Turbine Engine Technology (IHPTET) Phase III goals and will transition into improved engines for future naval aircraft.
- (U) Initiated the development of mechanics analysis for glass fabric composite structures for future naval topside structures. This will provide the Navy with guidance for the rational selection of material design allowables based on material damage.
- (U) Initiated ultrasonic imaging camera development for non-destructive evaluation (NDE) of naval materials and structures. This wide area imaging technique will lower the inspection time by 30% while enhancing its reliability of detection.

Continued FY01

- (U) Continued corrosion sensor development in operational ship ballast tanks. This will enable the Navy to save maintenance costs by replacing a manual inspection process with an electrochemical monitoring technology for ship tanks.
- (U) Continued the development of environmentally acceptable coatings for application on non-magnetic ship hulls. This will enable the Navy to select lower cost austenitic stainless steel as a non-magnetic hull material in preference to higher cost titanium alloys.

- (U) Continued the evaluation of upgraded seawater valves in land based tests. This will provide the Navy with 40-year valves in seawater systems, thereby eliminating valve replacements currently needed at 10-year intervals.
- (U) Continued friction stir welding of steel effort to develop apparatus and processing routes for superior solid state welds in ship structures. This will provide Navy with a technique that drastically reduces weld fume and distortion and enhances stealth and affordability in ship construction.
- (U) Continued development of innovative composites casting technology for ship shafts and seals. This will allow the Navy to fabricate extraordinarily long life seals for propulsion shafts on Navy ships, enhancing combat readiness and affordability/reducing maintenance.
- (U) Continued the development of compositions and processing for more affordable, higher performance ship steels such as High Strength Low Alloy (HSLA) 65. This will provide the Navy with ship steels of superior strength/toughness and affordability, and significant weight reduction.
- (U) Continued the development and evaluation of weld processing of stainless steel for more affordable superior performance welds. This will provide the Navy with welding technology to fabricate non-magnetic, stealthy ships.
- (U) Continued the development/evaluation/qualification of the ausform finishing process for aerospace steel gears. This will provide the Navy with superior technology to produce rotorcraft gears with greater load capability and longer service life.
- (U) Progressed with demonstration of superior new MIL-100S welding wire for welding ship steels. This provides the Navy with improved weld metal for welding of HSLA steels with the elimination/minimization of preheat and thus enhanced affordability in ship and submarine construction.
- (U) Continued evaluation of advanced transducer single crystal high strain materials. These materials will revolutionize essentially all Navy Sonic Navigation and Ranging (sonar) devices by doubling bandwidths and increasing energy densities more than an order of magnitude.
- (U) Continued the development of advanced carbon/carbon materials processes for missile heat shield applications for naval strategic missiles. This work will provide replacements for no-longer available materials and develop better, more affordable new heat shield materials.
- (U) Continued development of oxidation resistant molybdenum alloys that are leading candidates for the next generation of superalloys. These materials will provide major enhancement in performance and fuel economy for gas turbines by providing higher hot section capability and more thermodynamic efficiency.

- (U) Continued development of ultra-light heat exchanger for the E-2C aircraft. A planned upgrade in the E-2C radar requires heat dissipation beyond that achievable with standard pin-on-fin heat exchangers. This program will provide that capability and obviate expensive aircraft structural changes.
- (U) Continued bismalidie (BMI) composite (patch development) development for high temperature repair applications of present and future naval aircraft. Present epoxy patch technology does not meet the demanding aerospace material requirements.
- (U) Continue development of advanced composites and polymers with fire resistance for ship structures. Present day composite materials ignite easily generating thick and toxic fumes, therefore are not safe for man rated areas.
- (U) Continued to optimize the damage tolerance response versus the vibration damping characteristics of reinforced polyurethane composites for cost and weight reduction on future Navy ships.
- (U) Continued pulse thermographic imaging development for defect characterization in naval structures. This is a portable, wide-area and non-contact inspection technology with significant promise for maintenance cost reduction.
- (U) Continued fiber optic sensor development for health monitoring of future naval structures. A distributed sensor system of this nature will allow lowering the maintenance cost by better scheduling inspections.
- (U) Continued development of frequency agile polymers for application in laser eye protection. These new nonlinear optical limiter materials will protect our sailors and marines from ever changing laser threats.
- (U) Continued to develop multi-functional transducer materials. These composite piezoelectric materials can have their properties tailored to meet the requirements of a broad range of sonar systems ranging from submarine obstacle avoidance sonar through multi-line towed hydrophone arrays to unmanned underwater vehicle (UUV) mounted mine hunting sonar.

Completed FY01

- (U) Completed ultra-sonic corrosion/erosion detection technology. This will enable the Navy to eliminate the more costly manual inspections for aircraft.
- (U) Completed development and laboratory testing of a corrosivity sensor for aircraft internal spaces based on a gold-cadmium galvanic couple. These sensors are currently being tested in Navy helicopters under Naval Air Systems Command (NAVAIR) funding.

– (U) An advanced finger seal to reduce air leakage in gas turbine engines was demonstrated. This technology for use in future naval aircraft engines will improve engine efficiency and reduce specific fuel consumption.
– (U) Development of plasma sprayed nanostructured ceramic wear coatings was completed and transitioned to the fleet. These coatings reduce or eliminate required maintenance on a wide variety of components of shipboard systems such as pumps, valves, motors, and propulsion systems, with a resulting reduction of total ownership cost.

- **(U)($8,354) Medical Technologies:** (FY01 accomplishments were funded in PE 0602233N)

Initiated FY01

– (U) Develop new pharmaceuticals and treatment approaches to repair damage to the inner ear caused by noise induced hearing loss. These clinical strategies, if successful, will help protect and restore hearing and balance disorders caused by sustained operations in high noise military operational environments.
– (U) Efforts were initiated to assess the impact of thermal (i.e., heat and cold) stress on operational performance in Navy and Marine Corps personnel. These studies will lead to the formulation of strategies to mitigate the performance decrements induced by exposure to thermal extremes.
– (U) Development of predictive measures for oxygen-induced seizures were initiated in the hope that a physiologically-based “early warning system” can be engineered to warn divers using hyperbaric oxygen of the impending likelihood of central nervous system seizures.
– (U) Studies were initiated to assess submarine watchstanding schedules. The current submarine watchstanding schedules are based upon an “18-hour day” which may be less than optimal based upon research with shift-workers. These studies will compare and contrast performance during the 18-hour watchstanding schedules with schedules based upon a 24-hour day.
– (U) A model for the clearance of (insoluble) smoke particles from the lung in order to determine the optimal exposure limits for toxic exposure to smoke in Navy Firefighters will be developed to provide the basis for guidance for exposure limits.

- (U) Studies began of the impact of high pressures on lyophilization of red cells. By increasing ambient pressure, the movement of water out of red cells may be facilitated, thus improving the efficiency of freeze-drying and quality of the freeze-dried red cell.
- (U) Evaluation began in models of hemorrhage combined with head trauma of arginine supplementation of hypertonic saline resuscitation fluid. By supplying arginine, the substrate for nitric oxide, it is believed that nitric oxide levels will increase and improve perfusion of the brain.
- (U) Studies were started on evaluating protection of the brain by melatonin in hemorrhagic shock. Melatonin is a readily available compound that was shown to prevent ischemic injury to the brain, and these studies will determine its full potential for treating head injury.
- (U) Efforts were initiated to extend circulation time of the gas diffusion enhancer, trans-sodium crocetinate (TSC). TSC shows promise as an additive to resuscitation fluid, but currently it is excreted too rapidly to sustain tissue oxygenation for more than 20 minutes.
- (U) Studies were initiated to examine the short- and long-term effects of acute and chronic exposure to hypobaric (high altitude aircraft and aircraft operations training chambers) oxygen. Efforts will attempt to define the long term risk to personnel and develop new approaches to training and operations that reduce risk of injury from oxygen toxicity.

Continued FY01

- (U) Applied research continued to develop prophylactic agents to prevent hyperbaric oxygen toxicity in Navy and Marine Corps divers breathing pure oxygen at depth. These efforts will identify physiological changes that occur after acute and chronic exposure to hyperbaric oxygen in order to assess if repeated exposure to hyperbaric oxygen increases the probability of seizure activity or brain damage with subsequent exposures.
- (U) Efforts have continued to find and develop agents that prevent the neurological damage associated with decompression sickness in Navy divers. Decompression sickness remains a major medical problem in Navy divers.
- (U) Continued exploring the effects of motion and acceleration and developing methods to predict and counteract the deleterious effects of low-to-high frequency acceleration (motion) in operational environments. Deleterious motion effects can range from extreme nausea to disorientation and have been identified as contributing factors in numerous fatal mishaps on ships and aircraft. Approaches to be studied include improved control surface and display design, optimal work-rest schedules, and diet and drug-based interventions.

- (U) The evaluation of effects of mild hypothermia on hemorrhagic shock outcomes progressed. Mild hypothermia was shown to prevent head injury following hemorrhage in rats, but will be further assessed in a swine model for its utility in large species.
- (U) Investigation was ongoing into the chemical properties of a hibernation factor. A factor isolated from hibernating squirrel serum has demonstrated the ability to protect cells from ischemic injury. The factor will be further characterized, cloned and tested in a small animal model of hemorrhage.
- (U) Development of a hemoglobin substitute continued. Hemoglobin is the most effective oxygen carrier at present, but it is expensive to isolate and process; these studies will characterize oxygen-binding heme peptides (to be encapsulated in liposomes) that could be manufactured inexpensively.
- (U) The evaluation of the effect of hypertonic fluids on head injury was continued. Clinical studies have suggested that hypertonic resuscitation is beneficial in head injury, but the optimal fluid and protocol requires analysis in an animal model of hemorrhage and resuscitation.
- (U) Evaluation continued of colloidal resuscitation effects on the development of lung injury. Acute respiratory disease (ARD) is the major killer of hemorrhagic shock casualties, and these studies will evaluate various colloidal fluids that may prevent ARD.
- (U) The evaluation continued of the control of systemic inflammation by the cytokine, IL-11. This cytokine, which is approved for human use, has shown promise for preventing intestinal injury following severe hemorrhage.
- (U) Investigation was ongoing on the effects of Federal Drug Agency (FDA)-approved resuscitation fluids on the inflammatory response. Fluids employed in standard of care resuscitation appear to potentiate systemic inflammation; this study will determine which of the currently employed fluids is least likely to promote inflammatory injury.
- (U) Efforts continued in the evaluation of selected cytokines as predictive indicators of trauma outcome. Data obtained in one clinical center will be replicated in two other clinical centers to determine whether effective markers of multiple organ failure have been identified.
- (U) Evaluation continued of trauma applications of hand-held ultrasound diagnostic instruments in the field. The relative merits of two systems will be evaluated under field conditions with minimally trained operators to determine if these devices require further development.
- (U) Efforts were ongoing to evaluate malaria Deoxyribonucleic Acid (DNA) vaccine gene sequences for protective efficacy. The optimal combination of oligomers for stimulating protective immunity is being determined based on protection tests in mice and monkeys.

- (U) The assessment of nasal ketamine to relieve acute pain was continued. This drug may have utility for controlling pain of injury and facilitating self-transport of casualties.
- (U) Studies to evaluate immunological function during harsh operational conditions were continued. These studies have demonstrated that individual differences in susceptibility to stress can be detected with certain immune tests, thus allowing identification of individuals more prone to infectious illness.

Completed FY01

- (U) An improved paper- and pencil-based test was developed to augment existing pilot selection tests to predict student naval aviator performance during training and in the Fleet. The resulting tests were provided to the Fleet for further validation and may reduce attrition during pilot training if successful.
- (U) Studies were completed that evaluated novel sensor technology to detect multiple toxicants which Navy personnel may be exposed to operationally aboard ships.
- (U) The development of new methods to detect and assess environmental pathogens, toxicants, and ultrafine particles that will provide exposure standards for operational personnel was completed.
- (U) Applied research was completed of a potassium adenosine triphosphate (ATP) channel inhibitor in hemorrhagic shock. This drug class will be further evaluated in large animal models.
- (U) Evaluation was finished of eicosenoid inhibitors in combined hemorrhage and blunt chest trauma. The protective benefit was shown to be minimal.

- **(U)($4,381) Environmental Quality:** (FY01 accomplishments were funded in PE 0602121N**)**

Initiated FY01

- (U) Initiated metal hydride battery technology development for Navy aircraft to reduce/eliminate hazardous waste generation, disposal costs and future liability. Technology development will also increase performance and reliability of aircraft battery systems.

- (U) Initiated identification of Navy air operations pollution control technology initiatives in order to enable continued critical depot maintenance activities while complying with environmental regulations.

Continued FY01

- (U) Continued automated dry-dock ship painting and applique technology for elimination of over-spray and hazardous air pollutants to enable adherence to environmental laws and regulations in dry-dock operations, increased productivity and reduced cost of compliance.
- (U) Continued shipboard non-oily wastewater bioreactor treatment system process controller development to enable monitoring of bioreactor status in order to reduce manpower intensive unscheduled maintenance, prevent bioreactor failure and the consequent lengthy start-up requirements.
- (U) Continued copper sensor technology for Navy Industrial Wastewater Treatment Plant (IWTP) and applique technology for ship hulls and structures. This technology will enable the continued use of in-water cleaning of ship hulls while monitoring copper discharges to comply with regulations and will allow Navy Industrial Wastewater Treatment Plants (IWTPs) to cost effectively monitor copper in their regulated discharges.
- (U) Continued environmentally compliant marine coatings test facility support for the field-testing of new, improved, non-toxic antifouling coatings and systems for ships and submarine hulls.

Completed FY01

- (U) Completed integrated characterization of Navy-contaminated marine sediments. Proven methods, tools and processes developed will enable Navy Remediation Program Managers (RPMs) to more easily characterize contaminated sediment sites at less cost and in a more timely manner; transitioned to NAVFAC (PE0603721N).
- (U) Completed submarine heat exchanger fouling control technology development using pulsed acoustic and electrical fields to prevent biofouling and maintain heat exchangers for ships and submarines; transferred to NAVSEA (09T, 05L) for advanced development.
- (U) Terminated Dense Medium Plasma (DMP) technology development for ship wastewater treatment in this PE and referred to 6.1 basic research program (PE 0601153N) for obtaining a better understanding of the process.

- **(U) FY 2001 CONGRESSIONAL PLUS-UPS:**

– **(U)($4,837) Advanced Materials Processing Center -** Continued to develop composite process models and advanced sensors for cost effective fabrication of materials. (Funded in PE 0602234N)

– **(U)($2,906) Aerospace Materials Technology Consortium** – Initiated a consortium on advanced aerospace materials. (Funded in PE 0602234N)

– **(U)($1,206) Biodegradable Polymers -** Completed development and physical characterization of soybean protein natural biodegradable polymers and in the process of undergoing biodegradation evaluation. (Funded in PE 0602121N)

– **(U)($1,931) Bioenvironmental Hazards Research Program -** Conducted efforts in bioenvironmental science in three areas: 1) Environmental Signals and Sensors, 2) Ecosystems Science, and 3) Environmental Management and Remediation. (Funded in PE 0602121N)

– **(U)($3,377) Biological Hazard Detection System -** Continued efforts to develop an integrated sampling, sensing, processing and warning system for pathogenic organisms using commercial off-the-shelf (COTS) sensors in the final stages of development. The system is intended to detect and identify emerging pathogens not previously characterized, known infectious agents whose genomes have been altered to confer antibiotic resistance or enhanced pathogenicity, and epidemogenic organisms that threaten the readiness of deployed forces. (Funded in PE 0602233N)

– **(U)($1,939) Ceramic and Carbon Based Composites** – Continued the development of advanced missile materials. (Funded in PE 0602234N)

– **(U)($1,931) Cognitive Research -** Conducted multidisciplinary efforts to optimize human performance in four high-priority Navy applications: new data understanding methodologies to study personnel selection and retention; advanced displays to enhance the performance of operators of complex aircraft (V-22 Osprey) and unmanned aerial combat vehicle systems (e.g., UCAV-N); a new approach to the study and solution of complex problems that underlie a range of performance support systems; and joint interactive planning of naval operations and exercises that flow from the Commander's intent. (Funded in PE 0602233N)

- **(U)($2,906) Composite Storage Module** – Evaluated designs and materials for advanced submarine modules. (Funded in PE 0602234N)

- **(U)($1,207) Environmentally Sound Ship Program -** Started initiative for development of non-volatile organic compounds (non-VOC) facilities and ship superstructures. (Funded in PE 0602234N)

- **(U)($1,966) Intermediate Modulus Carbon Fiber Qualification** – Completed the evaluation of intermediate carbon fibers for application in aerospace composites. (Funded in PE 0602234N)

- **(U)($1,931) Marine Fire Training Center at MERTS** - Efforts focused on the development of software and hardware for firefighting training and to design and build a firefighting training facility. (Funded in PE 0602233N)

- **(U)($1,931) Maritime Fire Training/Barbers Point** – A proposal is being developed and an environmental study is being conducted in preparation for efforts at Barber's Point, HI, to build a firefighting training facility. (Funded in PE 0602233N)

- **(U)($971) Materials Micronization Technology** – Continued the evaluation of grinding processes to form ultra fine particles for advanced materials processes. (Funded in PE 0602234N)

- **(U)** (**U)($1,941) Wood Composite Technology** – Evaluated the application of engineered lumber for piers and wharves. (Funded in PE 0602234N)

2. (U) FY 2002 PLAN:

- **(U)($6,785) Manpower, Personnel, and Human Factors:**

Initiate FY02

- (U) Begin to pre-test all instruments for the Person-Organization Fit effort. This work will develop and test all models and indices for assessing the degree of fit between the person and the organization.
- (U) Commence the selection of specific predictor measures and objective presentation for the Psychometrics of Measures program that help “tease out” important non-cognitive individual differences (social judgement/intelligence, emotional intelligence, tendency for negative outlook, coping skills, etc.) useful in making career decisions.
- (U) Initiate the Models of Aptitude and Interest effort to analyze data for job interest inventory. Verify and extend model through correlational and structural techniques to be used in a flexible and valid selection/classification system.
- (U) Start effort that focuses on development of algorithms that optimally assign individuals to jobs. Deliver software version 1.0 from this Usability and Contents research program.
- (U) Initiate a job matchmaker program, Sailor/Marine Assignment Matchmaker that develops intelligent agents to assess desires and qualifications of sailors/Marines as well as applying/analyzing incentives necessary to influence behavior.
- (U) Begin to develop a prototype multi-agent system for sailors in the Service Member/Command Intelligent Agents program. Demonstrate intelligent software agents with the necessary level of associative intelligence and cognitive capability (human intelligence and aptitude as measured by speed and accuracy of processing verbal, quantitative and spatial information) to gather information pertinent to the service member/command. The objective is for these agents to assist the sailor and the detailer with the complex assignment process.
- (U) Initiate the biopsychological investigation of relationships among performance on spatial abilities (human ability to reason about visual events in space), tests, and performance during stressful training. This could result in significant cost savings in predicting pilot performance.
- (U) Begin development of new tests of complex cognitive abilities that relate to situational awareness (human perception and information integration of elements in the environment such as other aircraft, terrain, system status and warning lights) during flight.
- (U) Begin integration of new technologies (non-cognitive and abilities) of whole person assessment for occupational selection and classification.
- (U) Start to develop a methodology to use cluster sampling for valid Navy surveys. This allows researchers to use smaller samplings without biasing the results.

- (U) Initiate effort to develop new psychological assessment methods to predict successful adaptation to military service.
- (U) Begin cognitive task analysis and function allocation study to better understand the workload management requirements for supporting the new land attack mission.
- (U) Initiate development of console functional requirements and feasibility of universal modeling language notations (method of expressing laboratory results).
- (U) Start user profile development in support of new land attack mission.

Continue FY02

- (U) Continue evaluation of alternatives to the Integrated Personnel Simulation Techniques program to validate the simulation algorithm.

Complete FY02

- (U) Finish the Student Value Model program by transitioning the model to both basic and advanced technical training school planners.
- (U) Demonstrate integration of the web view of statistical reports generated via extensible markup language application with models that exchange information across various platforms and with different communications media.
- (U) Complete the (E)-commerce Technologies for Personnel Distribution and Assignment program and develop a community-specific database of sailors and jobs to support further testing of the two-sided matching algorithm. Develop a robust simulation model capable of incorporating sailor command preferences. Develop experiments to test expected market behavior in the military environment.

- **(U)($10,819) Training**:

Initiate FY02

- (U) Start development of instructional strategies for overcoming misconceptions in science and technical education. This effort will compare instructional techniques with physical objects in a laboratory setting and implement the techniques via computer simulation. This effort will have direct applicability to the Navy's goal to fully utilize computer technologies to support advanced distance and distributed learning.
- (U) Initiate development of effective feedback in dynamic task Artificial Intelligence (AI) tutoring. This effort will explore the comparative strategies of learners with different types of feedback (such as hints and questions) to discover what types are most beneficial in aiding student performance.
- (U) Begin study of instructional impact of personified pedagogical agents. This effort will explore these agents as a means of helping students solve problems in complex problem-solving domains such as mathematics or some other form of problem-based learning.
- (U) Begin study of cognitive task analysis methods for subject matter experts. This effort will inform the development of models and frameworks for understanding complex warfighting tasks in dynamic environments and preparing suitable training, modeling, agents and simulations for Navy relevant domains.
- (U) Initiate program for measuring, developing and linking shared cognition to team and distributed team performance. The goals for this effort include the implementation of measures for diagnosis of weaknesses related to shared cognition in teams and multi-team environments, the introduction of training strategies to foster shared cognition in teams and multi-team environments, and the development of guidelines for making team staffing decisions in warfighting and operational environments.
- (U) Undertake program on Maintenance Training Support Technology.
- (U) Initiate programs on Training and Performance Aiding, Interactive Electronic Technical Manuals, and Condition Based Maintenance (IETMs/CBM) Systems.
- (U) Start development of algorithms for Generating Optimal Mentor-Prototype Pairings.
- (U) Initiate program for Designing Advanced Learner Support Tools in Advanced Distance and Distributed Learning (ADDL).
- (U) Begin development of Intelligent Agents for Objective-Based Training. Intelligent agents as tutors, mentors, and aides to learning in computer-based training efforts have the potential for reducing costs, speeding acquisition of skills and knowledge in complex, technical and scientific fields.
- (U) Undertake development of Multi-media Visualization Training Techniques.
- (U) Initiate program to Foster Continuous Learning On-The-Job Through Self Regulating Processes.

- (U) Begin study of On-Line Strategies for Collaborative Group Learning.
- (U) Initiate efforts assessing the Training Value of Multi-media Technologies.
- (U) Initiate efforts on the effects of ship motion on onboard Virtual Environment (VE) systems. Onboard training using VE systems can prepare students at sea, enhancing mission readiness. Ship motion can interfere and impede these systems, reducing the effectiveness of a valuable training tool.
- (U) Start investigations into alternate visual and aural presentations for individual vehicle simulators.
- (U) Initiate applied research into simulated interaction of spatially distributed individuals.
- (U) Initiate the simulation of human locomotion for use in Close Quarters Battle training.
- (U) Begin applications for weapons handling for dismounted combatants in Virtual Environments (VE). Virtual Environments are a cost-effective training venue that can improve training effectiveness and enable improved capabilities in training for dynamic, high-tempo warfighting environments.
- (U) Initiate task in Computer Generated Forces (CGF) assessing the capability of CGFs to act as instructional agents for scenario generation and provide coaching and feedback. This will provide a highly cost-effective approach to training that will reduce training personnel requirements by at least 25%.
- (U) Start task in Computer Generated Forces (CGF) aimed at improved techniques for human cognitive and behavioral modeling techniques to support realistically behaving simulated teammates and adversaries. This will create more challenging simulated adversaries for application in simulation based naval training. The consequence will be more effective training.
- (U) Start effort in Computer Generated Forces (CGF) aimed at developing enhanced modeling techniques for representing individual differences such as the effects of training in CGFs. This will reduce the predictability of simulated adversaries in simulations for training, and thereby reduce the likelihood that trainees will “game” the training scenarios—a tactic that compromises training value.

Continue FY02

- (U) Continue work on the Physics Tutor (electricity and magnetism). This effort will improve training effectiveness, advance students’ understanding, and improve students’ ability to problem solve on their own in a required, complex, Navy-relevant course at the U.S. Naval Academy, as well as providing empirical data on the effectiveness of intelligent tutoring systems.

- (U) Continue work on Instructional Authoring Tools. This effort improves the abilities of instructor to produce pedagogically sound computer-based training tailored for military settings and training needs.
- (U) Continue work applying Virtual Environments (VE) technology to the training of spatial behavior relevant to expeditionary forces combat vehicles including the Landing Craft Air Cushion (LCAC) and the Advanced Amphibious Assault Vehicle (AAAV).
- (U) Continue development of multi-sensory, spatially distributed computer interfaces and assess impact on human learning and memory.
- (U) Continue development of methods for measuring realism in Virtual Environments (VE) and determine the relationship between realism and training effectiveness of VEs.
- (U) Continue to address human computer interaction issues relevant to developing a training simulator for Close Quarters Battle for Military Operations in Urban Terrain (CQB for MOUT).

Complete FY02

- (U) Complete work on artificially intelligent tutoring in dynamic decision-making.
- (U) Complete work on augmenting displays to enhance learning.
- (U) Complete work on advancing applied cognitive task analysis.
- (U) Complete work in Computer Generated Forces (CGF) aimed at development of simulated team members to insert into team training and intelligent tutoring systems. This effort is providing more realistic simulated teammates for application in simulations for naval training. The result is more realistic, effective team training.

- **(U)($7,199) Expeditionary Logistics:**

Initiate FY02

- (U) Initiate algorithm development to incorporate captured use rates, improve source data quality, improve sustainment rate calculation, and establish stockage levels that are situationally dependent. This will provide a technology foundation to credibly automate many of the manual functions that drive logistics supportability determination. The automation is critical to battlefield information sharing.

- (U) Initiate material handling technologies for Sea State 5 strike up/down technologies for application to carriers and combatants. Effort will focus on robotics and sensor-based dynamic manipulation in unpredicted motion. The technology advances could significantly reduce the shipboard manpower required for logistics missions and is a critical step in meeting the future Multi Purpose Aircraft Carrier Nuclear (CVNX) manning goals.
- (U) Initiate annealing and similar algorithm optimization techniques for balancing large array logistics throughput equations. Slow solutions to the large matrix and array equations that define logistics currently prohibit much sustainment projection other than simplistic analysis to occur in real-time command and control systems.
- (U) Initiate skin to skin material transfer technology investigation through two independent recommendation studies in the areas of fendering materials, at-sea ship securing systems, future crane technology and surfactants. Employing new methods of ship to ship material transfer has the potential to allow interface with commercial shipping fleets at sea, and may also assist in the offload of large ships to small crafts, which have greater port access flexibility.

Continue FY02

- (U) Continue decision support technologies for Logistics Command and Control Course of Action generation. This investment will support the force deployment planning and execution at the tactical level, beginning with robust calculations for ground troop supportability estimates and tactical sustainment requirement determination.
- (U) Continue logistics modeling and simulation, focused on simulation engines and user interfaces. These modeling efforts are targeted at inserting robust logistics functionality into the joint and naval wargaming simulation systems, allowing future doctrine and concepts to explore logistics implications.

- **(U)($2,193) Energy Conversion:**

Initiate FY02

- (U) Begin evaluation of advanced fuels for enhanced explosive and propellant applications. These are metal based fuels which offer the potential to significantly improve the performance of energetic materials by enhancing ignition times and tailoring rates of energy release.
- (U) Initiate development of the capability to tailor propellant performance to combustion characteristics. This will permit the a-priori optimization of propellant formulation design in order to tailor the safe operating regime of the propellant to the system requirements.
- (U) Start to develop the capability to predict effects of ballistic modifiers on propellant performance parameters. This capability will permit one to tailor the pressure-combustion rate dependence of next generation propellants using current ballistic modifiers with a-priori design criteria and eliminate many of the empiricisms currently inherent to the development process.
- (U) Develop the capability to predict effects of energetic components on propellant burn rate parameters. This would permit the maximization of performance while simultaneously avoiding catastrophic propellant failure when new designs or design changes are implemented.
- (U) Develop diagnostics to monitor response of energetic materials to external stimuli. These diagnostics are essential in the understanding of how mechanical energy is absorbed into an energetic material and if it will lead to detonation or will quench.
- (U) Calibrate laboratory scale diagnostic to accurately determine underwater explosive performance and validate with large scale test results. This capability would enable laboratory characterization of the small quantities of experimental explosives initially available without the need to invest significant time and resources into material scaleup.

Complete FY02 (This work transitioned from PE 0601153N in FY02)

- (U) Complete a 1st generation model to predict effects of ammonium perchlorate size effects on propellant burn rate parameters.

- **(U)($21,620) Materials, Maintenance Reduction, and TOC:**

Initiate FY02

- (U) Initiate development of improved welding consumables for superior strength (greater than 110 ksi)/toughness ship steels. This will provide the Navy with superior performance weld metal with minimized preheat for affordable construction of future ships.
- (U) Assess applications of high force actuators for naval structures. These actuators will allow active control of structural vibrations reducing acoustic radiation from undersea vehicles, for example, in torpedo acoustic stealth applications.
- (U) Develop high strain-high force actuators for sonar source applications. These sonar transducers will allow reduction in device sizes by factors ranging from three to six in applications such as torpedo homing sonar and torpedo countermeasure decoys.
- (U) Initiate development of materials and processes for high temperature turbine disks. These materials/processes are needed to provide improved performance, durability and decreased operational cost in future naval gas turbine engines.
- (U) Initiate development of higher temperature aluminum alloys. These materials will reduce weight and cost of components, now fabricated from titanium, in the front end of naval gas turbine engines.
- (U) Initiate multi-laser-processing technology for the fabrication of ultra hard materials. This revolutionary new technology will allow us to reclaim old components back into service or produce new components with zero maintenance requirements.
- (U) Initiate investigations of a nondestructive evaluation technique based on the thermographic imaging of structures. Preliminary results indicate it to be very sensitive for the detection of small cracks in naval structures.
- (U) Initiate work on advanced smart wires for rapid aircraft maintenance. This will provide the Navy and Marine Corps the ability to rapidly diagnose defects in wiring and significantly reduce the time required for maintenance of complex wiring in aircraft and ships.
- (U) Evaluate the feasibility of non-destructive evaluation (NDE) methods for in water ship shaft health monitoring. This will provide the Navy the ability to more efficiently schedule maintenance associated with dry docking procedures and improve readiness.
- (U) Develop single coat corrosion control coatings for potable water ship tanks. This new coating will replace current five and three coat systems thereby reducing costs.

- (U) Initiate new wash-down processes for United States Marine Corps (USMC) vehicles using recyclable corrosion inhibitors. This will provide the Marine Corps with advanced corrosion control technology and contribute to life extension of vehicles such as the High Mobile Multi-Purpose Wheeled Vehicle (HUMVEE).
- (U) Initiate fighter/helo arc fault circuit breaker (AFCB) development. This will provide the Navy and Marine Corps the capability to prevent electrical arcing in areas such as fuel tanks greatly enhancing safety of operation.

Continue FY02

- (U) Continue development of environmental barrier coatings for ceramics/composites to provide higher combustor operational temperatures and extended combustor life times for future naval gas turbine engines. This work is necessary to meet IHPTET Phase III goals and will transition into improved engines for future naval aircraft.
- (U) Continue cadmium replacement technology development for corrosion control. This will provide the Navy with an environmentally acceptable technology for preventing corrosion and hydrogen embrittlement in high strength steel aircraft components such as landing gear and wing boxes.
- (U) Develop advanced applique technologies for aircraft corrosion control. This will enable the Navy to save maintenance costs by employing easily replaceable stick-on coatings having both corrosion prevention and stealth properties.
- (U) Develop environmentally acceptable coatings for nonmagnetic ship hulls. This will enable the Navy to select lower cost austenitic stainless steel as a non-magnetic hull material in preference to higher cost titanium alloys.
- (U) Continue evaluation of upgraded seawater valves in land based tests. This will provide the Navy with 40-year valves in seawater systems, thereby eliminating valve replacements currently needed at 10-year intervals.
- (U) Continue bristle brush development for paint and corrosion product removal. This will provide the Navy with the ability to spot-repair aircraft paint coatings without having to re-paint the whole aircraft, thereby reducing maintenance costs.
- (U) Continue stress corrosion tests on friction stir welded advanced amphibious assault vehicle (AAAV) aluminum alloy. This will enable the Marine Corps to select lower cost joining technologies for the AAAV, which yield aluminum alloy microstructures not susceptible to stress-corrosion cracking.
- (U) Continue friction stir welding of steels effort to develop apparatus and processing routes for superior solid state welds in ship structures. This will provide Navy with technique that drastically reduces weld fume and distortion/enhances stealth and affordability in ship construction.

- (U) Continue development of innovative composites casting technology for ship shafts and seals. This will allow the Navy to fabricate extraordinarily long life seals for propulsion shafts on Navy ships, enhancing combat readiness and affordability/reducing maintenance.
- (U) Continue the development of compositions and processing for more affordable, higher performance ship steels such as HSLA 65. This will provide the Navy with ship steels of superior strength/toughness and affordability, and significant weight reduction.
- (U) Continue the development and evaluation of weld processing of stainless steel for more affordable superior performance welds. This will provide the Navy with welding technology to fabricate non-magnetic, stealthy ships.
- (U) Continue to develop multi-functional transducer materials. These composite piezoelectric materials can have their properties tailored to meet the requirements of a broad range of sonar systems ranging from submarine obstacle avoidance sonar through multi-line towed hydrophone arrays to UUV mounted mine hunting sonar.
- (U) Continue development of ultra-light heat exchanger for the E-2C aircraft. A planned upgrade in the E-2C radar requires heat dissipation beyond that achievable with standard pin-on-fin heat exchangers. This program will provide that capability and obviate expensive aircraft structural changes.
- (U) Continue development of new thermal barrier technology using multiphase coatings for oxidation resistant molybdenum alloys, a likely candidate for the next generation of superalloys. These alloys will provide higher hot section operating temperatures for future naval gas turbine engines resulting in improved performance and decreased specific fuel consumption.
- (U) Continue development of oxidation resistant molybdenum alloys that are leading candidates for the next generation of superalloys. These materials will provide major enhancement in performance and fuel economy for gas turbines by providing higher hot section capability and more thermodynamic efficiency.
- (U) Continue the development of advanced carbon/carbon materials processes for missile heat shield applications for naval strategic missiles. This work will provide replacements for no-longer available materials and develop better, more affordable new heat shield materials.
- (U) Continue development of advanced composites and polymers with fire resistance for ship structures. Present day composite materials ignite easily generating thick and toxic fumes, therefore are not safe for man rated areas.
- (U) Continue the development of mechanics analysis for glass fabric composite structures for future naval topside structures. This will provide the Navy with guidance for the rational selection of material design allowables based on material damage.

- (U) Continue fiber optic sensor development for health monitoring of future naval structures. A distributed sensor sensor system of this nature will allow lowering the maintenance cost by better scheduling inspections.
- (U) Continue ultrasonic imaging camera development for non-destructive evaluation (NDE) of naval materials and structures. This wide area imaging technique will lower the inspection time by 30% while enhancing its reliability of detection.
- (U) Continue development of frequency agile polymers for application in laser eye protection. These new nonlinear optical limiter materials will protect our sailors and marines from ever changing laser threats.
- (U) Continue to develop multi-functional transducer materials. These composite piezoelectric materials can have their properties tailored to meet the requirements of a broad range of sonar systems ranging from submarine obstacle avoidance sonar through multi-line towed hydrophone arrays to UUV mounted mine hunting sonar.
- (U) Continue evaluation of advanced transducer single crystal high strain materials. These materials will revolutionize essentially all Navy sonar devices by doubling bandwidths and increasing energy densities more than an order of magnitude.

Complete FY02

- (U) Complete pulse thermographic imaging development for defect characterization in naval structures. This is a portable, wide-area and non-contact inspection technology with significant promise for maintenance cost reduction.
- (U) Complete effort to optimize the damage tolerance response versus the vibration damping characteristics of reinforced polyurethane composites for cost and weight reduction on future Navy ships.
- (U) Complete bismalidie (BMI) composite (patch development) development for high temperature repair applications of present and future naval aircraft. Present epoxy patch technology does not meet the demanding aerospace material requirements.
- (U) Complete corrosion sensor development for condition based maintenance of ballast tanks. This enables the Navy to save maintenance costs by replacing a manual inspection process with an electrochemical monitoring technology for ship tanks.
- (U) Complete the development/evaluation/qualification of the ausform finishing process for aerospace steel gears. This will provide the Navy with superior technology to produce rotorcraft gears with greater load capability and longer service life.

- (U) Demonstrate superior new MIL-100S welding wire for welding ship steels. This provides the Navy with improved weld metal for welding of HSLA steels with the elimination/minimization of preheat and thus enhanced affordability in ship and submarine construction.

(U)($17,195) Medical Technologies:

Initiate FY02

- (U) Efforts begin to develop a smart uniform to permit extended exposure to operational extreme conditions. Particular emphasis will be placed on the development of a diving ensemble that will protect divers while operating in environmental extreme (i.e., heat and cold) conditions.
- (U) Development begins of technologies for enhanced body protection against battlefield munitions. In particular, studies will be performed to assess the amount of blunt force trauma damage that is experienced using current and proposed chest protection devices.
- (U) Building on research into the underlying processes for cellular repair, applied research into the regeneration of auditory and vestibular hair cells in the inner ear will be initiated. This work will attempt to define the chemical changes in the cell during the damage process and develop target drug approaches that improve or imitate upon the body’s own damage repair.
- (U) Begin exploring accident trends aboard reduced-crewed and high performance vessels such as fast boats, smart ships and next generation aircraft carriers to determine new approaches to reduce injury through improved design of workstations, seats, and controls. This effort will include studies of musculo-skeletal injury and how fitness and strength affect injury potential.
- (U) Begin development of an improved aircrew protection suit for operational aircraft. The suits will be targeted to platforms. High performance aircraft operations will focus on extending g-force tolerance for operators. Helicopter operations will attempt to improve safe operations in extreme heat and cold. Initiate work on a smart ensemble that assesses physiological status and integrates into aircraft control systems, to reduce risk associated with loss of situational awareness or consciousness.

- (U) A casualty management tool is initiated for Operational Maneuvers from the Sea (OMFTS) and special operations. This tool will facilitate optimal distribution of medical supplies.
- (U) Evaluation of the effects of a colloidal fluid on brain injury is initiated. These studies will determine if a newly approved colloidal resuscitation fluid reduces brain damage following blunt trauma.
- (U) Evaluation of the effects of a hemoglobin red cell substitute on brain injury is initiated. These studies will determine if use of a newly developed soluble hemoglobin product will reduce brain damage following blunt trauma.
- (U) Studies are initiated to assess the energy status of various organs following resuscitation with standard crystalloids. Phosphorus nuclear magnetic resonance (NMR) will be used to determine adenosine triphosphate (ATP) levels in an animal model of hemorrhage following resuscitation, thus determining which fluid provides optimal resuscitation.
- (U) Studies begin to evaluate the effect of carbohydrate adducts on penetration of the brain by pain drugs. If morphine can be modified to enter the brain more efficiently, less will be required to control acute pain in casualties and the casualty can remain conscious and functional.

Continue FY02

- (U) Continue to evaluate ways to protect hearing and balance through new protective systems. The effort includes studies of new materials that reduce noise levels when applied to personal hearing protection as well as structural insulations. Additional work will continue to develop clinical strategies and interventions such as new drugs to protect and restore hearing and balance progress.
- (U) Efforts continue to assess the impact of thermal (i.e., heat and cold) stress on operational performance in Navy and Marine Corps personnel. These studies will lead to the formulation of strategies to mitigate the performance decrements induced by exposure to thermal extremes.
- (U) Development of predictive measures for oxygen-induced seizures continue in the hope that a physiologically-based "early warning system" can be engineered to warn divers using hyperbaric oxygen of the impending likelihood of central nervous system seizures.
- (U) Evaluation continues on the impact of high pressures on lyophilization of red cells. By increasing ambient pressure, the movement of water out of red cells may be facilitated, thus improving the efficiency of freeze-drying and quality of the freeze-dried red cell.

- (U) Evaluation continues in models of hemorrhage combined with head trauma of arginine supplementation of hypertonic saline resuscitation fluid. By supplying arginine, the substrate for nitric oxide, it is believed that nitric oxide levels will increase and improve perfusion of the brain.
- (U) Studies continue on evaluation of melatonin in hemorrhagic shock. Melatonin is a readily-available compound that was shown to prevent ischemic injury to the brain, and these studies will determine its full potential for treating head injury.
- (U) Applied research continues on extending the circulation time of the gas diffusion enhancer, trans-sodium crocetinate (TSC). TSC shows promise as an additive to resuscitation fluid, but currently it is excreted too rapidly to sustain tissue oxygenation for more than 20 minutes.
- (U) Efforts continue to develop prophylactic agents to prevent hyperbaric oxygen toxicity in Navy and Marine Corps divers breathing pure oxygen at depth. These efforts will also identify physiological changes that occur after acute and chronic exposure to hyperbaric oxygen in order to assess if repeated exposure to hyperbaric oxygen increases the probability of seizure activity or brain damage with subsequent exposures.
- (U) Continue the development of novel agents that prevent the neurological damage associated with decompression sickness in Navy divers. Decompression sickness remains a major medical problem in Navy divers.
- (U) Continue to examine the short- and long-term effects of acute and chronic exposure to hypobaric (high altitude aircraft and aircraft operations training chambers) oxygen. This work will attempt to define the long term risk to personnel and develop new approaches to training and operations that reduce risk of injury from oxygen toxicity.
- (U) Explore effects of motion and acceleration and develop methods to predict and counteract the deleterious effects of low-to-high frequency acceleration (motion) in operational environments. Deleterious motion effects can range from extreme nausea to disorientation and have been identified as contributing factors in numerous fatal mishaps on ships and aircraft. Approaches to be studied include improved control surface and display design, optimal work-rest schedules, and diet and drug-based interventions.
- (U) Efforts continue in the investigation of the chemical properties of a hibernation factor. A factor isolated from hibernating squirrel serum has demonstrated the ability to protect cells from ischemic injury. The factor will be further characterized, cloned and tested in a small animal model of hemorrhage.
- (U) Efforts progress in the development of a hemoglobin substitute. Hemoglobin is the most effective oxygen carrier at present, but it is expensive to isolate and process; these studies will characterize oxygen-binding heme peptides (to be encapsulated in liposomes) that could be manufactured inexpensively.

- (U) The evaluation continues of the control of systemic inflammation by IL-11. This cytokine, which is approved for human use, has shown promise for preventing intestinal injury following severe hemorrhage.
- (U) Applied research is ongoing on the effects of Federal Drug Agency (FDA)-approved resuscitation fluids on the inflammatory response. Fluids employed in standard of care resuscitation appear to potentiate systemic inflammation; this study will determine which of the currently employed fluids is least likely to promote inflammatory injury.
- (U) Studies continue in the evaluation of the trauma applications of hand-held ultrasound diagnostic instruments in the field. The relative merits of two systems will be evaluated under field conditions with minimally trained operators to determine if these devices require further development.
- (U) The evaluation continues of malaria DNA vaccine gene sequences for protective efficacy. The optimal combination of oligomers for stimulating protective immunity is being determined based on protection tests in mice and monkeys.
- (U) The assessment of nasal ketamine to relieve acute pain continues. This drug may have utility for controlling pain of injury and facilitating self-transport of casualties.
- (U) Studies to evaluate immunological function during harsh operational conditions continue. Particular emphasis is placed on characterizing the changes in immunological factors which may predict susceptibility to viral or bacteriological immunological challenges.

Complete FY02

- (U) The current submarine watchstanding schedules are based upon an “18-hour day” which may be less than optimal based upon research with shift-workers. The studies to compare and contrast performance during the 18-hour watchstanding schedules with schedules based upon a 24-hour day are completed.
- (U) Development of a model for the clearance of (insoluble) smoke particles from the lung in order to determine the optimal exposure limits for toxic exposure to smoke in Navy Firefighters is completed.
- (U) Studies are completed of the effects of mild hypothermia on hemorrhagic shock outcomes. Mild hypothermia was shown to prevent head injury following hemorrhage in rats, but will be further assessed in a swine model for its utility in large species.
- (U) Evaluation is completed of the effect of hypertonic fluids on head injury (transition). Clinical studies have suggested that hypertonic resuscitation is beneficial in head injury, but the optimal fluid and protocol requires analysis in a head injury model including hemorrhage and resuscitation.

- (U) Studies are completed of the colloidal fluid resuscitation effects on the development of lung injury. Acute respiratory disease (ARD) is the major killer of hemorrhagic shock casualties, and these studies will evaluate various colloidal fluids that may prevent ARD.
- (U) Evaluation is completed of selected cytokines as predictive indicators of trauma outcome (transition). Data obtained in one clinical center will be replicated in two other clinical centers to determine whether effective markers of multiple organ failure have been identified.

• **(U)($2,713) Environmental Quality (EQ):**

Initiate FY02

- (U) Initiate air and noise pollutant emissions control and treatment technologies for Navy platforms and assets. Air and noise emissions from existing aircraft do not meet local noise ordnances and air emission requirements and thus limit essential training at shore-based facilities. New technology will reduce or eliminate emissions to meet regulatory levels and ensure continued training and readiness.
- (U) Initiate advanced environmentally compliant antifouling (AF) hull coatings for ships and submarines and compliant anticorrosion (AC) coatings for ship and submarine structures. New materials will be non-toxic while preventing hull fouling and vessel structure corrosion.
- (U) Initiate advanced ship and submarine liquid, air, solid emissions control technology in compliance with Uniform National Discharge Standards (UNDS) and Marine Pollution Convention/International Maritime Organization (MARPOL/IMO). Pending discharge regulations will limit the ability of Navy ships to sail in any body of water. New control technologies will enable the Fleet with unrestricted access to all water bodies in compliance with all regulations.
- (U) Initiate investigation of biofouling/biocorrosion control mechanisms in order to gain a better understanding and knowledge of the processes at work that will enable the development of new materials and technologies to control biofouling and biocorrosion in an environmentally benign manner.
- (U) Initiate advanced pollution prevention/waste treatment technologies for ship, submarine and shoreside applications. Pollution prevention technologies will enable cost effective means for reducing hazardous waste and disposal, complying with regulations and meeting Executive Order (EO) goals.

- (U) Initiate automated underwater hull paint removal and application technology to eliminate hazardous waste discharges and enable continued in-water hull maintenance and repair operations in compliance with water quality regulations and avoid costly dry-docking.
- (U) Initiate advanced ship wastewater bioreactor technology to optimize non-oily wastewater bioreactor efficiency and thus reduce size and weight, provide the capability for treating other liquid waste streams (oily) and to develop quick bioreactor start-up products (reduce start-up time by 50%).
- (U) Initiate Navy ship ballast water exchange efficacy evaluation for non-indigenous species threat mitigation in order to validate the Navy's current double ballast exchange policy.

Continue FY02

- (U) Continue environmentally compliant marine coatings test facility support for the field-testing of new, improved, non-toxic antifouling coatings and systems for ships and submarine hulls.

Complete FY02

- (U) Complete shipboard non-oily wastewater bioreactor treatment system process controller development to enable monitoring of bioreactor status in order to reduce manpower intensive unscheduled maintenance, prevent bioreactor failure and the consequent lengthy start-up requirements; transition to NAVSEA (PE 0603721N) for integration/implementation.
- (U) Complete copper sensor technology for Navy IWTP and applique technology for ship hulls and structures. This technology will enable the continued use of in-water cleaning of ship hulls while monitoring copper discharges to comply with regulations and will allow Navy Industrial Wastewater Treatment Plants (IWTPs) to cost effectively monitor copper in their regulated discharges; transition to NAVFAC and NAVSEA respectively (PE 0603721N).
- (U) Complete metal hydride battery technology for lighter, more reliable and environmentally acceptable batteries for aircraft and systems; transition to NAVAIR, PMA 251.
- (U) Complete automated dry dock ship paint application, overspray control, collection and treatment technologies to enable adherence to environmental laws and regulations in dry-dock operations, increased productivity and reduced cost of compliance; transition to NAVSEA 04 (PE 0603721N) and Manufacturing Technology (MANTECH).

– (U) Complete identification of Navy air operations pollution control technology initiatives in order to enable continued critical depot maintenance activities while complying with environmental regulations; transition to SYSCOM/CNO EQRWG for prioritization.

- **(U)($2,138) Biocentric Technologies:**

Initiate FY02

– (U) Scale-up and determine yield optimization of green synthesis of energetic materials using enzymes toward an environmentally acceptable production method for energetic materials without the use of hazardous reagents and generation of hazardous by-products.
– (U) Evaluate whether sensors for trinitrotoluene (TNT) and other explosives can be used as autonomous underwater vehicle payloads for detection of unexploded ordnance (UXO).
– (U) Initiate feasibility of energy harvesting benthic fuel cells using bioelectrochemical mechanisms at the water-sediment interface. The goal is to use naturally occurring microbes to harvest low levels of power (~0.1 Watt) on a continuous basis.
– (U) Evaluate applicability of chemical sensing from autonomous underwater vehicles for Special Forces applications.

Continue FY02

– (U) Continue, within the Chemical Sensing in the Marine Environment Program, efforts for locating the source of chemical plumes in very shallow waters using sensors on autonomous underwater vehicles. This will provide the Navy with a new capability for the difficult task of remotely identifying unexploded ordnance (UXO) in the littoral zone.
– (U) Continue, within the Chemical Sensing in the Marine Environment Program, efforts to characterize chemical plume structure in the very shallow water regime. Previous research indicates that the plume structure is quite variable and heavily dependent on environmental conditions and interactions. Mapping of plume structure under various environmental scenarios is necessary to guide the development of sensor systems for underwater UXO detection.

- (U) Continue development of novel biosensors for explosives for underwater applications. These novel biosensor systems will provide sensitive, selective, and rapid detection of explosive signatures (such as TNT), a capability that the Navy currently lacks.

Complete FY02

- (U) Complete and transition the metallized lipid tubule materials for radar absorbing and antenna isolation applications. These materials show potential as replacement for the existing systems now used for this purpose, displaying competitive absorption properties but weighing approximately 60% less, a very important advantage on the small decoy vehicles on which they are deployed.
- (U) Complete investigation of bio-molecular barcodes for unique identification and tracing of materials. These barcodes or taggants act as microscopic markers that can be used to trace and identify material of naval interests, e.g., military equipment and personnel, and which have high applicability for counter-terrorism programs.
- (U) Complete, within the Chemical Sensing in the Marine Environment Program, efforts to characterize the source strengths of underwater unexploded ordnance. Distance from source and associated concentration profile data will drive the operational requirements necessary to guide the development of sensor systems for underwater UXO detection.

- **(U) FY 2002 CONGRESSIONAL PLUS-UPS:**

- **(U)($1,685) Advanced Fuel Additive Pilot** - Efforts focus on conducting a pilot demonstration of bio-derived alcohol fuel additives blended into diesel fuels.

- **(U)($991) Advanced Safety Tether Operation** – This effort develops tether technology to provide reliable and controlled boost and de-boost of spacecraft. The FY02 tasks are: 1. Establish system requirements for operational and demonstration systems, 2. Conduct tether dynamics simulations, 3. Develop concepts for attaching objects to a tether in deployment, 4. Design and test prototype tether systems.

- **(U)($1,487) Advanced Materials and Intelligent Processing -** Materials applied research is conducted to develop the resin molding process utilizing both sensor and model based approaches. These new materials will provide the Navy the capability to produce battle damage resistant aircraft with improved stealth characteristics.

- **(U)($8,425) Agile Vaccinology -** Investigations are conducted on modern vaccine technologies, including DNA-based vaccines. An example is the malaria DNA vaccine where efforts focus on the optimal vaccination strategy in mice and on determining whether the best co-vaccination strategy is a protein antigen delivered by a viral vector or by a replicon system.

- **(U)($2,577) Automated Diode Array Manufacturing -** Efforts include applied research related to automated diode array manufacturing.

- **(U)($3,370) Battlespace Information Display Technology (BIDT)-** This project established a state-of-the-art battlespace visualization environment to advance Joint Vision 2020 objectives and the United States Navy's "Forward from the Sea" strategy. BIDT integrates commercial technologies with emerging Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) capabilities, specifically for Navy and Marine Corps battlefield commanders and their staffs. In the absence of proven data correlation and information fusion algorithms, BIDT visually represents the positions and tracks of ships, aircraft, and ground-based units, along with threat envelopes - in a whole earth, scalable, multi-resolution virtual display linked to intelligence and operational databases. Therefore, BIDT presents the commander with the battlespace that closely approximates what one sees in their "mind's eye." This realization of the mind's-eye view is expected to result in intuitive actions that transform the 2-D battlespace into a 4-D battlespace so that the warfighter can view events in near-real time and fold in operational aspects associated with time - the 4^{th} dimension. In 2002, this effort demonstrates a BIDT prototype system enhanced with the capability to visualize the common undersea picture during Fleet Battle Experiment Juliet (FBE-J). Additionally, experiments are conducted to collect user information from the Navy, Army, Air Force and United States Central Command (USCENTCOM).

- **(U)($991) Bioenvironmental Hazards Research Program -** This applied research assesses the adverse impacts of Navy operations and training activities on the environment as well as the adverse health effects of contaminated environments on naval personnel.

- **(U)($2,082) Combinatorial Materials Synthesis -** This work explores combinatorial methods to provide a basis for the development of advanced materials.

- **(U)($1,487) Formable Aligned Carbon Thermo Sets (FACTS) -** This effort advances formable aligned carbon thermosets (FACTS) (fiber stretch breaking) by refining material fabrication processes, developing part-forming processes, and fabricating complex parts. Complex parts are currently formed from materials other than composites resulting in parts that are heavy (weight penalties), expensive, and subject to corrosion. Currently, composite materials (continuous fibers) cannot produce low cost, complex parts, and other attempts to address this problem (resin transfer molding and vacuum assisted resin transfer molding) have produced expensive, and sometimes poor quality parts.

- **(U)($1,100) Marine Mammal Research -** This work includes applied research related to marine mammals.

- **(U)($991) Modeling, Simulation and Training Immersion Facility -** This work includes applied research related to modeling, simulation and training immersion.

- **(U)($1,685) Printed Wiring Boards -** This work includes applied research related to printed wiring boards.

- **(U)($1,487) Rhode Island Disaster Initiative -** This effort includes technologies and techniques to determine effective solutions for medical disaster response. In particular, this effort focuses on handling mass casualties that would occur from natural disasters, terrorist acts such as the USS Cole, and both military and civilian casualties produced by weapons of mass destruction.

- **(U)($2,577) Titanium Matrix Composites Program -** Titanium metal matrix composites are developed to enhance future engine designs (rotating engine parts such as disks and spacers) by permitting greater thrust output to weight ratios than are achievable today with currently available materials. The use of titanium metal matrix composites will also allow high payoff applications in future engine compressor systems where extreme stiffness and strength requirements at elevated temperatures now require the use of significantly heavier superalloys and titanium. The application of titanium metal matrix composites will aid in achieving vertical/short take off and landing (V/STOL) aircraft designs without weight penalties.

- **(U)($1,090) Virtual Company Distributed Manufacturing** - This effort will continue and expand ongoing applied research of the West Virginia High-Technology Consortium Foundation, sponsored by plus-ups in FY 1997 and 2001. The purpose of the work is to establish a network of commercial businesses in the greater West Virginia economic region which are linked by updated, interoperable computer networks and databases, and supported through partnerships with government agencies and private suppliers and buyers of technology. This network will facilitate the flow of new technology among naval, other government, and commercial applications, and thereby foster robust businesses in the region. The Department of the Navy's goals are to reduce the total ownership cost of naval systems by increasing the availability of affordable new technologies through increased commercial activity and use of technologies developed primarily for the commercial marketplace. Work in FY2002 will focus on applications of business portals, webcrawling and websearch engines, database access tools, intercompany partnerships, and development of a self-sustaining organization. The program complements similar efforts in other regions, including for instance the "Hubs" initiative in Delaware, Maryland, New Jersey and Pennsylvania.

- **(U)($1,685) Visualization of Technical Information** - This effort includes applied research related to enhancing the visualization of technical information.

- **(U)($1,388) Wire Chaffing Detection Technology** - This effort develops advanced technologies (sensors, electronics, and algorithms) for aircraft wiring diagnostics. The project will provide the Navy a means of rapid detection of faults in wiring and enable rapid, efficient maintenance.

- **(U)($2,082) Wood Composite Technology** - This effort develops advanced-engineered lumber for application in Navy piers and wharves. These low cost composites will exhibit extreme resistance to environmental degradation thus greatly reducing maintenance costs.

- **(U)ADPICAS** - The ADPICAS (Adaptive Damping and Positioning Using Intelligent Composite Active Structures) effort modifies and refines the designs of active structural components such as composite struts and composite panels. It also explores and tests the integration of these components into systems. (Appropriated in PE 0602234N, $1,289)

- **(U)Anti-Corrosion Coatings** - This project uses combinatorial synthesis to explore advanced development of polymers for use as coatings to prevent corrosion of metals such as ship steels. (Appropriated in PE 0602234N, $3,469)

– **(U)Carbon Foam for Navy Applications -** This effort develops carbon foam materials for Navy use. These advanced materials will have significantly improved mechanical, thermal, and fire resistant properties that will permit their use in man-rated areas aboard ships and submarines. (Appropriated in PE 0602234N, $2,577)

– **(U)Maritime Fire Training/Barbers Point -** Environmental studies are conducted in preparation for efforts at Barber’s Point, HI, to build a firefighting training facility. This research tool will merge the real and virtual worlds to create an environment that can provide cost-effective realism without the dangers created by real fires. In addition, this trainer will enable firefighters to maintain their proficiency while being responsive to increasing environmental constraints related to smoke and water additives released into the atmosphere. (Appropriated in PE 0602233N, $2,577)

– **(U)Materials Micronization Technology -** This effort evaluates advanced grinding processes that can produce ultrafine particles. Such particles will be used as feed materials to form advanced, low cost, lightweight composites for applications in aircraft (F/A-18 E/F, V-22, JSF). (Appropriated in PE 0602234N, $3,469)

3. (U) FY 2003 PLAN:

- **(U)($6,642) Manpower, Personnel, and Human Factors:** These technologies enhance the Navy's ability to select, assign, and manage its people. Technology development in these areas responds to a variety of requirements, including: managing the force efficiently and maintaining readiness with fewer people and smaller budgets; providing warfighting capabilities optimized for low-intensity conflict and littoral warfare; and operating and maintaining increasingly sophisticated weapons systems while managing individual workload and supporting optimal manning.

Initiate FY03

- (U) Begin applied research effort, the Broker Agent program, to demonstrate a series of agents residing within the web-based marketplace that arbitrate between sailor/Marine and command agents when optimal matches cannot be achieved.
- (U) Initiate the Economics of Cost/Quality program to develop a cost/quality tradeoff model for force planners. This effort will develop measures that capture cost-quality tradeoffs as they pertain to the human resource allocation problem. The effort will assist decision-makers in developing flexible incentive packages that target retention efforts toward individuals most valuable to the Navy.

Continue FY03

- (U) Continue the Psychometrics of Measures program and begin the transition to the Non-Cognitive Measures advanced technology effort.
- (U) Development continues in the Usability and Contents effort and delivery of software version 2.0 to the user is scheduled to occur by end of FY03.
- (U) Effort is ongoing to establish a database supporting the Sailor/Marine Assignment Matchmaker program and to develop a plan to integrate auction theory using intelligent agent technology.
- (U) Continue the Service Member/Command Intelligent Agents effort and integrate multi-agent system for Sailors into a "personnel mall." These intelligent agents will provide information at appropriate times to adequately advise service members of impending career milestones with recommended choices and provide commands with necessary manpower information to ensure proper personnel planning. The prototype will be an interactive web-based labor market for the labor allocation of military personnel.
- (U) Continue to examine the biopsychological difference in spatial abilities, difference in training performance, and differences in negative psychological reactions to stress.
- (U) Evaluation progresses with new measures of complex cognitive abilities that relate to flight situational awareness.
- (U) Continue integration of new technologies (non-cognitive and abilities) of whole person assessment for occupational selection and classification. Assessment of the independent and interactive contributions of cognitive (perception, memory, judgement), affective (affects, feelings, emotions), and conative (inclination, drive, desire) trait measures.

- (U) Applied research advances through development of prototype implementation scenarios for manpower officials of military service adaptability.
- (U) Continue development of user profile in support of new land attack mission.

Complete FY03

- (U) Finish the Models of Aptitude and Interest effort and use measures of social judgements and personality to provide an overall structural model of individual and group differences. Deliver a stand-alone version of the interest inventory to an advanced technology effort.
- (U) Complete testing a cohort in the Recruit Training Center and A-school and begin data analysis on the cohort for the Person-Organization Fit program. Finalize assessment of the degree of fit between the person and the organization. Transition results to the Attrition Reduction Technologies advanced technology effort.
- (U) Effort concludes in testing the methodology of Navy clustering sampling survey strategy.
- (U) Efforts are complete to transition algorithm from the Integrated Personnel Simulation Technologies program to user.
- (U) Complete cognitive task analysis and function allocation study for workload management requirements in supporting the land attack mission.
- (U) Finish development of console functional requirements and feasibility of universal modeling language notations.

- **(U)($10,592) Training**: Training technologies enhance the Navy's ability to train effectively and affordably in classroom settings, in simulated environments, and while deployed, and to operate effectively in the complex, high-stress, information-rich and ambiguous environments of modern warfare. Technology development responds to a variety of requirements, including providing more affordable approaches to training and skill maintenance.

Initiate FY03

- (U) Undertake study of effective instructional strategies in artificially intelligent tutoring.
- (U) Initiate development of optimized Strategies for Performance Aiding and Training.

Continue FY03

- (U) Continue investigation of instructional strategies for overcoming misconceptions in science and technical education. This effort will compare instructional techniques with physical objects in a laboratory setting and implementing the techniques via computer simulation. This effort will have direct applicability to the Navy's goal to fully utilize computer technologies to support advanced distance and distributed learning.
- (U) Continue work on effective feedback in dynamic task Artificial Intelligence (AI) tutoring. This effort will explore the comparative strategies of learners with different types of feedback (such as hints and questions) to discover what types are most beneficial in aiding student performance.
- (U) Continue study of instructional impact of personified pedagogical agents. This effort will explore these agents as a means of helping students solve problems in complex problem-solving domains such as mathematics or some other form of problem-based learning.
- (U) Continue development of cognitive task analysis methods for subject matter experts. This effort will inform the development of models and frameworks for understanding complex warfighting tasks in dynamic environments and preparing suitable training, modeling, agents and simulations for Navy relevant domains.
- (U) Continue development of the Physics Tutor (electricity and magnetism).
- (U) Continue work in Computer Generated Forces (CGF) on the capability of CGFs to act as instructional agents for scenario generation and provide coaching and feedback. This work is leading toward more sophisticated and powerful instructional agents for applications in simulations for naval training, and is expected to enhance significantly the training value of these simulations.
- (U) Continue work in Computer Generated Forces (CGF) aimed to improve human cognitive and behavioral modeling techniques for CGFs in a distributed environment as simulated teammates and adversaries. This will increase the power and realism of simulated adversaries and teammates in simulation-based training, thereby offering more effective training.
- (U) Continue work in Computer Generated Forces (CGF) to develop enhanced modeling techniques for representing individual differences such as the effects of training in CGFs. This will increase the unpredictability of simulated adversaries in simulation-based training, thereby increasing the challenge and realism of the training.
- (U) Continue designing Advanced Learner Support Tools in Advanced Distance and Distributed Learning (ADDL).

- (U) Continue development of strategies for fostering continuous learning through on the job training (OJT).
- (U) Continue development of measures to link shared cognition with team performance. The goals for this effort include the implementation of measures for diagnosis of weaknesses related to shared cognition in teams and multi-team environments, the introduction of training strategies to foster shared cognition in teams and multi-team environments, and the development of guidelines for making team staffing decisions in warfighting and operational environments.
- (U) Continue program on Intelligent Agents for Objective-Based Training. Intelligent agents as tutors, mentors, and aides to learning in computer-based training efforts have the potential for reducing costs, speeding acquisition of skills and knowledge in complex, technical and scientific fields.
- (U) Continue program on Multi-media Visualization Training Techniques.
- (U) Continue development of Maintenance Training Support Technology.
- (U) Continue creation of Algorithms for Generating Optimal Mentor-Prototype Pairings.
- (U) Continue development of Multi-media Visualization Training Techniques.
- (U) Continue study of On-Line Strategies for Collaborative Group Learning.
- (U) Continue assessment of the Training Value of Multi-media Technologies.
- (U) Continue investigation of the effects of ship motion on onboard Virtual Environment (VE) systems. Onboard training using VE systems can prepare students at sea, enhancing mission readiness. Ship motion can interfere and impede these systems, reducing the effectiveness of a valuable training tool.
- (U) Continue investigation of alternate visual and aural presentations for individual vehicle simulators.
- (U) Continue simulation of the interaction of spatially distributed individuals.
- (U) Continue work on simulation of human locomotion for use in Close Quarters Battle training.
- (U) Continue application of weapons handling for dismounted combatants in Virtual Environments (VE).
- (U) Continue work on Instructional Authoring Tools. This effort improves the abilities of instructor to produce pedagogically sound computer-based training tailored for military settings and training needs.
- (U) Continue development of multi-sensory, spatially distributed computer interfaces and assess impact on human learning and memory.
- (U) Continue development of methods for measuring realism in Virtual Environments (VEs) and determine the relationship between realism and training effectiveness of VEs.

- (U) Continue to address human computer interaction issues relevant to developing a Close Quarters Battle for Military Operations in Urban Terrain (CQB for MOUT) simulator.

Complete FY03

- (U) Complete development of Training and Performance Aiding Interactive Electronic Technical Manuals for Condition Based Maintenance (IETMs/CBM) Systems.
- (U) Complete application of Virtual Environments (VE) technology to the training of spatial behavior relevant to expeditionary forces vehicles, including the Landing Craft, Air Cushion (LCAC) and the Advanced Amphibious Assault Vehicle (AAAV).

- **(U)($7,048) Expeditionary Logistics**: Expeditionary Logistics addresses enabling capabilities covering surface distribution, and tactical logistics command and control (C2). Expeditionary Maneuver Warfare (EMW), seabasing, and other future naval concepts hinge on timely and responsive sustainment from the sea. Work areas encompass surface replenishment of the seabase from naval and commercial shipping, ship-to-ship material handling, internal seabase material handling, and ship to shore material distribution. Additionally, EMW will rely on managing available assets more wisely. Technology areas include improved tactical combat service support information and battlefield logistics sensor arrays that feed into logistics situational awareness

Initiate FY03

- (U) Initiate ship to shore transfer technology development to include propulsion, and drive mechanisms, cargo transfer and cargo stabilization technologies, and possible connector systems. Current ships to shore transfer is either bound by the draft limitations of the delivery craft, or are speed/distance limited. Operating over the horizon will stress current systems.
- (U) Initiate a Ground Log C2 decision support Course of Action tool, emphasizing development of a combat service support virtual sand table. A virtual sand table will allow operators to explore in a faster than real time environment different courses of action to support operational intent.

Continue FY03

– (U) Continue decision support technologies for Logistics Command and Control Course of Action generation. This investment will support the force deployment planning and execution at the tactical level, beginning with robust calculations for ground troop supportability estimates and tactical sustainment requirement determination.
– (U) Continue logistics modeling and simulation; focus on simulation engines and user interfaces, to assist in doctrinal functions of mission planning and execution. This will allow a faster than real time projection of logistics support at the tactical level, and provide logistics calculations algorithms to be employed in joint war-game.
– (U) Continue refining algorithms to incorporate captured use rates, improve source data quality, improve sustainment rate calculation, and establish stockage levels that are situationally dependent. This effort will provide a technology foundation to automate critical to battlefield information sharing through web-based tools.
– (U) Continue material handling technologies for Sea State 5 strike up/down applied to carriers and combatants, as well as logistics future platforms. Technology areas include horizontal/vertical movement systems, cargo securing systems, and automated marinized warehousing systems for shipboard use. Strike up/down technology insertion is critical for meeting the future manning objectives of combatant platforms.
– (U) Continue skin to skin material transfer technology investigation in the areas of fendering materials, at-sea ship securing systems, and alternative methods of refueling. Technology advances will enable greater interface between military and commercial shipping, and large/small military crafts.

Complete FY03

– (U) Complete development of annealing and similar algorithm optimization techniques for balancing large array logistics throughput equations. Employ these equations in systems such as Joint Warfare Simulation (JWARS) and the Naval Simulation System (NSS), increasing the logistics play and emphasizing the logistics impact in military wargaming.

- **(U)($2,039) Energy Conversion:** Energy conversion efforts address technology development to provide significant improvements in energetic material systems and subsystems in terms of performance, safety, reliability, and affordability, and to transition advanced technology to the Fleet for warfighter sustainment. Goals include:

advanced energetic materials for both warheads and propellants with both superior performance and acceptable insensitivity characteristics to reduce vulnerability to both personnel and platforms; and reliable simulation tools and diagnostics to (1) develop and design superior performance reduced vulnerability systems tailored to specific warfighter missions, (2) improve safety, and (3) reduce cost by enabling simulation aided design and condition-based monitoring capabilities. This work develops technologies for cost-effective design, performance assessment, and vulnerability assessment of enhanced performance, insensitive.

Initiate FY03

- (U) Begin to develop the capability to exploit metal water reactions to enhance delivered energy for underwater shaped charge applications. This has the potential to substantially increase the performance of these systems by utilizing replacing inert liners with those that can react with sea water.

Continue FY03

- (U) Evaluate advanced fuels for enhanced explosive and propellant applications. These are metal based fuels which offer the potential to significantly improve the performance of energetic materials by enhancing ignition times and rates of energy release.
- (U) Continue to develop the capability to tailor propellant performance to combustion characteristics. This will permit the a-priori optimization of propellant formulation design in order to tailor the safe operating regime of the propellant to the system requirements.
- (U) Continue to develop the capability to predict effects of ballistic modifiers on propellant performance parameters. This capability will permit the tailoring of the pressure-combustion rate of next generation propellants using current ballistic modifiers with the design criteria under development and thus eliminate many of the empiricisms currently inherent to the development process.
- (U) Continue to develop the capability to predict effects of energetic components on propellant burn rate parameters. This would permit the maximization of performance while simultaneously avoiding catastrophic propellant failure when new designs or design changes are implemented.

– (U) Continue to develop diagnostics to monitor response of energetic materials to external stimuli. These diagnostics are essential in the understanding of how mechanical energy is absorbed into an energetic material and if it will lead to detonation or will quench.

Complete FY03

– (U) Complete development and validate a laboratory scale diagnostic to accurately determine underwater explosive performance scaleable to large scale events. This capability would enable laboratory characterization of the small quantities of experimental explosives initially available without the need to invest significant time and resources into material scaleup.

- **(U)($21,165) Materials, Maintenance Reduction, and TOC reduction:** Materials, Maintenance Reduction, and TOC reduction efforts address significant improvements in terms of affordability, reliability and performance to transition advanced technology to the Fleet for warfighter sustainment. Goals include: advanced, lightweight materials and processes to reduce weight and cost; ultrareliable materials and sensors to reduce cost by enabling condition-based and zero maintenance capabilities; environmentally acceptable long-life coatings for aircraft and ships to improve the quality of life for sailors; advanced low cost welding and joining methods, and new low cost sensors. Turbine improvement efforts cover the Navy's share of the turbine engine component development efforts under the Department of Defense (DOD)/National Aeronautics and Space Administration (NASA) Industry Integrated High Performance Turbine Engine Technology (IHPTET) program, ensuring that Navy unique design and operational requirements are met. Also included are aircraft and ship electrical power generation and thermal management technologies. Airframe and ship corrosion efforts address an integrated approach for the control of the effects of external and internal corrosion. The work develops advanced cost effective prevention and life cycle management technologies. This is particularly significant to life extension for the aging fleet.

Initiate FY03

– (U) Initiate shipboard testing of upgraded seawater valves. This will provide the Navy with 40-year valves in seawater systems thereby eliminating valve replacement currently needed at 10 year intervals.

- (U) Initiate development of durable new materials for naval gas turbine engine hot sections. This work will provide improved performance, engine life, and reduced operating costs for naval aircraft engines.
- (U) Initiate development of novel thermal barrier coating technology for gas turbine engine hot section components. Thermal barrier coating reduces hot section metal temperature, thus prolonging engine life and permitting improved operational performance in naval engines.
- (U) Initiate development of ultralight, blast resistant structural materials for force protection. These materials will have applications in protecting ship hulls, command and control centers, Marine vehicles, personnel shelter walls, etc.
- (U) Evaluate joint behavior effects on materials for modular hybrid pier construction.
- (U) Assess non-destructive methods for aging piers and wharves. These methods will provide the Navy the capability to extend the life of the aging infrastructure thus avoiding immediate large construction and repair costs.

Continue FY03

- (U) Continue development of environmental barrier coatings for ceramics/composites to provide higher combustor operational temperatures and extended combustor life times for future naval gas turbine engines. This work is necessary to meet IHPTET Phase III goals and will transition into improved engines for future naval aircraft.
- (U) Continue cadmium replacement technology development. This will provide the Navy with an environmentally acceptable technology for preventing corrosion and hydrogen embrittlement in high strength steel components such as landing gear and wing boxes.
- (U) Continue corrosion prevention by applique technology development for aircraft. This will enable the Navy to save maintenance costs by employing easily replaceable stick-on coatings having both corrosion prevention and stealth properties.
- (U) Continue development of environmentally acceptable coatings for corrosion protection for nonmagnetic ship hulls. This will enable the Navy to select lower cost austenitic stainless steel as a non-magnetic hull material in preference to the higher cost titanium alloys.
- (U) Continue friction stir welding of steels effort to develop apparatus and processing routes for superior solid state welds in ship structures. This will provide Navy with technique that drastically reduces weld fume and distortion/enhances stealth and affordability in ship construction.

- (U) Continue development of innovative composites casting technology for ship shafts and seals. This will allow the Navy to fabricate extraordinarily long life seals for propulsion shafts on Navy ships, enhancing combat readiness and affordability/reducing maintenance.
- (U) Continue the development of compositions and processing for more affordable, higher performance ship steels such as HSLA 65. This will provide the Navy with ship steels of superior strength/toughness and affordability, and significant weight reduction.
- (U) Continue the development and evaluation of weld processing of stainless steel for more affordable superior performance welds. This will provide the Navy with welding technology to fabricate non-magnetic, stealthy ships.
- (U) Continue the development of improved welding consumables for superior strength (greater than 110 ksi)/toughness ship steels. This will provide the Navy with superior performance weld metal with minimized preheat for affordable construction of future ships.
- (U) Continue to assess applications of high force actuators for naval structures. These actuators will allow active control of structural vibrations reducing acoustic radiation from undersea vehicles, for example, in torpedo acoustic stealth applications.
- U7(U) Continue to develop multifunctional transducer materials. These composite piezoelectric materials can have their properties tailored to meet the requirements of a broad range of sonar systems ranging from submarine obstacle avoidance sonar through multi-line towed hydrophone arrays to UUV mounted mine hunting sonar.
- (U) Continue development of new thermal barrier technology using multiphase coatings for oxidation resistant molybdenum alloys, a likely candidate for the next generation of superalloys. These alloys will provide higher hot section operating temperatures for future naval gas turbine engines resulting in improved performance and decreased specific fuel consumption.
- (U) Continue development of oxidation resistant molybdenum alloys that are leading candidates for the next generation of superalloys. These materials will provide major enhancement in performance and fuel economy for gas turbines by providing higher hot section capability and more thermodynamic efficiency.
- (U) Continue the development of advanced carbon/carbon materials processes for missile heat shield applications for naval strategic missiles. This work will provide replacement for no-longer available materials and develop better, more affordable new heat shield materials.

- (U) Continue development of materials and processes for high temperature turbine disks. These materials/processes are needed to provide improved performance, durability and decreased operational cost in future naval gas turbine engines.
- (U) Continue development of higher temperature aluminum alloys. These materials will reduce weight and cost of components, now fabricated from titanium, in the front end of naval gas turbine engines.
- (U) Continue development of advanced composites and polymers with fire resistance for ship structures. Present day composite materials ignite easily generating thick and toxic fumes, therefore are not safe for man rated areas.
- (U) Continue the development of mechanics analysis for glass fabric composite structures for future naval topside structures. This will provide the Navy with guidance for the rational selection of material design allowables based on material damage.
- (U) Continue fiber optic sensor development for health monitoring of future naval structures. A distributed sensor system of this nature will allow lowering the maintenance cost by better scheduling inspections.
- (U) Continue ultrasonic imaging camera development for non-destructive evaluation (NDE) of naval materials and structures. This wide area imaging technique will lower the inspection time by 30% while enhancing its reliability of detection.
- (U) Continue investigations of a new nondestructive evaluation technique based on the thermographic imaging of structures exited ultrasonically. Preliminary results indicate it to be very sensitive for the detection of small cracks in naval structures.
- (U) Continue multi-laser-processing technology for the fabrication of ultra hard materials. This revolutionary new technology will allow us to reclaim old components back into service or produce new components with zero maintenance requirements.
- (U) Continue work on advanced smart wire for rapid aircraft maintenance. This will provide the Navy and Marine Corps the ability to rapidly diagnose defects in wiring and significantly reduce the time required for maintenance of complex wiring in aircraft and ships.
- (U) Continue to evaluate the feasibility of non-destructive evaluation (NDE) methods for in water ship shaft health monitoring. This will provide the Navy the ability to more efficiently schedule maintenance associated with dry docking procedures and improve readiness.
- (U) Continue to develop single coat corrosion control coatings for potable water ship tanks. This new coating will replace current fire and three coat systems thereby reducing coats.

- (U) Continue development of new wash-down processes for USMC vehicles using recyclable corrosion inhibitors. This will provide the Marine Corps with advanced corrosion control technology and contribute to life extension of vehicles such as the HUMVEE.
- (U) Continue to develop fighter/helo arc fault circuit breaker (AFCB) technology. This will provide the Navy and Marine Corps the capability to prevent electrical arcing in areas such as fuel tanks greatly enhancing safety of operation.
- (U) Continue to develop high force high strain actuators for structural applications and sonar transducers. These actuators will allow active control of structural vibrations reducing acoustic radiation from undersea vehicles, for example, in torpedo acoustic stealth applications, while the sonar transducers will allow reduction in device sizes by factors ranging from three to six in applications such as torpedo homing sonar and torpedo countermeasure decoys.
- (U) Continue evaluation of advanced transducer single crystal high strain materials. These materials will revolutionize essentially all Navy sonar devices by doubling bandwidths and increasing energy densities more than an order of magnitude.

Complete FY03

- (U) Complete land based tests of upgraded seawater valves. This will provide the Navy with 40-year valves in seawater systems, thereby eliminating valve replacement currently needed at 10-year intervals.
- (U) Incorporate bristle brush technology for paint and corrosion product removal into the NA 01-1A-509 aircraft corrosion controls Manual, April 2003. This will provide the Navy with the ability to spot-repair aircraft paint coatings without having to re-paint the whole aircraft, thereby reducing maintenance costs.
- (U) Complete stress corrosion tests on friction stir welded advanced amphibious assault vehicle (AAAV) aluminum alloy. This will enable the Marine Corps to select lower cost joining technologies for the AAAV which do not yield aluminum alloy microstructures susceptible to stress-corrosion cracking.
- (U) Complete development of ultra-light heat exchanger for the E-2C aircraft. A planned upgrade in the E-2C radar requires heat dissipation beyond that achievable with standard pin-on-fin heat exchangers. This program will provide that capability and obviate expensive aircraft structural changes.
- (U) Complete development of frequency agile polymers for application in laser eye protection. These new nonlinear optical limiter materials will protect our sailors and marines from ever changing laser threats.

- **(U)($16,833) Medical Technologies:** Medical Technologies improve warfighter safety and enhance personnel performance capabilities under adverse conditions, enhance diagnosis of medical emergencies and treatment of casualties, and prevent costly occupational injury and disease in hazardous environments. Requirements which support technology development in these areas include: improving warfighting capabilities through enhanced supply and long-term storage of pre-positioned medical supplies such as blood; providing better stress endurance/control for key personnel; and providing enhanced casualty care onboard amphibious casualty receiving ships.

Initiate FY03

– (U) Efforts begin to develop salivary tests for disease, toxin, allergen and agent exposure and to determine immunization status. Particular emphasis is placed on salivary tests to assess immune status to the anthrax vaccine.
– (U) Studies are initiated to develop methods for the non-invasive detection of bubbles in tissue and blood for improved diagnostics of decompression sickness. Current diagnosis of decompression sickness must rely on the presentation of outward symptoms that may not be manifest for several hours after the dive. The development of technology to detect nitrogen bubbles immediately after a dive will go a long way in identifying likely cases of decompression sickness and thus permitting treatment before major injury occurs.
– (U) Development is initiated of a treatment for decompression sickness using perfluorocarbon-based compounds. An initial study has shown that artificial blood substitutes which utilize perfluorocarbon molecules to transport oxygen can also increase nitrogen transport in the body and thus may provide a new treatment for preventing decompression sickness after diving.
– (U) Studies are initiated to evaluate the hibernation induction trigger for metabolic downregulation in hemorrhage. These studies will determine the potential value of the factor in the induction of torpor in non-hibernators.

Continue FY03

– (U) Continue to evaluate ways to protect hearing and balance through new protective systems. The research includes studies of new materials that reduce noise levels when applied to personal hearing protection as well as structural insulations. Additional work will continue to develop clinical strategies and interventions such as new drugs to protect and restore hearing and balance progress.

- (U) Research continues to assess the impact of thermal (i.e., heat and cold) stress on operational performance in Navy and Marine Corps personnel. These studies will lead to the formulation of strategies to mitigate the performance decrements induced by exposure to thermal extremes.
- (U) Research continues to develop prophylactic agents to prevent hyperbaric oxygen toxicity in Navy and Marine Corps divers breathing pure oxygen at depth. These efforts will also identify physiological changes that occur after acute and chronic exposure to hyperbaric oxygen in order to assess if repeated exposure to hyperbaric oxygen increases the probability of seizure activity or brain damage with subsequent exposures.
- (U) Evaluation continues on the impact of high pressures on lyophilization of red cells. By increasing ambient pressure, the movement of water out of red cells may be facilitated, thus improving the efficiency of freeze-drying and quality of the freeze-dried red cell.
- (U) Evaluation continues in models of hemorrhage combined with head trauma of arginine supplementation of hypertonic saline resuscitation fluid. By supplying arginine, the substrate for nitric oxide, it is believed that nitric oxide levels will increase and improve perfusion of the brain.
- (U) Studies continue on evaluation of melatonin in hemorrhagic shock. Melatonin is a readily available compound that was shown to prevent ischemic injury to the brain, and these studies will determine its full potential for treating head injury.
- (U) Efforts continue on extending the circulation time of the gas diffusion enhancer, trans-sodium crocetinate (TSC). TSC shows promise as an additive to resuscitation fluid, but currently it is excreted too rapidly to sustain tissue oxygenation for more than 20 minutes.
- (U) Explore effects of motion and acceleration and develop methods to predict and counteract the deleterious effects of low-to-high frequency acceleration (motion) in operational environments. Deleterious motion effects can range from extreme nausea to disorientation and have been identified as contributing factors in numerous fatal mishaps on ships and aircraft. Approaches to be studied include improved control surface and display design, optimal work-rest schedules, and diet and drug-based interventions.
- (U) Efforts continue in the investigation of the chemical properties of a hibernation factor. A factor isolated from hibernating squirrel serum has demonstrated the ability to protect cells from ischemic injury. The factor will be further characterized, cloned and tested in a small animal model of hemorrhage.

- (U) Efforts continue in the development of a hemoglobin substitute. Hemoglobin is the most effective oxygen carrier at present, but it is expensive to isolate and process; these studies will characterize oxygen-binding heme peptides (to be encapsulated in liposomes) that could be manufactured inexpensively.
- (U) The evaluation continues of the control of systemic inflammation by the cytokine, IL-11. This cytokine, which is approved for human use, has shown promise for preventing intestinal injury following severe hemorrhage.
- (U) Studies are ongoing on the effects of Federal Drug Agency (FDA)-approved resuscitation fluids on the inflammatory response. Fluids employed in standard of care resuscitation appear to potentiate systemic inflammation; this study will determine which of the currently employed fluids is least likely to promote inflammatory injury.
- (U) Continue to examine the short- and long-term effects of acute and chronic exposure to hypobaric (high altitude aircraft and aircraft operations training chambers) oxygen. Research will attempt to define the long-term risk to personnel and develop new approaches to training and operations that reduce risk of injury from oxygen toxicity.
- (U) Applied research continues to develop novel agents that prevent the neurological damage associated with decompression sickness in Navy divers. Decompression sickness remains a major medical problem in Navy divers.
- (U) Studies continue in the evaluation of the trauma applications of hand-held ultrasound diagnostic instruments in the field. The relative merits of two systems will be evaluated under field conditions with minimally trained operators to determine if these devices require further development.
- (U) The evaluation continues of malaria DNA vaccine gene sequences for protective efficacy. The optimal combination of oligomers for stimulating protective immunity is being determined based on protection tests in mice and monkeys.
- (U) Efforts are ongoing to develop a smart uniform to permit extended exposure to operational extreme conditions. Particular emphasis will be placed on the development of a diving ensemble that will protect divers while operating in environmental extreme (i.e., heat and cold) conditions.
- (U) Development continues of technologies for enhanced body protection against battlefield munitions. In particular, studies are being performed to assess the amount of blunt force trauma damage that is experienced using current and proposed chest protection devices.
- (U) Building on research into the underlying processes for cellular repair, efforts on the regeneration of auditory and vestibular hair cells in the inner ear are initiated. These efforts attempt to define the chemical changes in the cell during the damage process and develop target drug approaches that improve or imitate upon the body’s own damage repair.

- (U) Continue exploring accident trends aboard reduced-crewed and high performance vessels such as fast boats, smart ships and next generation aircraft carriers to determine new approaches to reduce injury through improved design of workstations, seats, and controls. This effort will include studies of musculo-skeletal injury and how fitness and strength affect injury potential.
- (U) Continue development of an improved aircrew protection suit for operational aircraft. The suits will be targeted to platforms. High performance aircraft operations will focus on extending g-force tolerance for operators. Helicopter operations will attempt to improve safe operations in extreme heat and cold. Continue work on a smart ensemble that assesses physiological status and integrates into aircraft control systems, to reduce risk associated with loss of situational awareness or consciousness.
- (U) Development is continued of a casualty management tool within Operational Maneuvers from the Sea (OMFTS) and special operations. This tool will facilitate optimal distribution of medical supplies far forward.
- (U) Evaluation continues of the effects of a colloidal fluid on brain injury. These studies will determine if a newly approved colloidal resuscitation fluid reduces brain damage following blunt trauma.
- (U) Evaluation continues of the effects of a hemoglobin red cell substitute on brain injury. These studies will determine if use of a newly developed soluble hemoglobin product will reduce brain damage following blunt trauma.
- (U) Studies continue to assess the energy status of various organs following resuscitation with standard crystalloids. Phosphorus nuclear magnetic resonance (NMR) will be used to determine adenosine triphosphate (ATP) levels in an animal model of hemorrhage following resuscitation, thus determining which fluid provides optimal resuscitation.
- (U) The investigation continues of carbohydrate adduct effects on penetration of the brain by pain drugs. If morphine can be modified to enter the brain more efficiently, less will be required to control acute pain in casualties and the casualty can remain conscious and functional.

Complete FY03

- (U) Studies to evaluate immunological function during harsh operational conditions are completed. Particular emphasis is placed on characterizing the changes in immunological factors that may predict susceptibility to viral or bacteriological immunological challenges.

- (U) Development of predictive measures for oxygen-induced seizures in the hope that a physiologically-based “early warning system” can be engineered to warn divers using hyperbaric oxygen of the impending likelihood of central nervous system seizures is completed.
- (U) The evaluation ends of trauma applications of hand-held ultrasound diagnostic instruments in the field. The relative merits of two systems under field conditions with minimally trained operators will be determined.
- (U) Efforts are completed that evaluate malaria DNA vaccine gene sequences for protective efficacy. The optimal combination of oligomers for stimulating protective immunity will be determined based on protection tests in mice and monkeys, and vaccine design will transition to the next stage of development.
- (U) The assessment of nasal ketamine to relieve acute pain is completed. The utility of this drug for controlling the pain of injury and facilitating self-transport of casualties will be determined.

• **(U)($2,548) Environmental Quality (EQ):** Environmental Quality (EQ) technologies enable sustained world-wide Navy operations, in compliance with all local, regional, national, and international laws, regulations and agreements. Technology development in this area supports the Chief of Naval Operations (CNO) prioritized Navy S&T requirements and leads to systems and processes that provide the Fleet with environmentally compliant forward presence, ashore and afloat. Specifically, this area supports requirements to minimize the curtailment of military operations due to ship, shore and aircraft compulsory compliance with national and international environmental regulations, and to sustain forces in a timely and environmentally compliant manner.

Initiate FY03

- (U) Initiate advanced far-term noise and air pollution emissions abatement technology for future Navy platforms to enable unrestricted operations and training while complying with environmental laws and regulations and to reduce costly back-fit scenarios.
- (U) Initiate advanced environmental protection sensor and system control technology for future Navy platforms to enable more efficient system operation and to decrease manpower requirements for monitoring, diagnostics and repair evolutions.

Continue FY03

- (U) Continue air and noise pollutant emissions control/treatment technologies for Navy platforms and assets. Air and noise emissions from existing aircraft do not meet local noise ordnances and air emission requirements and thus limit essential training at shore-based facilities. New technology will reduce or eliminate emissions to meet regulatory levels and ensure continued training and readiness.
- (U) Continue environmentally compliant marine coating test facility support for the field-testing of new, improved, non-toxic antifouling coatings and systems for ships and submarine hulls.
- (U) Continue automated underwater hull paint removal and application technology to eliminate hazardous waste discharges and enable continued in-water hull maintenance and repair operations in compliance with water quality regulations and avoid costly dry-docking.
- (U) Continue advanced ship wastewater bioreactor technology to optimize non-oily wastewater bioreactor efficiency and thus reduce size and weight, provide the capability for treating other liquid waste streams (oily) and to develop quick bioreactor start-up products (reduce start-up time by 50%).
- (U) Continue identification of biofouling/biocorrosion control mechanisms in order to gain a better understanding and knowledge of the processes at work and that will enable the development of new materials and technologies to control biofouling and biocorrosion in an environmentally benign manner.
- (U) Continue advanced development of environmentally compliant antifouling (AF) hull coatings for ships and submarines and compliant anticorrosion (AC) coatings for ship and submarine structures. New materials will be non-toxic while preventing hull fouling and vessel structure corrosion.
- (U) Continue advanced development of ship and submarine liquid, air, solid, emissions control technology in compliance with Uniform National Discharge Standards (UNDS) and Marine Pollution/International Maritime Organization (MARPOL/IMO). Pending discharge regulations will limit the ability of Navy ships to sail in restricted waters. New control technologies will enable the Fleet with unrestricted access to all water bodies in compliance with all regulations.
- (U) Continue advanced pollution prevention/waste treatment technologies for ship, submarines and shoreside applications. Pollution Prevention technologies will enable cost effective means for reducing hazardous waste and disposal, complying with regulations and meeting Executive Order (EO) goals.
- (U) Continue Navy ship ballast water exchange efficacy evaluation for non-indigenous species threat mitigation in order to validate the Navy’s current double ballast exchange policy.

- **(U)($1,985) Biocentric Technologies:** Biocentric technologies provide novel solutions for naval needs based upon the applications of biosensors, biomaterials, and bioprocesses. This program brings the power of modern biotechnology methods to bear on naval problems and reduces the technical risk associated with basic research advances by conducting demo-centric technology development programs. Topic areas include advanced sensors for force protection against weapons of mass destruction, novel methods for radar and acoustic signature reduction, chemical sensing in the marine environment for unexploded ordnance detection, green synthesis of energetic materials, and novel energy sources for chemical and biological sensors deployed in the littorals.

Initiate FY03

- (U) Initiate development of stochastic chemical sensors for naval applications to provide single molecule detection.
- (U) Initiate investigation of using compliant light-harvesting materials as energy sources in support of development of soldier/marine-wearable and deployable photovoltaic devices to be competitive with the use of primary batteries in future naval operations.

Continue FY03

- (U) Continue development of novel biosensors for explosives for underwater applications. These novel biosensor systems are expected to provide sensitive, selective, and rapid detection of explosive signatures (such as TNT), a capability that is currently lacking but is needed to provide real-time data for swift decision making.
- (U) Continue scale-up and optimize the yield of a green synthetic methodology for production of energetic materials using enzymes toward an environmentally acceptable production method for energetic materials without the use of hazardous reagents and generation of hazardous by-products.
- (U) Carry forward efforts directed toward using trinitrotoluene (TNT) and other explosives sensors as autonomous underwater vehicle payloads for detection of UXO.
- (U) Continue development of energy harvesting benthic fuel cells using bioelectrochemical mechanisms at the water-sediment interface. The goal is to use naturally occurring microbes to harvest low levels of power (~0.1 Watt) on a continuous basis.

- (U) Continue investigation of chemical sensing from autonomous underwater vehicles for Special Forces applications.

Complete FY03

- (U) Complete, within the Chemical Sensing in the Marine Environment Program, efforts on locating the source of chemical plumes in very shallow waters using sensors on autonomous underwater vehicles. The resulting field tests will demonstrate whether the onboard sensor systems possess the necessary sensitivity and speed to accurately locate UXO.
- (U) Complete, within the Chemical Sensing in the Marine Environment Program, efforts to characterize chemical plume structure in very shallow water regimes. Search strategies which have been optimized will be used onboard an AUV to trace chemical plume from UXO.

(U) PROGRAM CHANGE SUMMARY:

	FY 2001	FY 2002	FY 2003
FY 2002 President's Budget	**	71,294	
Adjustments from FY 2002 President's Budget			
Congressional Plus-Ups		37,510	
8123 Management Reform Initiative Reduction		-962	
FY 2003 President's Budget	**	107,842	68,852

**The Science and Technology Program Elements (PEs) were restructured in FY 2002. The work described in FY 2001 was funded in PEs 0602121N, 0602233N, and 0602234N.

(U) CHANGE SUMMARY EXPLANATION:

(U) Funding: Not applicable.
(U) Schedule: Not applicable.

BUDGET ACTIVITY: 2 PROGRAM ELEMENT: 0602236N
PROGRAM ELEMENT TITLE: Warfighter Sustainment Applied Research

(U) OTHER PROGRAM FUNDING SUMMARY:

(U) NAVY RELATED RDT&E:

(U) PE 0601152N In-House Laboratory Independent Research
(U) PE 0601153N Defense Research Sciences
(U) PE 0603236N Warfighter Sustainment Advanced Technology
(U) PE 0603721N Environmental Protection
(U) PE 0603724N Navy Energy Program (Adv)
(U) PE 0604561N SSN-21 Developments
(U) PE 0604703N Personnel, Training, Simulation, and Human Factors
(U) PE 0604771N Medical Development
(U) PE 0605152N Studies and Analysis Support - Navy
(U) PE 0708011N Industrial Preparedness

(U) NON-NAVY RELATED RDT&E:

(U) PE 0601102A Defense Research Sciences
(U) PE 0602105A Materials Technology
(U) PE 0602211A Aviation Technology
(U) PE 0602303A Missile Technology
(U) PE 0602601A Combat Vehicle and Automotive Technology
(U) PE 0602705A Electronics and Electronic Devices
(U) PE 0602709A Night Vision Technology
(U) PE 0602716A Human Factors Engineering Technology
(U) PE 0602785A Manpower, Personnel, and Training Technology
(U) PE 0602786A Warfighter Technology
(U) PE 0602787A Medical Technology
(U) PE 0603002A Medical Advanced Technology
(U) PE 0603003A Aviation Advanced Technology

(U) PE 0601102F Defense Research Sciences
(U) PE 0602102F Materials
(U) PE 0602202F Human Effectiveness Applied Research
(U) PE 0602203F Aerospace Propulsion
(U) PE 0602204F Aerospace Sensors
(U) PE 0602702F Command, Control and Communications
(U) PE 0603216F Advanced Propulsion and Power Technology
(U) PE 0601103D8Z University Research Initiatives
(U) PE 0603716D8Z Strategic Environmental Research Program
(U) PE 0602712E Materials and Electronics Technology
(U) PE 0603851D8Z Environmental Security Technical Certification Program

E. (U) SCHEDULE PROFILE: Not applicable.

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602270N
PROGRAM ELEMENT TITLE: Electronic Warfare Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE
Electronic Warfare Technology		
	24,398	*

*This PE was restructured in FY 2002. FY 2001 efforts are described in PEs 0602114N, 0602123N, 0602235N, and 0602271N.

Congressional Plus-ups: None

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 2
PROGRAM ELEMENT: 0602271N
PROGRAM ELEMENT TITLE: RF Systems Applied Research

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
RF Systems Applied Research	**	68,300	56,263	57,974	57,702	60,333	60,233	CONT.	CONT.

**The Science and Technology (S&T) Program Elements (PEs) were restructured in FY 2002. FY 2001 efforts were funded in PEs 0602232N, 0602233N, 0602234N, and 0602270N.

A (U)MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The Radio Frequency (RF) Systems Applied Research Program addresses technology deficiencies associated with naval platform needs for new capabilities in RF surveillance, RF electronic warfare, communications, navigation, RF solid state power amplifiers, vacuum electronics power amplifiers, and supporting RF electronics technologies. The program supports development of technologies to enable capabilities in missile defense, directed energy, platform protection (including electric warship), time critical strike, and information distribution. RF Systems Applied Research developments directly support the Department of Defense Joint Warfighter Plan and the Defense Technology Area Plans. Projects within this PE have attributes that focus on enhancing the affordability of warfighting systems. The program also provides for technology efforts of the Naval Fleet/Force Technology Innovation Office (NFFTIO) to maintain proactive connectivity and collaboration between Department of the Navy (DoN) S&T and Joint, Navy, and Marine Corps commands worldwide.

(U) Due to the number of efforts in the PE, the programs described are representative of the work included in the PE.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the APPLIED RESEARCH Budget Activity because it investigates technological advances with possible applications toward solution of specific Naval problems short of a major development effort.

B. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 2001 ACCOMPLISHMENTS:

- (U)($17,610) RF Surveillance Technology. Emphasizes non-optical advanced sensor and sensor processing systems for continuous high volume theater-wide air and surface surveillance, battle group surveillance, real time reconnaissance and ship defense. Major technology goals include long-range target detection, discrimination, target identification (ID) and fire control quality target tracking in adverse weather, background clutter and electronic countermeasure environments. Shipboard S-Band Digital Array Radar (DAR) technology investigations were conducted and included wideband (1.0 GHz–1.8 GHz) digital Transmit/Receive modules, array architectures and beam forming techniques. DAR is identified as a needed new long range sensor for theater air and missile defense operations by Program Exective Office (PEO) Theater Surface Combatants (TSC), PMS-426. Design efforts were conducted for the Electronically Steered Array (ESA) antenna for the AN/APY-6 Multi-Mode Air-Ground prototype radar. The ESA antenna is needed to extend the test bed radar system field of view and provide beam-on-demand and real time track-while-scan capabilities for time critical strike operations. The baseline AN/APY-6 Wideband Multi-Mode Air-to-Ground prototype radar installed in the Naval Air (Hairy Buffalo) P-3C test bed aircraft successfully demonstrated new capabilities for radar imaging of slow moving ground targets in both Fleet Battle Exercises and in North Atlantic Treaty Organization (NATO) Project Caesar. The AN/APY-6 is the first radar system configured for carrier based tactical aircraft to simultaneously perform multi-mode synthetic aperture and ground moving target operations from a single radar system. Laboratory performance assessment and operational utility evaluations of an 89 GHZ Passive Millimeter-Wave Imaging (PMMWI) Sensor for passive, all weather short range reconnaissance and surveillance operations were performed. The PMMWI sensor demonstrated significant capability gains over similar infrared sensing when operating in fog and clouds. PMMWI technology is being considered for transition to the Assistant Chief of Naval Operations for Naval Expeditionary Warfare. A fifty-four channel Silicon Carbide (SiC) transmitter and corresponding fifty-four channel digital receiver that operate over the E-2C radar Ultra High Frequency (UHF) operating band were developed. This effort provides the RF front-end efficient power generation needs of the UHF Electronically Scanned Array (UESA) to be used for an advanced Airborne Early Warning (AEW) radar applications on the E-2C AEW radar. The multi-channel SiC transmitter and digital receiver technologies are considered key enablers for the E-2C Radar Modernization Program (RMP). AEW Space Time Adaptive Processing (STAP) technologies to enable high performance radar operations in clutter and countermeasures typical of littoral operations were developed. This work permits correlation of measured circular array data and theoretical predictions to be made. STAP has the potential to significantly mitigate dynamic range limitations experienced by most fleet radar systems when operating in littoral/near land and electronic countermeasure environments. Development and performance assessment of littoral Small Craft Automatic Target

Recognition algorithms were conducted which are now being considered for transition to Naval Air Systems Command (NAVAIR), PMA-290 AN/APS-137 radar system improvement program. A system concept development and trade studies were conducted for an Affordable Ground Based Radar (AGBR) for US Marine Corps applications. (Future AGBR system development will be pursued under PE 0603271N in FY 2002 and beyond.) (FY 2001 accomplishments in this thrust were funded in PE 0602232N.)

- (U)($5,258) RF Electronic Warfare Technology. Emphasizes non-optical passive sensors and active and passive RF countermeasure systems including High Power Microwave (HPM) which exploit and counter a broad range of electromagnetic threats. Program focus is on maintaining near perfect real-time knowledge of the enemy; countering the threat of cruise missiles to deployed Naval forces; precision ID and location of threat emitters, and networking of electronic warfare sensors and systems. In FY 2001 new routines were developed in the Next Generation Specific Emitter Identification (SEI) and Signal Processing project with the evaluation and selection of a statistical clustering algorithm for pulse matching. SEI provides the capability to detect, locate, identify and track tactical emitters of interest to on-scene and theater commanders. Several different breadboard models were fabricated for the most promising designs under the Surgical Global Positioning System (GPS) Denial project that attempts to provide the U.S. military use of RF navigation information but denies hostile forces the use of the same information. The ANGUILA project develops technology to provide warfighters with near real time targeting of threat radars. All hardware and software was developed prior to FY 2002 live-fire testing. Work in the Digital Deception Technologies area that will provide the capability to generate realistic false target signatures against synthetic aperture, inverse synthetic aperture (ISAR) and high range resolution (HRR) radars was developed with the evaluation of various tradeoffs in tap circuit design. Assembly and testing of the Command and Control Warfare (C2W) net emulator was developed under the Electronic Attack (EA) for Coherent Complex Modern Emitters project that provides electromagnetic battlefield dominance through target denial, obscuration and signature alteration. The single card digitizer was laboratory and field tested as part of the RF electronic warfare (EW) Sensor Miniaturization project to provide small surface and land-based units with RF EW surveillance systems. The fuzzy resource manager was developed under the Network Centric Battleforce EW project that will develop an EW architecture that produces a self-adaptive force behavior. New algorithms for interference suppression were developed and demonstrated. Hardware for maximizing existing wavelets processing capability under the Wavelets technology area that is attempting to demonstrate emitter classification without jammer blanking was also demonstrated. The miniature SEI module was developed and tested for the SEI Miniaturization project which provides the capability to identify and track specific emitters based upon unique signal characteristics. (FY 2001 accomplishments in this thrust were funded in PE 0602270N.)

- (U)($8,959) RF Communications Technology. Addresses critical Navy communications technology deficiencies and needs that are not addressed by the commercial technology sector. The program emphasis is on reliable interoperable communications between U.S and coalition forces, at all levels of command, and rapid and reliable utilization of government and commercial telecommunications assets worldwide that are efficient and responsive to warfighting needs. To extend the dynamic range of receiving systems operating aboard ship and permit multiple ultra high frequency (UHF) users to coexist onboard the same surface platform, an effort on co-site interference mitigation was emphasized. Design trade and optimization studies to maximize performance of a high performance K/Ka band phased array was continued. This effort to permit naval surface and ground platforms to effectively communicate with beyond-line-of-sight forces by using the relay capabilities of the Wideband Gapfiller Satellite, MILSTAR and Commercial Satellite constellations was continued. The Ultra Small Aperture Terminal (USAT) K/Ka Band Phased Array is a limited capability being developed jointly with Defense Advanced Research Projects Agency (DARPA) and can be used aboard surface ships and moving ground vehicles. The Code Division Multiple Access High Data Rate satellite communications (SATCOM) network, which included the development and testing of a Very Small Aperture Terminal (VSAT) for use on Navy ships and other mobile ground-based platforms, was studied and validated. This effort focused on bi-directional networked connectivity among disadvantaged users. Codes Division Multiple Access technology to provide Low Probability of detection (LPD) access to a internet protocol network was designed. LPD access technology in the Extending the Littoral Battlespace advanced concept technology demonstrations (ACTD) was demonstrated, and the Joint Wireless Working Group, with membership from the Joint Services, DARPA and National Security Agency (NSA), was formed. Studies of multi-functional antenna designs for X/Ku-band and the development of Bandwidth Efficient Advanced Modulation (BEAM) technology were conducted. A turbo coding design for additive white Gaussian noise SATCOM channels was developed which provides a three to five-fold data throughput increase and is being targeted as an improvement for the ARC-210 radio. The design of a large aperture submarine antenna for K/Ka band was conducted and a compact, submarine-survivable 20 GHz receive array was successfully designed, fabricated, and tested. To enable interoperable UHF SATCOM communications with submarines below periscope depth, a concept for UHF demand-assigned multiple access (DAMA) was designed. To develop antennas that can significantly improve gain, bandwidth, beam pattern and polarization performance over current state-of-the art UHF and above antenna designs, the design study of buoyant cable advanced antenna technologies was conducted. The study of a Vertical Takeoff Unmanned Aerial Vehicle (UAV) communications payload capability to provide extended range for surveillance information gathering was conducted. This effort focused on directional antennas between two UAVs in order to relay high data rates. The study for an On-Hull Extremely Low Frequency (ELF) communications system antenna that will support the reception of ELF signals on submarines while submerged, without the operational restrictions associated with the current Buoyant Cable Antenna, was conducted. Algorithms and the design of a Littoral Mobile Wireless Networking effort focused on providing over-the-horizon reach in littoral and expeditionary warfare environments were developed. The adaptive, reconfigurable networking algorithms developed will allow for the seamless transfer of communications between Navy ships and Marine Corps forces ashore. (FY 2001 accomplishments in this thrust were funded in PE 0602232N.)

- (U)($2,385) RF Navigation Technology: Develops key navigation technologies for Naval Battle Groups, Aircraft, UAVs, Unmanned Underwater Vehicles (UUVs), Ships, Submarines and other Navy vehicles and platforms. This technical area applies leading-edge S&T to enhance GPS capabilities in order to make GPS more resistant to noise and jamming. This effort is also concerned with the coupling of GPS with inertial systems. This effort generally does not cover guided munitions, nor does it duplicate DARPA developments in Micro Electromechanical Systems (MEMS) devices. The development of anti-jam antennas to preserve GPS functions in a hostile jamming environment continued through three antenna efforts. The first, the Miniature-Controlled Radiation Pattern Antenna (M-CRPA) has sensitivity patterns that allow jamming signals originating from earth to be suppressed and allow clustered jammers that may dominate the GPS signal even at great distances off shore to be suppressed. This allows Navy aircraft to travel from carriers towards shore-based jammers and to not be markedly affected by them. This antenna has been fabricated and its angular response pattern measured and found to be acceptable. The second effort, Non-linear Array Antenna, achieves nulling of jammers and beaming towards desired signals through non-linear coupling algorithms. This work has application to scenarios in which there is a large number of jammers or the jammers have wide angular separation. This antenna would be particularly effective if a jamming-field approach was employed by enemy forces. Algorithms have been developed and circuit cells have been fabricated allowing cell/element coupling to be demonstrated. The third effort, High Dielectric Mini-Array, actively suppresses jammers by a null-steering approach and can result in low cost and small size antennas. The size feature will allow this antenna to be a quick-change-out for the existing omni antenna on a wide range of platforms, with a resulting very significant savings when the installation is performed on aircraft. A single frequency antenna has been fabricated and has demonstrated nulling depths of 35dB. The effort to reduce GPS vulnerability to jamming by integrating GPS with inertial navigation capabilities is part of this effort. This integration is being pursued at Raytheon (using a MEMS Inertial Measurement Unit (IMU) approach) and Litton Industries (using a Fiber Optics Gyro IMU approach). In such hybrid systems, reliance is placed upon the inertial subsystem during intense jamming and GPS during periods of non-jamming. The development addressed system architecture and security issues concerning the encryption aspects of system operation. The Geophysical Low Observable Bathymetric Enhancement (GLOBE) effort treats non-GPS approaches to navigation that utilize topographical features of land or undersea areas. Analyses performed in this effort quantified the level of positional accuracy that can be obtained in bathymetric sounding, as would be achieved from a submarine platform. These levels are considered to provide acceptable positional accuracy to SSN platforms. (FY 2001 accomplishments in this thrust were funded in PE 0602232N.)

- (U)($10,139) RF Solid State Power Amplifiers. Provides for the generation of Very High Frequency (VHF), UHF, Microwave (MW), and Millimeter Wave (MMW) power amplifiers for Navy all-weather radar, surveillance, reconnaissance, electronic attack, communications, and smart weapons systems. The technology developed cannot, for the most part, be obtained through Commercial-Off-the-Shelf (COTS) as a result of the simultaneous requirements placed on power, frequency, linearity, bandwidth, weight, and size. Silicon carbide (SiC) bipolar transistors, suitable for high RF pulsed power generation at UHF-L band frequencies, for application to naval airborne surveillance sytems were developed based upon Ft and Fmax predictions. The development of millimeter wave (MMW) AlGaN/GaN wide bandgap, high electron mobility transistors (HEMTs) for naval electronic warfare and surveillance system applications continued with the demonstration of 5W/mm at 26 GHz. This work is laying the foundation for expanded circuit work by DARPA and the Army where the focus is MMIC demonstrations. The development of multi-octave wide bandgap power amplifiers, that will enable highly versatile, multifunction systems with multiple simultaneous RF beams, demonstrated a doubling of the output power. No other agencies are sponsoring similar work. (FY 2001 accomplishments in this thrust were funded in PE 0602234N.)

- (U)($7,500) RF Vacuum Electronics Power Amplifiers. Provides for the development of MW, MMW, submillimeter wave power amplifiers for use in naval all-weather radar, surveillance, reconnaissance, EA, and communications weapons systems. The technology developed cannot, for the most part, be obtained through COTS as a result of the simultaneous requirements placed on power, frequency, bandwidth, weight, and size. Responding to strong interest from the Navy satellite community, the Vacuum Power Booster (VPB) effort was focused on the development of a highly efficient ultra-linear amplifier capable of handling the complex digital waveforms required to support network centric warfare. The objective is to demonstrate improved digital signal error performance using a vacuum power booster (VPB) amplifier designed using newly-developed digital optimization criteria. This will result in a several fold increase in power margin and provide the capability to handle the ten-fold increase in data-rates for data rates exceeding 1 Gbps. Ongoing efforts in industry to develop K_a-band Coupled Cavity Traveling Wave Tubes (CC-TWTs) for radar (PAC-3) and communications applications are adversely affected by limitations in available circuit design capabilities. In response, the extension of GATOR, a multi-dimensional, large-signal code, for coupled-cavity circuits, was emphasized. The experimental development of multiple beam klystrons (MBKs) requires a complete suite of three dimensional (3D) design codes. The development of a 3D electron gun collector code, MICHELLE, is ongoing and MAGY, a two dimensional (2D) large-signal code, was emphasized for application to klystrons. An updated version of CHRISTINE-1D was released to industry and the development of 2D/3D helix TWT design codes continued with the introduction of models to handle reflection at severs and internal matching elements. For computational simplicity, all current nonlinear circuit design codes operate in the frequency domain. Proper understanding of device physics relevant to amplification of the complex digital waveforms to be used in high data rate (HDR) communications will require the availability of codes operating in that time domain. To provide initial guidance to HDR TWT development, a methodology to incorporate the results of frequency-domain, nonlinear TWT simulation, using the improved version of CHRISTINE, into simplified time-domain models was demonstrated. The development of a true time-domain code for helix circuits will use 1D models. A W-band gyro-twystron (P_{pk} = 65 kW, bandwidth = 1.5 GHz) and a K_a-band gyro-TWT are under development. Reliable (> 10^5 hrs), high current density (>10 A/cm^2) cathodes will be required for the development of the multiple beam klystrons needed for reduced noise improvement of shipboard multi-function radars. Experimentation with noble metal-based scandate emitters has established the effectiveness of using rhenium to promote cathode life. (FY 2001 accomplishments in this thrust were funded in PE 0602234N.)

- (U)($13,064) Supporting Technologies. Provides for the radiation, reception, signal control and processing of VHF, UHF, MW, and MMW power for Navy all-weather radar, surveillance, reconnaissance, EA, communications, and smart weapons systems. The technology developed cannot, for the most part, be obtained through COTS as a result of the requirements placed on power, frequency, linearity, bandwidth, weight, and size. Indium phosphide (InP) devices and circuit architecture were developed for a 20 GHz Direct Digital Synthesizer(DDS) frequency source, with programmable integral modulation capabilities, for application to a new class of multifunction electronically scanned arrays. The approach and goals of the DDS are unique to the Navy. Alumimum Gallium Nitride (AlGaN) HEMTs with a 1.08 dB noise figure at 10 GHz were demonstrated to support the development of high dynamic range low noise amplifiers (LNAs) covering the 4-20 GHz range. The use of AlGaN will provide for a more compact LNA by eliminating the need for input protection diodes. The effort to develop a digitally programmable true-time delay (TTD) integrated circuit using ultra high-speed InP, to achieve sub-pico second levels needed for performing electronic scanning of arrays operating at microwave frequencies, continued with a demonstration of key circuit devices and elements. The objective of a monolithic integrated circuit that can be packaged into a DDS is unique to the Navy. Development of a high performance analog-to-digital converter (ADC) continued with the record demonstration of 20 GHz using a unique superconducting low-pass ADC that has application to a "software radio" style, digital receiver designed to reduce co-site interference. Development of compact tunable filters for multifunction system applications continued with the demonstration of a wideband filter that could be tuned over a 4X frequency range by use of a micro-electromechanical MEMS switched device. The 100 GHz low noise digital clock effort being developed to enhance system dynamic range continued with fabrication of the full custom packaging necessary for concept demonstration. The development of a MW frequency DDS capable of generation of very stable RF/microwave frequency sources for use in wide bandwidth communications, high-resolution radar and electronically scanned arrays continued with demonstration of a world record frequency of 4.56 GHz direct digital signal conversion. The development of ultra low noise, broad band, high linearity receiver amplifiers for multifunction systems applications continued with the demonstration of low noise receiver amplifiers that cover the 4-20 GHz range, with a noise figure below 1.5 dB over the full frequency range. Development of silicon-compatible 4 Gb/in^2 giant magneto-resistance (GMR) non-volatile memory technology to implement a hard-drive on a chip continued with the demonstrated control of vertical GMR devices. A 3.3V silicon-based power converter demonstrated 100 W/in^3 power density and 93% efficiency for application to avionics and communications systems. Supporting Technologies also provides a small effort in macro-electrical power conditioning and distribution. The development of SiC-based bipolar transistors and properties of interfacial nanostructures (PIN) diodes for application to motor-drive power conversion systems resulted in devices with a record current gain of 50 and blocking voltages over 1000 V. (FY 2001 accomplishments in this thrust were funded in PE 0602234N.)

- (U)($1,798) NFFTIO. The purpose of NFFTIO is to ensure the Fleet/Force (F/F) helps shape the DoN investment in S&T, develop teaming relationships to rapidly demonstrate and transition technology, support development of technology-based combat capability options for naval forces, and enable warfighting innovations based on technical and conceptual possibilities. This is accomplished through proactive connectivity and collaboration between DoN S&T and Joint, Navy, and Marine Corps commands worldwide. Projects executed by NFFTIO are used to accelerate the process of exploring good ideas and initiatives that originate in the Fleet/Force. Special emphasis is given to force protection and development of transformation capabilities that address situational awareness. The operational commands in Command, Control, Communications, Computers, Intelligence, Surveillance, & Reconnaissance (C4ISR) were supported. Specifically, support to develop the following systems was provided: Radiant Argon Hyperspectal Imaging; Collaborative Digital Target Folders (DTF); Environmental Analysis and Receiver Systems (EARS); and the Virtual Information Processing Agent Research (VIPAR). Provided support to the Fleet/Force in quality of service and quality of life initiatives to reduce maintenance frequency and manpower requirements. Projects included a Shipboard Quality of Life (QOL) electronic deck log system utilizing a wireless network and a Shipboard Non-tactical Automated Data Processing (SNAP) system for off-ship connectivity. Addressed F/F operational readiness and combat capability issues that were amenable to the demonstration and application of technology solutions. Accomplishments included a Remote

Water Craft (RWC) project for force protection and counter-drug applications, an Amphibian Suit for Navy Special Operations Forces, Submarine Platform Avoidance of Close Encounters (SPACE), and Air Warfare Training Technology Development (AWTTD). (FY 2001 accomplishments in this thrust were funded in PE 0602233N.)

(U) FY 2001 Congressional Plus-Ups:

(U)($1,448) Advanced Materials Innovative Communications Materials (Funded in PE 0602234N) The goal of this effort is to develop a special class of magnetic materials called barium ferrites which would have properties necessary for implementing advanced microwave circuits. These circuits are essential for making improvements in radar and communication systems, with components which are smaller in size, lower in volume, and more cheaply fabricated and assembled. To achieve the goal, methods for growing thin films of these barium ferrites on an appropriate substrate without altering their properties must be developed. It has been demonstrated that by careful design of the layering of the materials, the intrinsic magnetic properties could be achieved.

(U)($1,932) Innovative Communications Material (Funded in PE 0602234N). The goal of this effort is to develop materials processing procedures which are necessary for the large scale manufacturing of high density, non-volatile memory circuits, based on magnetic storage called Magnetic Random Access Memory. This technology is expected to provide an alternative source of memory components for computing, data storage, and portable communications. These memory components have no mechanical parts, unlike hard disk drives and CD drives, it is faster than any other type of computer memory, there will be much higher density memory, it is non-volatile, and it allows for orders of magnitude faster data transfer. Accomplishments include installation and operation of equipment for making nanoscale magnetic elements, the fabrication of test structures of nanometer dimension and the development of procedures and processes to optimize the properties of the magnetic memory devices.

(U)($1,938) Laser Welding and Cutting (Funded in PE 0603508N). The goal of this program is to provide for the qualification of the process, and products of the process, for laser fabricated structural shapes for Naval applications. All members of the project team are under contract and an overall project plan and schedule have been developed integrating the statements of work for all participants. Steel required for testing has been ordered. The structural testing matrix has been developed. Welding and testing fixtures have been built. The manufacturing system control architecture has been selected. The economic analysis has been initiated.

(U)($2,414) Nanoscale S&T Program (Sensor Research) (Funded in PE 0602234N). The goal of this effort is to develop new material structures which have novel properties when reduced in size to nanometer dimensions. Nanoscale electronic and magnetic devices have enormous potential for electronic functions, such as high speed computing, high data storage for computers and sensors, which are focus areas for the DoD. This effort has demonstrated that nanoscale magnetic devices exhibit enhanced magnetic properties for exploitation in magnetic logic and memory. Several new materials have been discovered which allow for novel new technology developments.

(U)($1,448) Program Increase (Materials, Electronics, and Computer Technology) (Funded in PE 0602234N). The goal of this program is to develop the materials processing technology for large scale fabrication of magnetic memory circuits, based on Giant Magnetoresistance effects in multi-layer materials. The large magnetoresistance effects in these materials are being incorporated in the design of high density memory components which can replace all forms of computer memory currently in use. A new device design and improvements in the processing technology which will be required for high density memory development were demonstrated.

(U)($3,865) Silicon Carbide Semiconductor Material (Funded in PE 0602234N). The goal of this effort is to identify and, to the extent possible, eliminate structural and electrical defects from SiC, and help discover and develop technologies for exploiting the properties of SiC in DoD related electronics. Accomplishments include the reduction in crystal defect densities in epitaxial SiC films by a factor 8, (1-> 0.12) by using porous SiC substrates, demonstration of n- and p-Si MOSFETs (8µm - 0.35µm) on SiC, AlSiC and AlN substrates that exhibited 35% increased performance with applied strain <0.05%/, development of methods to determine the transport and impurity concentrations in wide gap semiconductors without adjustable parameters, and experimental demonstration that the density of micropipes in SiC bulk crystals can be reduced to < 100/cm2 at a high growth rate by increasing the growth temperature.

(U)($9,659) UHF Electronically Scanned Array (UESA) Signal Processing Support (Funded in PE 0602232N). A performance specification was developed, a competitive procurement conducted and a contract to design, fabricate, integrate and evaluate an advanced UESA signal processor in the Mountaintop advanced radar technology testbed was conducted. Development of a UESA signal processor is planned for completion and delivery to the Navy in FY 2002.

2. (U) FY 2002 PLAN:

- (U) ($16,180) RF SURVEILLANCE SYSTEMS. Emphasizes technology developments in non-optical advanced sensor and sensor processing systems for continuous high volume theater-wide air and surface surveillance, battle group surveillance, real-time reconnaissance and ship defense. Major technology goals include long-range target detection, discrimination, target ID and fire control quality target tracking in adverse weather, background clutter and electronic countermeasure environments. Digital Array Radar technologies that include wideband digital beamforming techniques to enable rapid steering and precision control of multiple beams over multiple degrees of freedom in azimuth and elevation will be developed. Processing technologies to detect and track large doppler variations, generate and control environmentally-adaptive waveforms, and perform non-cooperative target identification (NCTR) will also be developed. Investigations into automated beam steering and aperture management technologies for the AN/APY-6 Electronically Steered Array to enable strike aircraft to simultaneously discriminate, detect, geo-locate/track and identify both stationary and slow moving ground targets without compromising full volume surveillance operations needed for continuous situational awarenesss will also be pursued. Horizon extension radar system technology investigations will be performed with emphasis on light weight, high power RF transmit/receive front-ends that are integral to multi-element electronically steered arrays and are deployable from surface combatants via tethered or powered elevated platform methods. Non-Cooperative Target Recognition techniques will be developed that include one dimensional high resolution signatures, coupled with multi-dimensional characteristics, such as two- and three-dimensional imaging combined with radar signal modulation and micro-doppler techniques. These technology areas have been identified as needed to address identified enabling capabilities for missile defense, time critical strike and platform protection. E-2C UESA with embedded L-Band Identification Friend or Foe (IFF) antennas will be developed. UESA with embedded/co-boresighted IFF will enable fleet units to perform real time Identification Friend or Foe at the same look angle of the radar system. The Current E-2C TRAC-A antenna IFF elements are one hundred eighty degrees off the radar boresight resulting in non-real time interrogation of radar targets. STAP techniques and algorithms will be developed to enable high performance E-2C radar operation in complex clutter and electronic countermeasure environments typical of those encountered in littoral operations. Shipboard digital array radar wideband RF transmit/receive technologies with emphasis on performance in the S-band (3.0 GHZ – 4.0 GHZ) frequency spectrum will be developed. This technology is identified in the Surface Navy Radar Roadmap as a critical system enabler for planned Theater Air and Missile Defense radar developments, and is also identified as a critical element in PEO-TSC, PMS-426’s high power S-band radar system development for application to future surface combatant platforms. Advanced algorithms will be developed to enable new AN/APY-6 wideband, multi-mode radar capabilities for the simultaneous detection, geo-location/track and identification of stationary and moving ground targets moving at velocities of less than three knots over the ground, and provide for ISAR detection, discrimination and identification of sea-going platforms ranging in size from small craft (<150ft) to large commercial and combatant platforms (>500ft).

- (U)($12,537) Electronic Warfare Technology. Supports those technologies that enable the development of affordable, effective and robust EW systems that will increase the operational effectiveness and survivability of U.S. Naval units. Emphasis is placed on non-optical passive sensors and active and passive RF countermeasure systems that exploit and counter a broad range of electromagnetic threats. Program focus is on maintaining near perfect real-time knowledge of the enemy; countering the threat of missiles to deployed Naval forces; and precision identification and location of threat emitters. Development in the Expeditionary EW Grid for Surface Unit project will provide for modification of the Advanced Reactive EW Simulation (ARES) code for application to surface unit defense against RF systems. This effort will enable offboard devices to be coupled with existing EA systems to deny surveillance, targeting and missile seeker radars the capability to acquire and track surface platforms. The Wideband EW Channelizer project will develop a 500 MHz Very Large Scale Integration (VLSI) single chip filter bank. This effort will enable the development of low cost, small size and low power channelizers for use in tactical applications such as unmanned aerial vehicles. The Advanced Countermeasures Technique Development project will develop coherent and non-coherent deception techniques that will support future EA testing against advanced threat seekers. The Hard Kill (HK)/EW Techniques Development project will develop and demonstrate EA techniques against frequency modulated continuous wave surveillance radars that will ultimately increase survivability of U.S. Naval units. The Electronic Support (ES) Detection of Low-Probability of Intercept (LPI) Periscope Detection Radar project will develop requirements, definitions and system design to enable U.S. naval units to approach, enter and operate in denied areas by detecting the presence of LPI threat systems. Optimization of the C2W/EA network and second field test will occur under the EA for the Coherent Complex Modern Emitters project that supports future testing of a heterogeneous EA network. The Network Centric Battle Force EW project will conduct testing of new multi-platform EA techniques and experiments that will assist in the formulation of coordinated EA defense strategies. Evaluation of Phase-Locked Loop (PLL) and synthesized local oscillator (LO) design for the miniature receiver will be conducted under the continuing RF EW Sensor Miniaturization project, that will ultimately expand the deployability of EW surveillance systems to small platforms. Investigation of output digital-to-analog converter processing requirements will continue under the Digital Deception Technologies project that increases platform survivability in the presence of advanced surveillance systems. The ANGUILA project will conduct light testing of the fully integrated system. The Next Generation SEI and Signal Processing program which aids in platform discrimination and identification will integrate the statistical clustering algorithm to SEI and the AN/UYX-4. EA Techniques to Counter Advanced Threats will develop and demonstrate advanced EA techniques to counter advanced RF-guided missiles that can be used in an anti-ship role. In FY02 work will be focused on coherent false target techniques versus anti-ship missiles (ASM) and time/amplitude/frequency modulated techniques evaluations.

- (U)($7,629) RF Communications Technology. Addresses critical Navy communications technology deficiencies and needs that are not addressed by the commercial technology sector. The program emphasis is on reliable interoperable communications between U.S and coalition forces at all levels of command, and rapid and reliable utilization of government and commercial telecommunications assets worldwide that are efficient and responsive to warfighting needs. A VHF/UHF L-Band Antenna design effort will be conducted to consolidate antennas from several bands into a single configuration, thereby reducing topside space requirements while maintaining electromagnetic compatibility for legacy and future communications equipment. This system includes a new class of low-observable maritime antennas. An X/Ku band antenna will be designed to provide improved Intelligence, Surveillance, and Reconnaissance (ISR) connectivity through the use of transmitting and receiving phased array antennas compatible with the shipboard environment. This antenna will also facilitate wideband communications to airborne relay assets via the Tactical Common Data Link to support beyond line-of-sight connectivity needed in network centric warfare. A multi-function digital receiver incorporating a superconductive front-end with a digital cross correlator for use in a Joint Tactical Radio compliant system will be developed. The hardware simplicity should result in cost savings and an increased number of simultaneous users. To achieve higher data rates and interference mitigation for the user, Bandwidth efficient advanced modulation Line-of-sight Technologies (BLT) that focus on advanced modulation, turbo coding designs and equalization for multipath mitigation over LOS channels will be developed. An optically-tunable microwave filter for multifunction antennas for out-of-band signal interference rejection and co-site interference mitigation will be developed. A Next Generation Buoyant Cable Antenna will be designed to provide submarines a multi-band buoyant cable antenna capable of supporting sufficient network connectivity for participation in network centric operations. Technologies to support a Naval Battleforce Network (NBN) will be investigated. Networking architectures to integrate line-of-sight wireless networks into the existing over-the-horizon (satellite-based) network will be developed. Reduction of current dependence on satellite connectivity and reduced latency for communications within the battle group, for both the joint planning and joint data networks, is important. An ELF submarine On-Hull Antenna design will be developed with improved noise mitigation performance. This will allow ELF operation when the submarine is operating at speed and depth. The Ultra Small Aperture Terminal (USAT) K/Ka Band Phased Array is a limited capability being developed, jointly with DARPA, and can be used aboard surface ships and moving ground vehicles. More capable K/Ka band phased arrays will be developed with the ultimate goal of addressing K/Ka/Q Band Phased array antenna technology needed for use on Naval surface/ground platforms. This effort will provide a means of connecting to the Wideband Gapfiller Satellite, MILSTAR and Commercial satellite constellations to support the beyond-line-of-sight connectivity needed in network centric warfare. Demonstrate co-site interference mitigation to enable dynamic range extension of receiving systems operating aboard ship. The effort will permit multiple UHF users to operate on the same surface platform.

- (U)($2,211) RF Navigation Technology. Develops key navigation technologies for Naval Battle Groups, Aircraft, UAVs, UUVs, Ships, Submarines and other Navy vehicles and platforms. This technical area applies leading-edge S&T to enhance GPS capabilities in order to make GPS more resistant to noise and jamming. This effort is also concerned with the coupling of GPS with inertial systems. This effort generally does not cover guided munitions nor does it duplicate DARPA developments in MEMS devices. Development of the Miniature-Controlled Radiation Pattern Antenna will continue with extensive testing and design refinement. Practical consideration for airframe installation will be treated to insure the designed-in features are realized in a stable manner and the antenna is immune to weather-related effects. The non-linear antenna concept will be carried to the RF stage and tested in a laboratory setting. The high dielectric antenna will be weatherized and field tested. Further design will be performed to extend the capability to both L1 and L2 GPS frequencies. The development of techniques to suppress jamming will continue with an effort emphasizing digital signal processing. Processing methods will be identified and their effectiveness will be assessed.

- (U)($3,500) RF Solid State Power Amplifiers. Provides for the generation of VHF, UHF, MW, and MMW power amplifiers for Navy all-weather radar, surveillance, reconnaissance, electronic attack, communications, and smart weapons systems. The technology developed cannot, for the most part, be obtained through COTS as a result of the simultaneous requirements placed on power, frequency, linearity, bandwidth, weight, and size. Development of silicon carbide bipolar transistors suitable for high RF pulsed power generation at UHF-L band frequencies will be continued with demonstration of transistors that will output 300 W (pulsed) at 425 MHz. AlGaN/GaN wide bandgap HEMTs will provide the basis for demonstration of a 10 W amplifier with 45% power added efficiency at 35 GHz. The design of ultra broadband (multi-octave) power amplifiers will be optimized for efficiency and packaged parts tested for application to highly versatile, multifunction systems with multiple simultaneous RF beams. No other agencies are sponsoring similar work.

- (U)($6,500) RF Vacuum Electronics Power Amplifiers. Provides for the development of MW, MMW, submillimeter wave power amplifiers for use in naval all-weather radar, surveillance, reconnaissance, EA, and communications weapons systems. The technology developed cannot, for the most part, be obtained through COTS as a result of the simultaneous requirements placed on power, frequency, bandwidth, weight, and size. An experimental high dynamic range (HDR) vacuum power booster will be designed and fabricated using current analog standards of linearity for use as a test vehicle to validate physics-based, time dependent codes and simplified communication-link models. This effort addresses the need for improved amplifier models and VPB designs that support the increased dynamic range, phase linearity, and bandwidth requirements associated with the multi-level, broadband digital signals needed in such systems as the Wideband Gapfiller and the improved AN/WSC-6 shipboard terminal. The development of 2D/3D CC-TWT design codes continues with the insertion of an improved alternating current (AC) space charge model in GATOR. The 1 dimensional (1D) large signal circuit design code will be used interactively with HDR VPB experiments to guide the development and validate the code. Following the development of 2D/3D CTLSS/CHRISTINE, this helix TWT design code will be released to industry for beta testing and validation. The 2D klystron design code for single-beam configurations will be tested and then extended to multiple beams beginning with the development of appropriate AC and direct current (DC) space charge models. These models will be inserted into the multiple beam version of MAGY. A K_a-band gyro-TWT will be developed using a ceramic loaded circuit to obtain a 3% bandwidth. Targeted performance is peak power of 140 kW, 50 dB gain, and an efficiency of 20%. Once the 60 kW W-Band gyro-twystron is fabricated and assembled 1.5% bandwidth will be demonstrated. Based on the success of the rhenium coating studies, the effort was extended to investigate the use of pulsed laser deposition to fabricate uniform, high current density scandate emitters.

- (U)($11,015) Supporting Technologies. Provides for the radiation, reception, signal control and processing of VHF, UHF, MW, and MMW power for Navy all-weather radar, surveillance, reconnaissance, EA, communications, and smart weapons systems. The technology developed cannot, for the most part, be obtained through COTS as a result of the requirements placed on power, frequency, linearity, bandwidth, weight, and size. A new class of >2:1 bandwidth active filters and linearizer circuits needed for use in high power microwave amplifier circuits to enable Navy systems to simultaneously operate over greater bandwidths, higher power and improved sensitivity will be developed. The materials and processing issues that contribute to the instability failure mechanisms of wide bandgap devices (SiC and GaN) at microwave frequencies will be initially determined. Results of this work will accelerate the insertion of wide bandgap technologies into DoD systems and will have collateral return in the area of power switching for applications such as the all-electric ship. High power (20W/channel) channelizers, small enough to be used behind a transmitter array face as power combiners in a multifunction system, will be developed. This effort is essential to multiple simultaneous signal transmission and is currently unavailable except in units ~4x the required size. A high power, wideband isolator technology will be developed by application of improved modeling and control of low frequency losses (<2 dB insertion) to a low power isolator with >15dB of isolation operating over the 4-20 GHz frequency range. Development of a DDS frequency source to 20 GHz with programmable integral modulation capabilities will be continued with demonstration of the scaling of Indium-Phosphide transistors and development of the supporting devices and circuits required in the DDS. The high performance analog-to-digital converters effort will continue with the development of bandpass designs to reduce the complexity, hardware parts count, and cost of receivers used in multifunction system arrays. The development of compact tunable filters will be continued with the demonstration of a 100 MHz filter that can be tuned anywhere in a 4 GHz band, in a package smaller than achieved to-date, to enable testbed demonstrations of software-selected digital reception. The 100 GHz low noise digital clock effort will continue by development of a phase locking subcircuit and demonstration of the expected ultra-low phase noise performance over both the short time scales, critical for accurately clocking digital circuits, and long time scales, required to accurately beam steer a 10 m^2 phased array. Development of robust, wide bandgap low noise amplifiers will continue with the integration of HEMTs to form high gain, low noise LNA circuits. Development of ultra low-noise, broadband, high linearity receiver amplifiers will continue with the demonstration of 4-20 GHz receiver amplifiers using an optimized Metamorphic HEMT structure, with increased linearity and dynamic range to further reduce intermodulation products. A SiC power converter using large BJT's with optimized design to realize Ion = 15A and VB=1200 for application to a 16-40 kW motor drive will be developed. A packaged MW Frequency DDS with integral modulator in integrated circuit form, for use in an electronically scanned array operating to 4.5 GHz, will be demonstrated. The effort to develop a digitally programmable true-time delay (TTD) integrated circuit will demonstrate a monolithic integrated circuit (IC) with low phase noise. Operation of a 4Gb/in^2 basic GMR non-volatile memory cell will be demonstrated and the technology will be transitioned to private industry.

(U)($1,988) NFFTIO. The purpose of NFFTIO is to ensure the F/F helps shape the DoN investment in S&T, develop teaming relationships to rapidly demonstrate and transition technology, support development of technology-based combat capability options for naval forces, and enable warfighting innovations based on technical and conceptual possibilities. This is accomplished through proactive connectivity and collaboration between DoN S&T and Joint, Navy, and Marine Corps commands worldwide. Projects executed by NFFTIO are used to accelerate the process of exploring good ideas and initiatives that originate in the F/F. Special emphasis will be given to force protection and development of transformation capabilities that address situational awareness and service/quality of life initiatives to reduce maintenance frequency and manpower requirements. Projects will include the development of a capability for the Tactical Exploitation of Side Scan Sonar and the continued development of the RWC for force protection and counter-drug applications.

- (U) FY 2002 Congressional Plus-Ups:

(U) ($4,262) Maritime Synthetic Range. This program will develop a synthetic virtual range at the Pacific Missile Range Facility (PMRF) to extend the PMRR's capability. Realistic world models will be used in conjunction with real time systems.

(U) ($991) Nanoscale Devices (Wide Bandgap Materials). This program will develop nanometer dimension electronic devices based on wide bandgap semiconductor materials which could be used as sources of high power, high frequency electromagnetic radiation for applications in radar and communication systems.

(U) ($1,487) Nanoscale Science and Technology Program. This program will perform applied research to advance the understanding and applications of magnetic, electronic and optical nanostructures leading to programmable logic, mass storage, non-volatile storage, and electromagnetic devices.

(U) Magnetic Random Access Memory (Appropriated in PE 0602234N ($991)). This program will perform applied research to develop technology for the magnetic random access memory with emphasis placed on growth optimization to enhance the signal-to-noise ratio in high density non-volatile memories.

(U) High Brightness Electron Source Program (Appropriated in PE 0602234N ($1,487)). This program will perform applied research to develop advanced cathodes for use in high power vacuum electronic devices and ultra-bright display devices.

(U) Microarray Technology (Appropriated in PE 0602234N ($3,470)). This program will perform applied research to develop microarray technology for Navy and Marine Corps needs.

(U) Silicon Carbide Semiconductor Material (Appropriated in PE 0602234N ($1,388)). This program will perform applied research to develop insulating SiC boules of high quality and larger than three inches in diameter.

(U) Thick Film Ferrite Magnetic Materials for Microwave Applications (Appropriated in PE 0602234N ($991)). This program will perform research in thick film ferrite magnetic materials for microwave applications for Navy and Marine Corps needs.

3. (U) FY 2003 PLAN:

- (U)($13,085) RF Surveillance Technology. Emphasizes technology developments in non-optical advanced sensor and sensor processing systems for continuous high volume theater-wide air and surface surveillance, battle group surveillance, real-time reconnaissance and ship defense. Major technology goals include long-range target detection, discrimination, target ID and fire control quality target tracking in adverse weather, background clutter and electronic countermeasure environments. Advanced adaptive radar exciter/waveform generator technologies will be developed for application to current and future radar systems to significantly improve operational performance in dense background clutter and complex electronic countermeasure environments. Development of the UESA with embedded L-Band IFF antennas will continue with emphasis placed on system compatibility to enable low risk cost effective integration into the E-2C Radar Modernization Program (RMP) system. Development and refinement of STAP techniques and algorithms for application to the E-2C RMP system will be continued with emphasis placed on improving the performance of electronically scanned circular arrays in the presence of directional jamming and complex clutter sources typical of those encountered in littoral operations. Initial laboratory and field evaluations of STAP processing and algorithms integrated with the E-2C RMP/UESA system will be conducted and performance metrics quantified. Shipboard Digital Array Radar (DAR) wideband digital beamforming technologies will be developed and preliminary performance evaluations in a high fidelity (multiple degrees of freedom) modeling and simulation environment will be conducted. S-band RF transmit/receive modules will be developed and electrical operating characterization and performance evaluations in a laboratory environment conducted. Performance metrics and operational characteristics will be incorporated into the PMS-426 Advanced S-band radar system specification. Horizon extension radar system investigations will be performed to include RF front-end design and definition of lift vehicle requirements and options. Elevated radar sensing is expected to provide extended range surveillance, target discrimination and detection capabilities against low flying targets out to three times current shipboard horizon limited range capabilities. Advanced algorithms for the AN/APY-6 wideband multi-mode radar will be developed with emphasis placed on processing technologies to improve image fidelity and provide real time high confidence recognition of both sea going targets and slow moving (<3Kts) ground targets in adverse clutter and countermeasure environments. A flyable brassboard of the AN/APY-6 electronically steered array test and evaluation system will be developed. This array will be the technological basis for follow on development of a Pod Configured ESA for time critical strike, surveillance, and targeting operations aboard Navy F/A-18 aircraft.

- (U)($12,469) Electronic Warfare Technology. Supports those technologies that enable the development of affordable, effective and robust EW systems that will increase the operational effectiveness and survivability of U.S. Naval units. Emphasis is placed on non-optical passive sensors and active and passive RF countermeasure systems that exploit and counter a broad range of electromagnetic threats. Program focus is on maintaining near perfect real-time knowledge of the enemy; countering the threat of missiles to deployed Naval forces; and precision identification and location of threat emitters. Technology development efforts will be conducted in the areas of Surface MMW Countermeasures and Autonomous EW CM/Sensors Network that will demonstrate the ability of a autonomous jammer to adapt itself to the dynamic environment and provide maximum protection against precision guided munitions. These will include antenna integration technology for decoy platforms, MMW target characterization for anti-ship missile defense and developing optimum network EA concepts for C2W. Analyses of EA grid constellations will be conducted for the Expeditionary EW Grid for Surface Unit project to assist scenario development. Evaluation of Monolithic Microwave Integrated Circuit (MMIC) receiver modules will continue under the RF EW Sensor Miniaturization project to provide optimum subsystem integration and performance. Fabrication of Application Specific Integrated Circuits (ASICs) will be performed under the Digital Deception Technologies project that provides real time alteration of operating parameters permitting rapid and adaptive shifting among different type of large targets. Analysis and optimization of hardware for the third field test and identification of concept performance and enabling technologies are planned for the EA for Coherent Complex Modern Emitters project that will protect surface vessels against modern and future anti-ship missile threats. The Wideband EW Channelizer project will continue by combining the on-chip filter bank and channel discrimination on a single chip with the goal of providing a 6U Virtual Memory Extension (VME) brassboard channelizer with a instantaneous operating bandwidth of 2GHz. The Advanced Countermeasures Technique Development project will continue with shore-based field testing of coherent countermeasures techniques that provide enabling technologies to counter advanced MMW, surface-to-air and air-to- air threats. The HK/EW Techniques Development project will continue with the development of a datalink to network EW systems in order to facilitate cooperative synchronized blinking jamming between platforms and to provide frequency set-on and spot width information to off-board active decoys to radiate noise techniques. This project provides layered EA concepts to increase capability against the launch platform and a stream of maneuvering anti-ship missiles having fixed or frequency agile capability. A proof of concept demonstration will be conducted under the Network Centric Battle Force EW project that will enable fleet assets to use coordinated EA techniques to achieve battle force defense. The Electronic Support (ES) Detection of LPI Periscope Detection Radar project will enable U.S. naval units to approach, enter and operate in denied areas by detecting the presence of LPI threat systems and will emphasize system fabrication and algorithm development. EA Techniques to Counter Advanced Threats will develop and demonstrate advanced EA techniques to counter advanced RF-guided missiles that can be used in an anti-ship role. In FY03 work will focus on synthetic sea clutter waveform effectiveness vs ASM seekers and coordinated coherent/non-coherent techniques.

- (U)($7,587) RF Frequency Communications Technology. Addresses critical Navy communications technology deficiencies and needs that are not addressed by the commercial technology sector. The program emphasis is on reliable interoperable communications between U.S and coalition forces at all levels of command, and rapid and reliable utilization of government and commercial telecommunications assets worldwide that are efficient and responsive to warfighting needs. The design and development of a prototype multi-band X/Ku band phased array antenna, that has multiple simultaneous transmit/receive beams, operates across both frequency bands and is compatible with shipboard environments (Electro-magnetic Compatibility (EMC) and Radio Frequency Interference (RFI)) and operations will be continued. This effort will provide significant improvements in connectivity for non-line-of-sight Intelligence, Surveillance and Reconnaissance (ISR) operations. Continuous and reliable network connectivity using satelite communications channels not previously accessible for such use by Naval surface combatants will also be provided. The Ultra Small Aperture Terminal (USAT) K/Ka Band Phased Array that can be used aboard surface ships and moving ground vehicles, and being developed jointly with DARPA, will be demonstrated on ground platforms. Development of a multi-function digital receiver, which uses a superconducting front-end with a digital cross-correlator with application to a Joint Tactical Radio compliant system, will be continued with emphasis placed on completing the receiver design. Development of bandwidth efficient advanced modulation line-of-sight technologies (BLT) will be continued with emphasis focused on the waveform design and preparing for a demonstration in FY 2004. The design of an optical tunable microwave filter for multifunction antennas will be developed and preparations made for a demonstration in FY 2004. Prototype of the Next Generation Buoyant Cable Antenna will be designed for demonstration of submarine connectivity at operational depth. The design of a Naval Battleforce Network (NBN) architecture to enable dispersed units to operate with connectivity comparable to line-of-sight units will be optimized.

- (U)($2,199) RF Navigation Technology. Develops key navigation technologies for Naval Battle Groups, Aircraft, UAVs, UUVs, Ships, Submarines and other Navy vehicles and platforms. This technical area applies leading-edge S&T to enhance GPS capabilities in order to make GPS more resistant to noise and jamming. This effort is also concerned with the coupling of GPS with inertial systems. This effort generally does not cover guided munitions, nor does it duplicate DARPA developments in MEMS devices. Development of the Miniature-Controlled Radiation Pattern Antenna (M-CRPA) will be continued with installation of the antenna on Navy airframes and the performance assessed under the actual conditions for which the antenna was designed. Development of the Non-linear array effort will continue with progression to an operational prototype capable of operating at RF frequencies and functioning successfully against a field of jammers in a simulated environment. The Geophysical Low Observable Bathymetric Enhancement (GLOBE) efforts are to be demonstrated to submarine forces. Development of digital signal processing routes shown to be effective will be implemented in one of several candidate GPS receivers. Field tests will determine the efficacy of these approaches and viability for network-wide incorporation.

- (U)($3,500) RF Solid State Power Amplifiers. Provides for the generation of VHF, UHF, MW, and MMW power amplifiers for Navy all-weather radar, surveillance, reconnaissance, electronic attack, communications, and smart weapons systems. The technology developed cannot, for the most part, be obtained through COTS as a result of the simultaneous requirements placed on power, frequency, linearity, bandwidth, weight, and size. GaN wide bandgap, high dynamic range, linear RF power amplifier for MW applications will be developed to increase the third-order intercept by 10 dB for multifunction systems applications. Wide bandgap psuedomorphic HEMTs with Indium incorporated in the channel region will be developed to improve the high frequency gain and amplifier efficiency for application to multifunction systems. If successful, this device type could be included in future phases of the DARPA Wide Bandgap Program. SiC bipolar transistors suitable for high RF pulsed power generation at UHF-L band frequencies will demonstrate a very high pulsed output power at 1.5 GHz.

- (U)($4,500) RF Vacuum Electronics Power Amplifiers. Provides for the development of MW, MMW, submillimeter wave power amplifiers for use in naval all-weather radar, surveillance, reconnaissance, EA, and communications weapons systems. The technology developed cannot, for the most part, be obtained through COTS as a result of the simultaneous requirements placed on power, frequency, bandwidth, weight, and size. High dynamic range vacuum power booster experiments will demonstrate improved digital signal error performance resulting in a two-fold increase in power margin and data rates in excess of 1 Gbps. 2D/3D CC-TWT design code development continues with the addition of a model to handle reflections at internal matching elements. The time dependent helix TWT design codes will be extended to 2D. The gyro-amplifier effort continues by extending the bandwidth of the K_a-band gyro-TWT to 2.5 GHz (~7%). The high brightness scandate emitter effort continues with emphasis on the optimization of top-layer scandate composition.

- (U)($10,946) Supporting Technologies. Provides for the radiation, reception, signal control and processing of VHF, UHF, MW, and MMW power for Navy all-weather radar, surveillance, reconnaissance, EA, communications, and smart weapons systems. The technology developed cannot, for the most part, be obtained through COTS as a result of the requirements placed on power, frequency, linearity, bandwidth, weight, and size. The development of a new class of >2:1 bandwidth active filters and linearizer circuits needed for use in high power microwave amplifier circuits will be continued with the development of digital and active filter hardware for demonstration of high linearity and dynamic range at microwave frequencies. The wide bandgap transistor reliability effort will be continued with insertion of the knowledge gained in FY 2002 into the device technology and subsequent testing to document the improvements in the stability and lifetime of next-generation SiC and GaN devices. The effort to develop high power channelizers will be continued by demonstrating the feasibility of meeting channelizer size and power requirements in a single filter, and development of a preliminary design for the channelizer. The development of high power, wide band, isolators will be continued by demonstrating increased power handling (up to 20 Watts), reduced losses (<1 dB), and size reduction to fit the 20 GHz array spacing. Development of a DDS frequency source to 20 GHz with programmable integral modulation capabilities will be continued with the demonstration of a design to achieve a world record for digitally generated frequency of at least 10 GHz. Development of a high performance ADC will continue with demonstration in simulation of the desired band pass characteristic along with the hardware design, fabrication, and test of critical components. Development of tunable compact filters will continue with a demonstration of 10x narrower band filters with acceptable size and insertion loss and design for a 7 bit assembly that is no larger than current 4 bit units. Development of 100 GHz low noise digital clock will continue by demonstrating fine control of the frequency and full phase noise testing of the complete unit will be performed at NIST. Monolithic wide bandgap low noise receiver amplifiers with increased survivability under RF drive, enhanced linearity, and high temperature operation will be developed. Within the SiC power converter effort BJT's and PiN diodes with Ion=25A and Vb=1200 will be fabricated and demonstrated for application to a 40-100 kW motor drive.

- (U)($1,977) NFFTIO. The purpose of NFFTIO is to ensure the F/F helps shape the DoN investment in S&T, develop teaming relationships to rapidly demonstrate and transition technology, support development of technology-based combat capability options for naval forces, and enable warfighting innovations based on technical and conceptual possibilities. This is accomplished through proactive connectivity and collaboration between DoN S&T and Joint, Navy, and Marine Corps commands worldwide. Projects executed by NFFTIO are used to accelerate the process of exploring good ideas and initiatives that originate in the F/F. Special emphasis will be given to force protection and development of transformation capabilities that address situational awareness. Technology developments to the F/F in high life cycle cost maintenance areas through the application of transitional technologies to reduce maintenance frequency and manpower requirements will be supported.

C. (U) PROGRAM CHANGE SUMMARY :

	FY 2001	FY 2002	FY 2003
(U) FY 2002 President's Budget	**	62,141	
(U) Adjustments from FY 02 PRESBUDG:			
Congressional Plus-ups		6,800	
Section 8123 Management Reform Initiative Reductions		-609	
FFRDC Reduction		-32	
(U) FY 2003 President's Budget Request:	**	68,300	56,263

**The Science and Technology PEs were restructured in FY 2002. FY 2001 efforts were funded in PEs 0602232N, 0602233N 0602234N, and 0602270N.

(U) PROGRAM CHANGE SUMMARY EXPLANATION:

(U) Schedule: Not applicable
(U) Technical: Not applicable

D. (U) OTHER PROGRAM FUNDING SUMMARY: The Navy's 6.1 program contributes to this effort.

(U) RELATED RDT&E:

(U) NAVY RELATED RDT&E:
(U) PE 0601153N (Defense Research Sciences)
(U) PE 0602114N (Power Projection Applied Research)
(U) PE 0602123N (Force Protection Applied Research))
(U) PE 0603271N (RF Systems Advanced Technology)

(U) PE 0603114N (Power Projection Advanced Technology)
(U) PE 0603123N (Force Protection Advanced Technology)

(U) NON NAVY RELATED RDT&E:
(U) PE 0601102A (Defense Research Sciences)
(U) PE 0601102F (Defense Research Sciences)
(U) PE 0602204F (Aerospace Sensors)
(U) PE 0602702F (Command, Control, and Communications)
(U) PE 0602782A (Command, Control and Communications Technology)
(U) PE 0602705A (Electronics and Electronic Devices)
(U) PE 0602303A (Missile Technology)
(U) PE 0602270A (Electronic Warfare Technology)
(U) PE 0603270A (EW Technology)
(U) PE 0603270F (Electronic Combat Technology)

E. (U) SCHEDULE PROFILE: Not applicable.

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: PE 0602314N

PROGRAM ELEMENT TITLE: Undersea Warfare Surveillance Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE
Undersea Warfare Surveillance Technology		
	41,754	*

*This PE was restructured in FY 2002. FY 2001 efforts are described in PE 0602747N.

Congressional Plus-up appropriated in this PE is described under the following restructured program element:

TITLE	PE NUMBER	FY 2001	FY 2002
Lithium Carbon Monoflouride Coin Cells For Battery Applications	0602747N	$ 871K	

R-1 Line Item 16

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 2 PROGRAM ELEMENT: PE 0602315N

PROGRAM ELEMENT TITLE: MCM, Mining & Special Warfare Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE
MCM, Mining & Special Warfare Technology		
	52,360	*

*This PE was restructured in FY 2002. FY 2001 efforts are described in PEs 0602747N and 0602782N.

Congressional Plus-ups: None

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 2 PROGRAM ELEMENT: PE 0602435N
PROGRAM ELEMENT TITLE: Ocean Warfighting Environment Applied Research

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
N/A	75,375	62,035	55,180	55,570	55,480	56,568	55,715	CONT.	CONT.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This Program Element (PE)-previously named Oceanographic and Atmospheric Technology - provides the unique, fundamental programmatic instrument by which basic research on the natural-environment is transformed into technology developments that provide new or enhanced warfare capabilities for the Battlespace Environment (BSE). Natural-environment and BSE are used interchangeably; each term is to be understood to potentially encompass aspects of the ocean, atmosphere, space, or land.

(U) This PE also provides technologies that form the natural-environment technical base on which all systems development and advanced technology depend. This PE contains the National Oceanographic Partnership Program (NOPP)(Title II, subtitle E, of Public Law 104-201) enacted into law for FY 1997. A major component of the program supports Organic Mine Countermeasures (MCM). The objectives of the PE are met through measuring, analyzing, modeling and simulating, and applying environmental factors affecting naval material and operations in the BSE.

(U) This PE provides for BSE technology developments that contribute to meeting top joint warfare capabilities established by the Joint Chiefs of Staff. Major efforts of this PE are devoted to (1) gaining real-time knowledge of the BSE, (2) determining the natural-environment needs of regional warfare, (3) providing the on-scene commander the capability to exploit the environment to tactical advantage, and (4) developing atmospheric research related to detection of sea-skimming missiles and strike warfare.

(U) This PE provides natural-environment applied research for all fleet operations and for current or emerging systems. Major developments are routinely transitioned to the Fleet Numerical Meteorology and Oceanographic Command where they are used to provide timely information about the natural environment for all fleet operations. This PE supports virtually all the Joint Mission Areas/Support Areas with primary emphasis on Joint Littoral Warfare and Joint Strike Warfare.

(U) Joint Littoral Warfare efforts address issues in undersea, surface, and air battlespace. Programs include ocean and atmospheric prediction for real-time description of the operational environment, shallow water acoustics and multiple-influence sensors for undersea surveillance and weapon systems, and influences of the natural environment on mine countermeasure (MCM) systems.

(U) Joint Strike Warfare efforts address issues in air battlespace dominance. Programs include influences of the natural environment on electromagnetic (EM)/electro-optic (EO) systems used in the targeting and detection of missile weapon systems as well as improvements in tactical information management about the BSE.

(U) These efforts support the Joint Warfare Strategy "Forward From the Sea." This program fully supports the Director of Defense Research and Engineering's Science and Technology Strategy and is coordinated with other DoD Components through the Defense Science and Technology Reliance process. Work in this PE is related to and fully coordinated with efforts in accordance with the ongoing Reliance joint planning process. There is close coordination with the US Air Force and US Army under the Reliance program in the Battlespace Environment categories of Lower Atmosphere, Ocean Environments, Space & Upper Atmosphere, and Terrestrial Environments.

(U) The Navy program includes projects that focus on, or have attributes that enhance, the affordability of warfighting systems.

(U) Due to the breadth of efforts included in this PE, the programs described in the Accomplishments and Plans sections are representative selections of the work included in this PE.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within APPLIED RESEARCH, Budget Activity, because it investigates technological advances with possible applications toward solution of specific Naval problems, short of a major development effort.

B. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 2001 ACCOMPLISHMENTS:

- (U)($8,335) BSE Sensors and Data: (This thrust encompasses efforts to develop new, or enhance existing, shipboard, in-situ, airborne, and spaceborne sensors and appropriate inversion techniques and data handling techniques to obtain/store/manage environmental data. Data on a variety of processes in the environment are essential for several reasons: the data can serve as input to computer prediction schemes; data can be used to provide characterizations of processes for use in other developments; and data can be used in testing/validating current understanding of ocean and atmospheric behavior.) Efforts were extended in: a Global Data Assimilation Experiment, advanced ocean wave prediction, development of a bioluminescence sensor, field data for physics-based models for hyperspectral imaging sensors, naval impact of natural environmental processes (especially in the littoral zone), and AUV sensors and technology for oceanography and mine countermeasures. Preliminary field tests of a new digital bioluminescence sensor were completed as well as completion of Phase I of testing the utility of synthetic aperture sonar for increased ranges.

- (U)($25,699) BSE Concept Enablers: (Concept enablers for the battlespace environment represent technology developments that are expected to provide revolutionary, enabling capabilities but require a long period of development. Generally, the concept enablers represent ideas of wide applicability for which the basic research has been accomplished with indications as to a high payoff to naval warfare interests.) Efforts were advanced aimed at providing naval battlespace awareness, precise time/time interval for precision location, geoclutter, the National Oceanographic Partnership Program, biosensor technology, SecNav/CNO Ocean Chairs, and collaborative efforts with the basic research programs. An effort was initiated in Air-Sea Interaction because of the importance of this area to both better ocean and atmospheric forecasts. An effort was also initiated on "capturing uncertainty" in environmental predictions. Environmental predictive models have reached a point of maturity where one can now deal with the role of incomplete or imperfect input data, the aim being to give the user a better idea as to reliability of predictions. A completed effort dealt with the dual-use radar and weather effort which demonstrated that tactical radars could be used to determine weather and also to reduce clutter in the tactical display that owes its origin to weather features. Completed FY98 Broad Agency Announcement NOPP projects, which represent partnership efforts between several federal agencies, state and local governments, universities, and industry; these NOPP projects encompassed several methodologies for ocean observing. Completed NOPP projects in the following technology development efforts: Operational Technique Development-Float Technology Development; Planning for a National Community Sediment Transport Model; A Renewal of the Ocean systems from chemical, Optical, and Physical Experiments (O_Scope) Program; Ocean Acoustic Observatory Federation; Completion and Field Demonstration of a Portable Coastal Observatory; Innovative Coastal-Ocean Observing Network, and Autonomous Profilers for Carbon-system and Biological

Observations. These NOPP efforts established important bases for future developments in the areas of research "observatories," a "commons" for ocean information (i.e., a community-wide linked "system" of resources, collaborations, and elements for ocean observing and predicting activities), as well as other critical areas of oceanography. A report to Congress on the National oceanographic Partnership Program was prepared and submitted in March 2001. An Ocean.US Office of NOPP was chartered in FY 2001 to serve as a central focal point in the development of a national, integrated, sustained ocean observing system. A report was prepared and submitted in response to the Office of Science and Technology on a "Strategic Vision for Achieving Sustainable Marine Resources Within the US EEZ."

- (U)($13,277) Ocean and Atmospheric Modeling/Prediction and Effects: (The battlespace environment represents a critical factor in naval warfare and in any naval operation, often resulting in a "go" or "no-go" decision for any contemplated action. The extent to which this environment can be modeled through computational models, that can be used to then make predictions of characteristics of the environment, provides an important means by which naval forces can gain mastery over the environment and deny an adversary "home field" advantage.) Further developments were made with ocean model nowcast/forecast at a variety of scales (global, regional, semi-enclosed seas, local), including relocateable and nested models; a variety of scales are necessary because of the differing types of application in which differing resolutions arise. Nested models are needed to allow for a larger domain ocean model to set boundary conditions for a smaller domain model. Further developments occurred in advanced on-board ocean models where the aim is to maximize the on-board forecast capabilities available to the on-scene commander. Model testing/validation represent an on-going activity in this technology area, often with the joint participation of the Fleet Numerical Meteorological and Oceanographic Command (where models will ultimately be used by the Fleet for operational use). Coupled ocean/atmosphere models received further development to allow for more accurate ocean and atmospheric models. Nested atmospheric models (global, regional, local) and on-scene weather prediction received additional development. Efforts also advanced capabilities in prediction of atmospheric effects on electromagnetics/electro-optics because of the central importance of electromagnetic and electro-optic propagation to so many modern warfare systems. Construction of an end-to-end observation/analysis/prediction system for coastal aerosol and dust has become a recent focus of activities in atmospheric effects. A "rough evaporation duct" atmospheric field program was conducted to gain data on the atmospheric effects on electromagnetic/electro-optic propagation and for validating models.

- (U)($11,861) Naval Warfare System-Focused Efforts: (This program element is the only applied research program element dedicated to determination of the impact of the natural environment on naval warfare and naval operations. As such, many questions about the impact of the natural environment on either operational systems or on naval warfare systems under development and their performance become technical issues for this program element. Where feasible, joint field work was conducted with system developers to maximize the opportunity to focus on the question of impact of the environment on the system and performance prediction. The littoral zone has been the natural environment of greatest interest; aspects of this environment that greatly impact naval warfare are the generally shallow waters of the littoral zone, the consequent closeness and physical significance of the ocean bottom, and the complexities inherent to potentially rapid changes of the ocean structure as well as the ocean bottom.) In acoustic processing techniques experiments were conducted on the New Jersey Shelf to support inversions for seabed inhomogenities using chirp sonar; such inhomogenities may impact underwater acoustic waves used in mine countermeasures or anti-submarine warfare. Additional development occurred in remote sensing techniques, especially hyperspectral imaging technology, for the littoral zone because of their very promising potential to allow inference of littoral ocean characteristics and overcome the problem of "denied" waters.
- Several aspects of underwater acoustics received focused development because of their general importance to acoustic systems: for environmental impact on acoustics, measurements were performed through the ONR ASIAEX Experiment necessary to validate horizontal coherence models; for soliton internal wave packet predictions established and validated a method for simulating an acoustic field through an ocean model soliton realization for comparison to propagation through actual soliton data; and determination of internal wave/coastal front influences on acoustic propagation.

(U) FY 2001 Congressional Plus-Ups:

- (U)($9,660) Chemical, Optical and Physical Sensor Systems for MCM and other Applications: This effort was focused on the development of a variety of sensor systems that can be utilized on autonomous vehicle platforms, especially in littoral regions. Considerable advances have been made in demonstrating the utility of such sensor systems with some of the technology transitioned to higher category programs. The Navy has recently initiated a Future Naval Capability in Autonomous Operations which will benefit from advances achieved through this plus-up.

- (U)($2,899) Distributed Marine Environment Forecast System (DMEFS): DMEFS represents a technology area with the objective of performing marine environment forecasts through use of computational resources that exist on a variety of computer systems, located at different sites which may be either operational or research-oriented. Computational resources would include computer forecast models, computer software development, computer architecture, databases, and specialist and operational personnel. Technology efforts have advanced capabilities in this challenging area of technology whereby distributed marine environment forecast resources are "brought together" for the purpose of making marine forecasts for fleet operations.

- (U)($1,939) Littoral Acoustic Demonstration Center: Advances have been made in development of better strategies for monitoring underwater acoustic ambient noise with specific application to marine mammal identification and movement or tracking, unpredictability of shallow water acoustic propagation, statistical characterization of shallow water ambient noise, acoustic monitoring and mitigation techniques for marine mammals, and ocean measurement/experimentation.

- (U)($1,705) South Florida Ocean Measurement Center (SFOMC): The SFOMC represents a special resource in terms of a number of university partners with interests in marine vehicle research and a littoral ocean test range which has advantages for developing and demonstrating autonomous underwater vehicle technology. The SFOMC has been used to demonstrate technology development of use to on-going Navy programs, especially in the context of autonomous underwater vehicle technology and mine countermeasure technology.

2. (U) FY 2002 PLAN:

- (U)($7,453) BSE Sensors and Data: (A background description of the nature of the BSE Sensors and Data thrust is given under the FY01 ACCOMPLISHMENTS section. The goals of the thrust are expected to remain unchanged. However, consideration is routinely given to the basic research available in Sensors and Data to determine if new opportunities exist that can be exploited to rapidly advance toward the goals of the BSE Sensors and Data thrust.) Additional focus is given to the Global Data Assimilation Experiment, bioluminescence sensor, field data for physics-based models for hyperspectral imaging sensors, naval impact of natural environmental processes (especially for the littoral zone), and autonomous underwater vehicle sensors and technology for oceanography and mine countermeasures. A completion that occurs is the advanced ocean wave prediction development which improves the predictive capability of wave prediction in the littoral region and establishes a mechanism by which other developments in wave prediction can easily transition to the fleet.

• (U)($20,057) BSE Concept Enablers: (A background description of the nature of this thrust is given under the FY01 ACCOMPLISHMENTS section. The goals of the BSE Concept Enablers thrust are expected to remain unchanged. However, consideration is routinely given to the goals to ensure that they are adequate for the presumed naval warfare needs as reflected in higher level Navy Science and Technology strategy. This particular thrust is most sensitive to opportunities as represented by breakthroughs in the basic research domain which may represent new opportunities for achieving goals of the BSE Concept Enablers thrust.) Efforts are advanced aimed at providing naval battlespace awareness, precise time/time interval for precision location, geoclutter, the National Oceanographic Partnership Program, SecNav/CNO Ocean Chairs, and collaborative efforts with basic research programs. The National Oceanographic Partnership Program solicits proposals for a FY2002 BAA for Ocean Biogeographical Information System (OBIS) (this is the outcome of an earlier decision by the Science Ministers of 29 countries to establish a Global Biodiversity Information Facility; NOPP and the Sloan Foundation seek through the BAA to capitalize here on an initial effort begun in FY 2000 in this topic). Further development occurs in air-sea interaction because of the importance of this area to better both ocean and atmospheric forecasts. Efforts further advance an effort on capturing uncertainty in environmental predictions as a means of giving the user an idea of the reliability of those predictions. The biosensor technology effort completes. The question of the impact of noise, as generated by naval activities, on marine mammals has become of increasing concern; consequently an effort is initiated to participate in a jointly conducted marine mammal program to focus on the effect of noise on marine mammals and to provide tools to detect and mitigate effects. In the National Oceanographic Partnership Program, efforts begin in the following efforts: Real-Time Forecasting System of Winds, Waves, and Surge in Tropical Cyclones; PARADIGM: The Partnership for Advancing Interdisciplinary Global Modeling; and a Partnership for Modeling the Marine Environment of Puget Sound, Washington.

• (U)($12,057) Ocean and Atmospheric Modeling/Prediction and Effects: (A background description of the nature of this thrust is given under the FY01 ACCOMPLISHMENTS section. The goals of the Ocean and Atmospheric Modeling/Prediction and Effects thrust are not expected to change. However, consideration is routinely given to the nature of developments in Ocean and Atmospheric Modeling/Prediction and Effects to ensure that that the technical efforts take appropriate measure of developments in basic research and represent the most effective means of achieving progress toward the goals of the Ocean and Atmospheric Modeling/Prediction thrust.) Efforts continue in ocean model nowcast/forecast at a variety of scales (global, regional, semi-enclosed seas, local), including relocateable and nested models; a variety of scales are necessary because of the differing types of application in which differing resolutions arise. Nested models are needed to allow for a larger domain ocean model to set boundary conditions for a smaller domain model. Make additional developments in advanced on-board ocean models to maximize the on-board forecast capabilities available to the on-scene commander. Model testing/validation represent an on-going activity in this technology area, often with the joint participation of the Fleet Numerical Meteorological and Oceanographic Command (where models will ultimately be used by the Fleet for operational use). Coupled ocean/atmosphere models receive additional development based on past advances to allow for more accurate ocean and atmospheric models. Nested atmospheric models (global, regional, local) and on-scene weather prediction are advanced toward more efficient schemes for operational evaluation and use. Also progress is sought in development of atmospheric effects on electromagnetics/electro-optics because of the central importance of electromagnetic and electro-optic propagation to so many modern warfare systems. Construction of an end-to-end observation/analysis/prediction system for coastal aerosol and dust has become and remains a recent focus of activities in atmospheric effects.

- (U)($10,722) Naval Warfare System-Focused Efforts: (A background description of the nature of this thrust is given under the FY01 ACCOMPLISHMENTS section. The goals of the Naval Warfare System-Focused Efforts thrust are expected to remain unchanged. However, continual evaluation is given to the state of naval warfare systems to ensure that technology development in the Naval Warfare System-Focused Efforts thrust reflects the optimum choices for greatest impact of the work on naval systems.) Efforts advance in 3-D geoacoustic predictions and inversion of chirp sonar data for seabed inhomogeneities through comparisons of geoacoustic inversion data with core measurements, mathematical transform methods, and high frequency bottom techniques. Further advances are pursued in remote sensing techniques, especially hyperspectral imaging technology, for the littoral zone because of their very promising potential to allow inference of littoral ocean characteristics and overcome the problem of "denied" waters. Several aspects of underwater acoustics receive additional development because of their general importance to acoustic systems: for environmental impact on acoustics, acquired acoustic data are used to determine the time-dependent array performance degradation; joint field experiments are performed with SACLANTCENTRE aimed at better characterization of soliton internal wave packets; and for determination of internal wave/coastal front influences on acoustic propagation, environmental reconstruction of large experimental areas (hundreds of meters horizontally) are completed and utilized.

(U) FY 2002 CONGRESSIONAL PLUS-UPS:

- (U)($991) Bioluminescence Truth Data and Signature Detection: Advances in basic research over several years on bioluminescence in the ocean have enabled the development of a fundamental understanding of the phenomena and the Navy operations that may be affected. Affordable, compact, efficient sensors that allow ease of deployment and permit the rapid measurement of bioluminescence in the ocean now seem feasible. The work supported by this plus-up aims to develop affordable, compact sensors: instruments for use on general survey ships or underwater vehicles for background bioluminescence data, instruments for use on autonomous platforms for application in mine warfare and anti-submarine warfare, instruments for use in Navy special warfare operations.

- (U)($991) Littoral Acoustic Demonstration Center: Advance development in the area of better strategies for monitoring underwater acoustic ambient noise with specific application to marine mammal identification and movement or tracking, unpredictability of shallow water acoustic propagation, statistical characterization of shallow water ambient noise, acoustic monitoring and mitigation techniques for marine mammals, and ocean measurement/experimentation.

- (U)($2,974) Multiple Intelligent Distributed Underwater Vehicles and Sensors: Underwater vehicle technology and sensor development has recently demonstrated many successes in applications to oceanography and mine countermeasures. Past development has basically focused on single-vehicle development and application. This plus-up focuses on the development of technology appropriate to the use of multiple intelligent distributed underwater vehicles and related sensor developments. Such vehicles must be endowed with the capability of making intelligent decisions about their operations, capable of communication with each other, and able to function in a network configuration for application to a variety of oceanographic applications. Tasks of interest span a broad spectrum of measurements to define the oceanographic state, including nature of the bottom topography and of the bioluminescence/chemical aspects of the ocean. Applications of interest are: measuring ocean conditions for input to ocean models for near real-time ocean nowcast/forecast; use of multiple intelligent vehicles in mine countermeasure operations; use of multiple intelligent vehicles in covert ocean survey operations to gain information about the ocean battlespace and deny an adversary "home-field" advantage.

- (U)($5,055) Oceanographic Sensors for MCM: Develop further capabilities in oceanographic sensor technology, and related platform technology (such as autonomous underwater vehicle technology) for application especially in littoral regions to mine countermeasures. The primary aim is to demonstrate capabilities through joint field work with other programs. The expectation is that further developments in this area will lead to additional transitions to higher category programs as well as to the recently initiated FNC in Autonomous Operations.

- (U)($1,735) South Florida Ocean Measurement Center: Utilize the capabilities offered by the components of the South Florida Ocean Measurement Center (a consortium of universities and agencies with oceanographic expertise) to join with applied naval development efforts to further advance underwater vehicle technology and its application to naval warfare problems.

`

3. (U) FY 2003 PLAN:

- (U)($8,501) BSE Sensors and Data: (A background description of the nature of this thrust is given under the FY01 ACCOMPLISHMENTS section. The goals of the BSE Sensors and Data thrust are expected to remain unchanged. However, consideration is routinely given to the nature of the technical efforts to ensure that they represent the most effective means of achieving progress. Developments in the BSE Sensors and Data thrust are of importance to littoral oceanography, mine countermeasures, and anti-submarine warfare. A main emphasis of work in this thrust remains the littoral ocean which continues to be seen as the primary battlespace of future conflicts.) Further developments are pursued in Global Ocean Data Assimilation Experiment, bioluminescence sensor, field data for physics-based models for hyperspectral imaging sensors, naval impact of natural environmental processes (especially for the littoral zone), and autonomous underwater vehicle sensors and technology for oceanography and mine countermeasures.

- (U)($22,084) BSE Concept Enablers: (A background description of the nature of this thrust is given under the FY01 ACCOMPLISHMENTS section. The goals of the BSE Concept Enablers thrust are expected to remain unchanged. However, continual evaluation is given to concept enabling technologies that emerge from basic or applied research and may lead to modifications of on-going efforts. The ever-recurring theme of the BSE Concept Enablers thrust is to advance technologies that offer the warfighter the greatest capabilities for gaining "advantage" over the natural environment to increase his warfighting ability.) Efforts further advance precise time/time interval for precision location, a capability of great importance in littoral regions which may contain numerous obstacles to passage.

Additional development is given to geoclutter, as a means of developing better insights into how the sub-sediment seafloor may contribute to acoustic clutter. Further emphasis is given to an effort on capturing uncertainty with the ultimate goal of providing the user of environmental predictions some idea as to the reliability of the predictions. Air-sea interaction measurements and theory receive additional development; efforts here are expected to have an impact on better ocean models and better atmospheric models as well as better understanding of how aerosols are injected into the lower atmosphere where they have a decisive influence on electromagnetic and electro-optic propagation. Further advances occur in the National Oceanographic Partnership Program (which now involves 14 governmental agencies) and the Ocean.US Office, SecNav/CNO Ocean Chairs, and collaborative efforts with the basic research program. Consideration will be given to the solicitation of additional NOPP projects to further advance toward an integrated ocean observing and prediction system.

- (U)($13,398) Ocean and Atmospheric Modeling/Prediction and Effects: (A background description of the nature of this thrust is given under the FY01 ACCOMPLISHMENTS section. The goals of the Ocean and Atmospheric Modeling/Prediction and Effects thrust are expected to remain unchanged. However, consideration is routinely given to basic research developments in this active technology area that are ready for incorporation in this applied research program. Critical new developments in computer technology, especially main frames computers, must be monitored for their potentially significant implications in terms of this thrust. Capabilites in this thrust area have rapidly matured over the past several years and similar maturation is expected to continue in future developments, all to the benefit of modeling/prediction needs for naval warfare. Therefore, the expectation is to achieve better decision capabilities relative to "go" or "no-go" decisions for contemplated actions; also expected is an improved means by which naval forces can gain mastery over the environment and deny an adversary "home field" advantage.) Further advances are sought in ocean model nowcast/forecast at a variety of scales (global, regional, semi-enclosed seas, local), including relocateable and nested models; a variety of scales are necessary because of the differing types of application in which differing resolutions arise. Nested models are needed to allow for a larger domain ocean model to set boundary conditions for a smaller domain model. Further development occurs in advanced on-board ocean models to maximize the on-board forecast capabilities available to the on-scene commander. Model testing/validation represent an on-going activity in this technology area, often with the joint participation of the Fleet Numerical Meteorological and Oceanographic Command (where models will ultimately be used by the Fleet for operational use). Coupled ocean/atmosphere models receive additional development to allow for more accurate ocean and atmospheric models. Nested atmospheric models (global, regional, local) and on-scene weather prediction are under continued development. Also further developments occur in atmospheric effects on electromagnetics and electro-optics because of the central importance of electromagnetic and electro-optic propagation to so many modern warfare systems. Construction of an end-to-end observation/analysis/prediction system for coastal aerosol and dust continues to be a recent focus of activities in atmospheric effects, primarily due to the significance of these components of the atmosphere (as demonstrated in the Persian Gulf conflict). Efforts also aim to build on recent successes of the application of atmospheric modeling demonstrated in the Persian Gulf conflict.

- (U)($11,197) Naval Warfare System-Focused Efforts: (A background description of the nature of this thrust is given under the FY01 ACCOMPLISHMENTS section. The goals of the Naval Warfare System-Focused Efforts thrust are expected to remain unchanged. However, consideration is routinely given to the nature of the thrust goals to ensure that the technical efforts represent the most effective means of achieving progress. The expectation is that joint field work with system developers maximizes the opportunity to focus on the question of environmental impact on the system and system performance predictability. The littoral zone remains the natural environment of greatest interest and continues to represent significant challenges in terms of environmental variability and role of the ocean bottom and sub-bottom.) Extensions are sought to 3-D geoacoustic prediction for "stochastic" inversions seeking improvements in speed and accuracy of inversion algorithms. Further development occurs in remote sensing techniques, especially hyperspectral imaging technology, for the littoral zone because of their very promising potential to allow inference of littoral ocean characteristics and overcome the problem of "denied" waters. Several aspects of underwater acoustics receive additional development because of their general importance to acoustic systems: for environmental impact on acoustics, models of horizontal acoustic coherence are validated through oceanographic reconstructions; for soliton internal wave packet predictions, the primitive equation soliton model is modified for the Yellow Sea and the capability is transitioned; for the internal wave/coastal front influences on acoustic propagation, acoustic focusing and the predictability of acoustic energy fluctuations are determined.

C. (U) PROGRAM CHANGE SUMMARY:

	FY 2001	FY 2002	FY 2003
(U) FY 2002 President’s Budget	76,363	50,738	0

(U) Adjustments from FY 02 PRESBUDG:

SBIR Reduction	-1,264		
Execution Adjustment	+276		
Congressional Plus-ups		+11,850	
Section 8123 Mgmt Reform Initiative		-553	
(U) FY 2003 President’s Budget Request:	75,375	62,035	55,180

(U) CHANGE SUMMARY EXPLANATION:

(U) Schedule: Not Applicable.
(U) Technical: Not Applicable.

D. (U) OTHER PROGRAM FUNDING SUMMARY: The Navy’s 6.1 program contributes strongly to this effort.

(U) NAVY RELATED RDT&E:
- (U) PE 0601153N (Defense Research Sciences)
- (U) PE 0602114N (Power Projection Applied Research)
- (U) PE 0602123N (Force Protection Applied Research)
- (U) PE 0602235N (Common Picture Applied Research)
- (U) PE 0602271N (RF Systems Applied Research)
- (U) PE 0602747N (Undersea Warfare Applied Research)
- (U) PE 0602782N (Mine and Expeditionary Warfare Applied Research)
- (U) PE 0603207N (Air/Ocean Tactical Applications)
- (U) PE 0603271N (RF Systems Advanced Technology)
- (U) PE 0603747N (Undersea Warfare Advanced Technology)
- (U) PE 0603782N (Mine & Expeditionary Warfare Advanced Technology)
- (U) PE 0604218N (Air/Ocean Equipment Engineering)

(U) NON NAVY RELATED RDT&E:
- (U) PE 0602601F (Space Technology)
- (U) PE 0602784A (Military Engineering Technology)
- (U) PE 0603410F (Space Systems Environmental Interactions Technology)

E. (U) SCHEDULE PROFILE: Not applicable.

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602633N
PROGRAM ELEMENT TITLE: Undersea Warfare Weaponry Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE
	Undersea Warfare Weaponry Technology	
	34,563	1,685

This PE was restructured in FY 2002. FY 2001 efforts are described in PEs 0602123N, and 0602747N.

Congressional Plus-ups appropriated in this PE are described under the following restructured program elements:

TITLE	PE NUMBER	FY 2001	FY 2002
Computational Engineering Design Design	0603123N	$3,862	$ 0
Undersea Warfare Microelectromechanical Systems (MEMS)	0602747N	$1,931	$ 0
SAUVIM	0602747N	$ 0	$1,685

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602747N

PROGRAM ELEMENT TITLE: Undersea Warfare Applied Research

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
	Undersea Warfare Applied Research								
	**	75,834	71,294	72,850	73,324	71,108	71,793	CONT.	CONT.

**The Science and Technology PEs were restructured in FY 2002. FY 2001 efforts were funded in PEs 0602314N, 0602315N, and 0602633N.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION:

(U) In countering the proliferation of quiet diesel submarines to third world countries and Russia’s continued investment in submarine technology, work within this Program Element (PE) provides an enabling capability for power projection and force sustainability. This approach protects the country’s capital investment in surveillance, submarine, surface ship and air Anti-Submarine Warfare (ASW) assets by exploring those high risk/high payoff technologies that promise to provide capabilities of exceptionally high military value in five to fifteen years. These technology options include research in the following areas:

- Improving reliable undersea target detection and tracking to enable on-command application of precision offensive military force. Programs include undersea sensors and arrays to provide robust shallow water surveillance and reconnaissance, and to detect undersea threats to the surface battleforce. This effort also includes Navy unique research and technology issues associated with creating a timely and intelligible tactical picture of the undersea battlespace.
- Dominating the undersea battlespace to enable timely execution of joint/combined operations and to ensure joint force sustainability. Programs include advanced sensors and arrays for both improved ASW surveillance and enhanced battleforce self-defense, ASW data fusion for better tactical control, and low frequency active sonar and rapidly deployable surveillance systems for covert/non-covert indication and warning.
- Improving reliable undersea target detection and tracking, thus enabling joint battleforce sustainability. Programs include the entire spectrum of technology development undertaken in support of the Littoral ASW (LASW) Future Naval Capability (FNC).

- Improving undersea weapons effectiveness while reducing overall costs through improvements to current systems as well as the development of new weapons concepts. The goal of Undersea Weaponry is to produce cost effective, quick reaction intelligent weapons incorporating broadband processing with battlegroup connectivity, intelligent countermeasures, hard kill torpedo defense, improved littoral operation, and weapon flexibility. Several Science and Technology (S&T) challenges must be addressed including cluttered operating environments, multi-path acoustic propagation, low/no doppler targets, detonation physics, high density power sources, and fusing/safety/arming mechanics. The technology developed under this project will be transitioned to the acquisition community for incorporation into existing platforms. These efforts support the Littoral ASW and Platform Protection FNCs.

(U) The Navy Science and Technology program includes projects that focus on or have attributes that enhance the affordability of warfighting systems.

(U) Due to the number of efforts in the PE, the programs described are representative of the work included in the PE.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is funded within the Applied Research Budget Activity because it investigates technological advances with possible applications toward solutions to specific Naval problems, short of an advanced development effort.

B. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 2001 ACCOMPLISHMENTS:

- (U)($10,087) <u>Wide Area Surveillance</u>:

<u>INITIATED</u>:
(U) Development of signal processing algorithms for active sonar systems that remove unwanted clutter produced by sound reflecting off the ocean surface and bottom, thereby improving the ability to detect weak echoes from submarines (Funded in PE 0602314N).
(U) New Kelp design based on HYDRA technology. KELP is a bottom-moored, ultra-light, buoyant vertical line array that employs a node concept that allows autonomous processing of threat signals and transmission of detection, classification, and localization (DCL) data. HYDRA is a bottom-mounted, ultra-light sparse barrier array employing autonomous signal processing and self-repairing features (Funded in PE 0602314N).

(U) Development of ultra low power electronics to support advanced remote sensing devices (Funded in PE 0602314N).
(U) Improved multi-static processing for air deployed impulsives using cepstrum analytic processing (Funded in PE 0602314N).
(U) Depth estimation techniques for coherent echo ranging in coherent surveillance systems (Funded in PE 0602314N).
(U) Assessment to evaluate the use of an acoustic intensity sensor as an active receiver (Funded in PE 0602314N).
(U) Implementation of Compact Deployable Multistatic Receiver (CDMR) Processing Laboratory (Funded in PE 0602314N).
(U) Development and demonstration of In-Buoy Signal Processing strings for CDMR (Funded in PE 0602314N).
(U) Development of advanced technology deployable planar array (Funded in PE 0602314N).
(U) Development of an enhanced acoustic sparker source for environmental and ASW applications including tank measurements (Funded in PE 0602314N).

CONTINUED:
(U) Development of acoustic signal processing Detection, Classification, and Localization techniques for autonomous undersea applications (Funded in PE 0602314N).
(U) Refurbishment and fabrication of T-Size X-Glider to demonstrate standoff ASW surveillance concept development and evaluation (Funded in PE 0602314N).
(U) Development of a family of ultra-lightweight, ultra-low power air-, surface ship- or submarine-deployable, Matched Field Tracking Arrays to be used for barrier (Hydra) or area (Kelp) surveillance or as organic off-board sensors for submarines (Funded in PE 0602314N).
(U) Development of improved off-board, acoustic multi-static source components, processing algorithms, and performance predictive tools (Funded in PE 0602314N).
(U) Multi-static ASW Capabilities Enhancement (MACE) multi-static processing development (Funded in PE 0602314N).
(U) At sea testing and data analysis for multi-static processing algorithm development (Funded in PE 0602314N).
(U) Transition of a suite of processing techniques to the Air Deployable Active Receiver project for use with undersea surveillance in-buoy processing (Funded in PE 0602314N).
(U) Development of Telesonar acoustic communications system for use with deployable, autonomous systems—Telesonar networks consist of modulators/demodulators (modems) used for communicating acoustic data among undersea sensing components. (Funded in PE 0602314N).

COMPLETED:

(U) Phase conjugation algorithm development and evaluation (Funded in PE 0602314N).
(U) Development of large aperture, bottom-mounted array/signal processing (Funded in PE 0602314N).
(U) Assessment and report on ASW performance of Hydra during RDS-3 (Rapidly Deployable Systems) experiment (Sep/Oct 2000) (Funded in PE 0602314N).
(U) Deployable Autonomous Distributed System (DADS) sensor/signal processing development for autonomous detection/classification of submarines using magnetic matched field processing (Funded in PE 0602314N).
(U) The development of a signal processing system for a new multistatic sonar system using air-deployed explosive sound sources and air-deployed sonobuoys based on an operational concept called “non-traditional scattering” of sound off of submarines (Funded in PE 0602314N).
(U) Assessment of initial sea test data using over-the-side multi-static sources. Detections were obtained at tactically significant ranges against a small submarine in a littoral environment. (Funded in PE 0602314N).
(U) Advanced compact multi-static Air Deployed Active Receiver with active & passive in-buoy signal processing design trade studies (Funded in PE 0602314N).

- (U)($30,796) Battlegroup ASW Defense:

INITIATED:
(U) Development of a suite of signal processing improvements for “coherent” active sonar systems, thereby improving the ability to detect, classify and locate small, slow moving submarines in shallow water environments (Funded in PE 0602314N).
(U) Development of structural magneto-restrictive materials for ruggedized acoustic transducer. The development of these materials will enable more rugged transducer designs thus extending the reliability and service life of acoustic transducers under explosive shock conditions. (Funded in PE 0602314N).
(U) Development of Lead Zirconate Titanate (PZT) materials for high field direct current (DC) biased operation to permit high power operation of acoustic transducers as means to double acoustic output (Funded in PE 0602314N).
(U) Design of Magnetostrictive Piezoelectric Transducer (MPT) for High Frequency (HF) broadband (2+ octave) use in the submarine conformal array program (Funded in PE 0602314N).
(U) Development of outboard power electronics for HF conformal array program requiring electronics coincident with the conformal array (Funded in 0602314N).
(U) Development of HF broadband panel projector array for HF conformal program utilizing feedback to maintain control over array behavior over a frequency range of 2+ octaves (Funded in PE 0602314N).
(U) Evaluate Fishline fiber optic sensor designs for submarine, surface ship & air deployed ASW arrays (This effort was reported previously under Cooperative ASW) (Funded in PE 0602314N).

(U) Demonstration of Environmentally Adaptive Sonar Technology (EAST) signal processing techniques in a Fleet operational effort (Funded in PE 0602314N).
(U) Design/integration of Ultra-Low Frequency (ULF) and Extremely Low Frequency (ELF) Electromagnetic (EM) sensors signal processing and environmental noise cancellation techniques for submarine detection onto the Vertical Take-off Unmanned Air Vehicle (VTUAV) (Funded in PE 0602314N).
(U) Sea tests of optical standoff sensor systems (Funded in PE 0602314N).

CONTINUED:
(U) Environmentally adaptive processing development for non-Gaussian background noise (Funded in PE 0602314N).
(U) Wideband transmit waveform investigations for reduced reverberation and improved detection (Funded in PE 0602314N).
(U) Development of Integrated Bow Conformal (IBC), Low Frequency Hull Array (LFHA), and Volumetric towed arrays (Funded in PE 0602314N).
(U) EAST: Development of technical approaches for automating the operational configuration of sonar systems in response to real-time analysis of the acoustic field and relevant (measured) environmental parameters to reduce operator workload, enable reduced manning, and improve performance in the littoral environments (Funded in PE 0602314N).
(U) Development of broadband hybrid transducer array for SSBN applications to replace the aging bathymetry transducer. (Funded in PE 0602314N).

COMPLETED:
(U) Development of signal processing methods that enable improved target localization estimates and differentiation between man-made and natural transient noises (Funded in PE 0602314N).
(U) Development of signal processing algorithms for submarine towed arrays that provide improved target localization estimates (Funded in PE 0602314N).
(U) Ultra-wide waveform target strength model-based measurements and modeling (Funded in PE 0602314N). Assessment of environmental and system factors on processing performance (Funded in PE 0602314N).
(U) Affordable towed array construction, demonstration and transition to Twinline Towed Array (TB-29) for SSNs (Funded in PE 0602314N).
(U) Development of a mid-frequency broadband panel projector utilizing active feedback for a towed acoustic source application with very small tow bodies (Funded in PE 0602314N).
(U) Development of low frequency, low profile cymbal transducers to be unobtrusively mounted on unmanned vehicles for mine-hunting applications (Funded in PE 0602314N).

(U) Evaluation of piezocomposites as broadband projector materials (Funded in PE 0602314N).
(U) Extremely Low Frequency Emissions (ELFE) technology through data analysis/final report of demonstrations and algorithm development (Funded in PE 0602314N).
(U) Development of a fully bistatic, broadband ocean surface scattering strength model and provided the model to the Navy Ocean and Atmospheric Master Library (OAML). Completed validation of multistatic active system performance models using experimental data. Completed fabrication of a threat submarine physical scale model. Completed validation of statistical models that characterize the non-gaussian (non-normal statistical distribution) properties of clutter for low frequency/mid frequency active sonar systems. Developed a simulation capability for forward scatter echo detection system concepts (Funded in PE 0602314N).
(U) Development of an interrogation system for a 96-channel optical array to be used for testing in a joint United States/United Kingdom (US/UK) program in FY 2002. Demonstrated a 30dB increase in response over previous coatings for a new polymer coated fiber sensor. Developed cross-frequency correlation and time-frequency filtering algorithms that reject false targets associated with surface shipping. Provided an improved surface shipping source spectra model to Space and Naval Warfare Systems Command (Funded in PE 0602314N).
(U) Demonstration of a preliminary application of Hidden Markov Models to identify/classify environmental clutter mechanisms encountered by active sonar systems. Hidden Markov Models are algorithms used to extract signals that are otherwise hidden by noise (Funded in PE 0602314N).

• (U) Cooperative ASW: The effort previously reported under this area (Cooperative ASW) is now included under Wide Area Surveillance (Funded in PE 0602314N).

• (U)($28,770) Neutralization:

INITIATED:
(U) Development of Stealth Torpedo Homing Concepts needed to demonstrate the operational utility of stealthy weapon sensors. The effort includes developing associated combat control algorithms needed for effective weapon employment as well as autonomous weapon guidance algorithms (Funded in PE 0602633N).
(U) Development of technologies to enable a Heavyweight torpedo and its host platform to be effectively employed as a fully linked on-board and off-board sensor system (Funded in PE 0602633N).

CONTINUED:

(U) Development of Undersea Weapon Design and Optimization (UWDO) tools using physics based models, computational techniques, and codes to optimize undersea weapon system designs with respect to cost and performance requirements (Funded in PE 0602633N).

(U) Development of broadband signal processing and intelligent torpedo control advancements (including waveforms, algorithms, etc.) that will dramatically improve single- and multi-ping detection, classification and localization of threat targets (Funded in PE 0602633N).

(U) Development of signal processing algorithms aimed at passively Detecting, Classifying and Localizing threat torpedoes and torpedo countermeasures for close-in waterborne/underwater threats and high-speed weapons (Funded in PE 0602633N).

(U) Development of Torpedo Noise Modeling and Control concepts that support development of long-range quiet weapons; including reduction of radiated noise of current and next generation torpedoes to minimize target alertment and classification of the launch platform (Funded in PE 0602633N).

(U) Development of concepts and design tools for undersea weaponry warhead fuzing, detonation processes and target interactions, and enhanced kill mechanisms. Development of these tools will permit the elimination of several iterations of empiricism's in the design and testing cycle with significant cost and time savings. Development of these advanced concepts will permit the development of enhanced performance torpedo warheads in reduced volumes (Funded in PE 0602633N).

(U) Development of active-passive vibration mount concepts to reduce weapon machinery vibration and noise radiation (Funded in PE 0602633N).

(U) Research on high power propulsion technologies and integrated hybrid power systems for advanced undersea weapons that reduce life-cycle costs, increase power and energy densities, and enhance stealth. Efforts include hybrid propulsion system modeling, high power rechargeable batteries, micro-turbines, and hydroreactive materials (Funded in PE 0602633N).

(U) Development of High-Speed Supercavitating torpedo vehicle control and homing sensor technologies. Continue conduct of experiments and tests on vehicle control concepts and homing sensors (Funded in PE 0602633N).

(U) Development of MicroElectroMechanical Systems (MEMs) Safing and Arming (S&A) technology (less Inertial Measurement Unit (IMU)) (Funded in PE 0602633N).

(U) Development of technologies to support connectivity between a torpedo and a fixed sensor. Includes: generation of a fire control quality track by the fixed sensor, communication between a torpedo at speed and a fixed sensor node, guidance of the torpedo by the fixed sensor in the face of countermeasures and evasive maneuvers by the target (Funded in PE 0602315N).

COMPLETED:

(U) Concept development of Feature Based Navigation and Mapping that offer underwater vehicle navigation methods that allow the potential of achieving bounded errors for long-duration missions and offering a method to avoid the need for acoustic beacons or surfacing for external position fixing and resets (Funded in PE 0602633N).
(U) Dual-mode warhead concept development for torpedo counterweapon(s) (Funded in PE 0602633N).

(U) FY2001 Congressional Plus-ups:

- (U) ($871) Lithium Carbon Monofluoride Coin Cells for Battery Application Technology Provides low toxicity electrolytes and safer, higher energy CFx cathode material than present lithium batteries. This battery technology could double the mission time of naval mines and surveillance systems over that provided by the use of existing lithium batteries. (Funded in PE 0602314N).
- (U) (1,931) Continued Undersea Warfare MEMS. This will permit reduction of size and cost of future torpedo S&A systems by up to 90%. (Funded in PE 0602633N).

2. (U) FY 2002 PLAN:

- (U)($13,206) Wide Area Surveillance:

INITIATE:
(U) Project to miniaturize DADS sensor/control nodes by a factor of 10 with equal or better performance for littoral applications
(U) Development of improved low frequency active source transducers to reduce their size and cost
(U) Compact multi-static Air Deployed Active Receiver with active and passive In Buoy Signal Processing—design Experimental Super Air Deployed Active Receiver at-sea data collection and demonstrate buoy based on FY01 design trade-off studies
(U) Performance evaluation of a new multistatic sonar system using air-deployed explosives and air-deployed sonobuoys based on an operational concept called “non-traditional scattering” of sound off of submarines

CONTINUE:
(U) Development of signal processing algorithms for active sonar systems that remove unwanted clutter produced by sound reflecting off the ocean surface and bottom, thereby improving the ability to detect weak echoes from submarines

(U) Development of a family of ultra-lightweight, ultra-low power air-, surface ship- or submarine-deployable, Matched Field Tracking Arrays to be used for barrier (Hydra) or area (Kelp) surveillance or as organic off-board sensors for submarines
(U) Development of ultra low power electronics to support advanced remote sensing devices
(U) At sea testing in support of algorithm development, source reliability, and system component demonstrations using multiple multi-static sources
(U) Development of improved off-board, acoustic multi-static source components, processing algorithms, and performance predictive tools
(U) Transition of a suite of signal processing techniques to the Super- Air Deployed Active Receiver undersea surveillance sonobuoy effort
(U) Assessment to evaluate the use of an acoustic Intensity sensor as an active receiver
(U) Development of an enhanced acoustic sparker source for environmental and ASW applications
(U) Implementation of CDMR Development laboratory to provide end-to-end development and test capability for the CDMR processing string
(U) Progressive development of the CDMR processing string through builds 2 and 3
(U) Telesonar acoustic communications system for deployable systems

<u>COMPLETE</u>:
(U) Development of acoustic signal processing detection, classification, and localization techniques for autonomous undersea applications
(U) Improved signal processing for multistatic sonar systems employing explosive sound sources based upon a signal processing method called “cepstrum-processing”
(U) Assessment and report on partial aperture Hydra acoustic ASW performance during Seaweb technical feasibility demonstrations in September 2001. Seaweb refers to collection of Telesonar modems.
(U) Design/integration of ULF/ELF EM submarine detection system mounted on VUAVs
(U) Demonstration of a full-scale X-Glider deployment gliding over a prescribed course
(U) Initial demonstration of multi-static processing
(U) Development of advanced technology deployable planar array. Complete investigation of technologies for packaging larger array apertures in expendable systems.
(U) Demonstration of first Build of CDMR In-Buoy processing String to demonstrate the initial reduction in required link bandwidth.

- (U)($40,390) <u>Battlegroup ASW Defense</u>:

INITIATE:

(U) Passive Acoustic array test-bed design and installation to support future passive sonar system designs
(U) Development, demonstration, and transition of signal processing algorithms designed to detect and classify acoustic signatures of threat submarines
(U) Planning for advanced Counter-Torpedo DCL (CTDCL) development for surface ship defense in complex salvo scenarios.
(U) Development of compact, broadband, high frequency cymbal arrays for conformal array applications that will provide greater than one octave transmit capability above 10 kHz for conformal array applications
(U) Evaluate Reduced Diameter towed arrays
(U) Pre-track fusion for shipboard coherent echo ranging systems
(U) Development of environmental adaptive track formation techniques for coherent echo ranging
(U) Assessment of Naval Sea Systems Command (NAVSEA) AN/WSQ-11( )/Tripwire design and performance documentation
(U) Assessment of Tripwire performance requirements in complex salvo and background acoustic scenarios
(U) Improvement of Tripwire system HF sensor acoustic signal loss for salvo data collection risk reduction
(U) Initiate research to design high frequency, high dynamic-range fiber optic acoustic arrays for the IBC system. Initiate research to develop the virtual sonar array concept for any hull-mounted sonar (e.g., submarine, autonomous underwater vehicle, torpedo).

CONTINUE:

(U) Development of a suite of signal processing improvements for “coherent” active sonar systems, thereby improving the ability to detect, classify and locate small, slow moving submarines in shallow water environments
(U) Development of IBC, and Volumetric towed arrays
(U) Development of outboard power electronics and controls for conformal arrays that are highly reliable and of a low profile design
(U) Development of structural magnetostrictive materials to enable more rugged acoustic transducer designs capable of explosive shock survivability and useable as structural members in innovative transducers.
(U) Development of PZT materials for high field DC biased operation to permit high power operation of acoustic transducers.
(U) Development of Fishline fiber optic sensor designs for submarine, surface ship & air deployed ASW arrays
(U) EAST: Development of technical approaches for automating the operational configuration of sonar systems in response to real-time analysis of the acoustic field and relevant (measured) environmental parameters to reduce operator workload, enable reduced manning, and improve performance in littoral environments.

(U) Demonstrate EAST signal processing techniques in a Fleet operational effort
(U) Improved multi-static processing for light weight sound system (LWSS) and air deployed impulsives
(U) Sea tests of optical standoff sensor systems
(U) Design/integration of ULF/ELF EM submarine detection system mounted on VTUAVs
(U) Collection measurement data in support of developing the forward scatter echo detection concept. Continue to develop threat target scattering databases using physical scale model submarines. Continue investigations into the application of time-reversal acoustic techniques applicable to active sonar systems.
(U) Determination of factors that limit the resolvability of individual noise sources by large aperture acoustic arrays in the littoral environments. Fabricate and test the response of long sections of polymer coated fibers
(U) Extension of Hidden Markov Model techniques to identify/classify submarine-like targets and additional environmental factors that produce scattering. Incorporate acoustic waveguide effects into the Hidden Markov Model algorithms.

COMPLETE:
(U) Transition of ultra-wide waveform target strength model-based measurements and modeling to related investigations
(U) Transition of environmentally adaptive processing development for non-Gaussian background noise
(U) Development of the MPT array for the HF conformal program that can deliver high power over a 2+ octave frequency band.
(U) Development of HF broadband panel projector array for the HF conformal array program with the capability of velocity control over the entire frequency band of operation
(U) Development of broadband hybrid transducer array for the SSBN program. Complete a demonstration on an SSBN test platform of this more reliable, modern replacement transducer array.
(U) Development and validation of bistatic, broadband boundary and volume scattering strength models. Complete development of physics-based active classification algorithms that extract specific signal components from a target echo.

• (U) Cooperative ASW: Efforts previously reported under this area (Cooperative ASW) are now included under Wide Area Surveillance

• (U)($22,238) Neutralization:

INITIATE:

(U) A Dual Use S&T (DUS&T) low noise integrated motor propulsor project entitled LAMPrEy (Low Acoustic signature Motor/Propulsor for Electrically powered undersea vehicles) to further enhance the Torpedo Stealth project.
(U) Development of an Active Noise Control technology that reduces vehicle shell vibration and noise radiation using Active Fiber Composite materials.
(U) Development of adaptive broadband processing algorithms that will dramatically improve single- and multi-ping detection, classification and localization of threat targets.
(U) Development of directed energy concept proof of principle for enhanced performance undersea warhead.

CONTINUE:
(U) Development of UWDO tools using physics based models, computational techniques, and codes to optimize undersea weapon system designs with respect to cost and performance requirements.
(U) Development of innovative adaptive broadband signal processing algorithms that will improve a torpedo's single ping detection, classification and localization performance. This initiative will leverage single processing advances made in the radar community.
(U) Development of signal processing algorithms aimed at Detecting, Classifying and Localizing threat torpedoes and torpedo countermeasures for close-in waterborne/underwater threats and high-speed weapons.
(U) Transition of counter-torpedo technologies to NAVSEA (PMS-415) Tripwire Torpedo Defense System (AN/WSQ-11).
(U) Research on high power propulsion technologies and integrated hybrid power systems for advanced undersea weapons that reduce life-cycle costs, increase power and energy densities, and enhance stealth. Efforts include models for hybrid propulsion systems, high power rechargeable batteries, micro-turbines, and hydroreactive materials.
(U) Development of concepts and design tools for enhanced kill mechanisms of Undersea Warheads. Development of these tools will permit the elimination of several iterations of empiricism's in the design and testing cycle with significant cost and time savings. Development of these advanced concepts will permit the development of enhanced performance torpedo warheads in reduced volumes.
(U) Development of Stealth Torpedo Homing Concepts needed to demonstrate the operational utility of stealthy weapon sensors. The effort includes developing combat control algorithms needed for effective weapon employment as well as autonomous weapon guidance algorithms.
(U) Development of technologies to enable a Heavyweight torpedo and a shooting platform to be effectively employed as a fully linked on-board and off-board sensor system.
(U) Development of active-passive mount technologies for reducing weapon machinery noise by conducting laboratory experiments and demonstrations.

(U) Development of High-Speed Supercavitating torpedo vehicle control and homing sensor. Continue to conduct experiments and tests on vehicle control concepts and homing sensors.
(U) Development of technologies to support connectivity between a torpedo and a fixed sensor. Includes: generation of a fire control quality track by the fixed sensor, communication between a torpedo at speed and a fixed sensor node, guidance of the torpedo by the fixed sensor in the face of countermeasures and evasive maneuvers by the target

<u>COMPLETE</u>:
(U) Development of torpedo noise modeling development and incorporate it into the UWDO design toolbox.
(U) Development of underwater explosive effects hydro code that provides computational methods to accurately evaluate the effects of damage resulting from underwater explosions.
(U) Development of MEMs S&A technology (less IMU). This capability permits reduction of size and cost of future torpedo S&A systems by up to 90%. Insertion of an IMU into the S&A permits the reduction of the safe standoff distance required for a quick reaction weapon without any own-ship safety compromise.

(U) FY2002 Congressional Plus-ups:
- (U) Semi-Autonomous Underwater Vehicle for Intervention Missions (SAUVIM): The objective of this project is to develop and demonstrate the control methodologies and algorithms necessary to perform complex tasks using a robotic arm attached to an underwater vehicle. The problem is enhanced by strong underwater currents, force feedback, object recognition, and object dimensioning. (Appropriated in PE 0602633N, $1,685)

3. (U) FY 2003 PLAN:

- (U)($16,418) <u>Wide Area Surveillance</u>:

<u>INITIATE</u>:
(U) Hydra adaptations for use as an off-board sensor for submarines
(U) Investigation of a new surveillance concept based on an underwater acoustic theory called “time-reversal echo ranging”
(U) Development of improvements for off-board multi-static source components to reduce cost and increase reliability

CONTINUE:
(U) Development of a family of ultra-lightweight, ultra-low power air-, surface ship- or submarine-deployable, Matched Field Tracking Arrays to be used for barrier (Hydra) or area (Kelp) surveillance or as organic off-board sensors for submarines
(U) Performance evaluation of a new multistatic sonar system using air-deployed explosives and air-deployed sonobuoys based on an operational concept called “non-traditional scattering” of sound off of submarines
(U) Development of ultra low power electronics to support advanced remote sensing devices
(U) Project to miniaturize DADS sensor/control nodes by a factor of 10 with equal or better performance for littoral applications
(U) Development of improved off-board, acoustic multi-static source components, processing algorithms, and performance predictive tools
(U) Development of low frequency active source transducers
(U) Sea tests of optical standoff sensor systems
(U) Telesonar acoustic communications system for deployable systems
(U) Assessment to evaluate the use of an acoustic Intensity sensor as an active receiver
(U) Design, fabrication and shakedown testing of Experimental Super Air Deployed Active Receiver
(U) Progressive development of the CDMR processing string through builds 3 and 4
(U) Telesonar acoustic communications system for deployable systems (This effort was reported previously under Cooperative ASW)

COMPLETE:
(U) Assessment and report on Hydra performance during RDS-4 (Rapidly Deployable Systems) testing scheduled for September 2002
(U) Transition of a suite of signal processing algorithms to Super Air Deployed Active Receiver undersea surveillance sonobuoy processing effort
(U) Analysis of FY 02 multi-static source sea-test data
(U) Demonstration of Build 2 of CDMR In-buoy processing string. Complete further reduction of link bandwidth over build 1.

- (U)($34,703) Battlegroup ASW Defense:

INITIATE:

(U) Improved techniques to distinguish submarine echoes from echoes produced by ocean bottom features using detailed surveys of the ocean bottom and its geologic properties
(U) Design of shipboard coherent sonar systems based on low probability of intercept waveform investigations
(U) Final design and subsequent fabrication of a partial HF conformal transducer array for concept demonstration. The design will be selected from candidate designs developed earlier in this program.
(U) Development of single crystal piezoelectric composite materials with the goal of adapting the materials to a viable transducer design capable of operating at a broad bandwidth and producing 5 times the power output over conventional piezoelectric materials.
(U) Research to optimize in-situ multi-static active sonar performance based on broadband, physics-based scattering models and environmental feedback algorithms
(U) Assembly and laboratory measurements of a large aperture virtual sonar array. Initiate research to determine the underwater channel capacity limits for high frequency acoustic communications in support of autonomous operations.
(U) Development of a geo-acoustic inversion capability for submarines that uses data from the submarine's passive towed array

CONTINUE:
(U) Passive acoustic array test-bed design and installation to support future passive sonar system designs
(U) Development, demonstration, and transition of signal processing algorithms designed to detect and classify acoustic signatures of threat submarines
(U) Testing of IBC, and Volumetric towed arrays
(U) Testing of Fishline fiber optic sensor designs for submarine, surface ship, and air deployed ASW arrays (This effort was reported previously under Cooperative ASW)
(U) Development of Reduced Diameter towed arrays
(U) Development of PZT materials (known as Galfenol) under high field DC biased operation as a means to improve high power performance and linearity under high power operation with at least double the power output of ordinary piezoelectric materials.
(U) Development of structural magnetostrictive materials for transducer applications requiring non-brittle components with the goal of producing a structurally strong and rugged magneto-active material for acoustic transducer applications
(U) Development of compact, high frequency cymbal transducer (a Class V flextensional transducer) for inclusion into a thin conformal array less than one-half inch thick

(U) Development of a suite of signal processing improvements for "coherent" active sonar systems, thereby improving the ability to detect, classify and locate small, slow moving submarines in shallow water environments
(U) Development of a new torpedo defense system for surface ships, including performance assessment, data collection, data analysis, and algorithm development
(U) EAST: Development of technical approaches for automating the operational configuration of sonar systems in response to real-time analysis of the acoustic field and relevant (measured) environmental parameter
(U) Demonstration of EAST signal processing techniques in multiple Fleet operational effort
(U) Development of advanced technology deployable planar array
(U) Development of outboard power electronics for high power, broadband conformal arrays including power amplifiers, tuning (and receive circuitry, if required), and pressure tolerant components
(U) Optical standoff sensors platform installation and performance testing
(U) Design/integration of ULF/ELF EM submarine detection system mounted on VTUAVs
(U) Development of acoustic time reversal techniques for active sonar systems through simulation studies and planning for at-sea testing
(U) Fabrication and field testing of the performance of a complete polymer coated fiber array. Continue fabrication and calibration of individual high frequency fiber optic sensors. Continue assembly and conduct laboratory measurements of a large aperture virtual sonar array.
(U) Integration of Hidden Markov Model techniques with traditional submarine tracking algorithms and evaluate overall effectiveness for in shallow water ASW applications.

COMPLETE:
(U) Current EAST development.
(U) Sea tests of optical standoff sensor systems
(U) Transition to Naval Air Systems Command (NAVAIR) EER (Extended Echo Ranging) the forward scattering echo detection algorithms. Complete acquisition of scale-model threat target scattering databases and assess robustness of target scattering features to environmental distortion.

- (U)($20,173). Neutralization:

INITIATE:
(U) Development of a Weapon Design and Optimization capability in a virtual environment using results of FY01 and FY02 efforts.
(U) Validation of torpedo vulnerability assessment methodology and codes.

CONTINUE:

(U) Implementation of Multidisciplinary Design Optimization (MDO) in weapon design. Continue optimization of undersea weapon system designs with respect to cost and performance requirements.

(U) Development of a DUS&T low noise integrated motor propulsor project entitled LAMPrEy to further enhance the Torpedo Stealth project.

(U) Development of High-Speed Supercavitating torpedo vehicle control and homing sensor. Continue to conduct experiments and tests on vehicle control concepts and homing sensors.

(U) Research on high power propulsion technologies and integrated hybrid power systems for advanced undersea weapons that reduce life-cycle costs, increase power and energy densities, and enhance stealth. Efforts include models for hybrid propulsion systems, high power rechargeable batteries, micro-turbines, and hydroreactive materials.

(U) Development of Stealth Torpedo Homing Concepts needed to demonstrate the operational utility of stealthy weapon sensors. The effort includes developing combat control algorithms needed for effective weapon employment as well as autonomous weapon guidance algorithms.

(U) Development of technologies to enable a Heavyweight torpedo and a shooting platform to be effectively employed as a fully linked on-board and off-board sensor system.

(U) Development of directed energy concept proof of principle to substantially enhance the performance of undersea warheads.

(U) Development of concepts and design tools for enhanced kill mechanisms for Undersea Warheads. Development of these tools will permit the elimination of several iterations of empiricism's in the design and testing cycle with significant cost and time savings. Development of these advanced concepts will permit the development of enhanced performance torpedo warheads in reduced volumes.

(U) Development of innovative adaptive broadband processing algorithms that will improve a torpedo’s single ping detection, classification and localization performance. This initiative will leverage signal-processing advances made in the radar community.

(U) Development of signal processing algorithms aimed at Detecting, Classifying and Localizing threat torpedoes and torpedo countermeasures for close-in waterborne/underwater threats and high-speed weapons.

(U) Development of technologies to support connectivity between a torpedo and a fixed sensor. Includes: generation of a fire control quality track by the fixed sensor, communication between a torpedo at speed and a fixed sensor node, guidance of the torpedo by the fixed sensor in the face of countermeasures and evasive maneuvers by the target.

BUDGET ACTIVITY: 2 PROGRAM ELEMENT: 0602747N
PROGRAM ELEMENT TITLE: Undersea Warfare Applied Research

COMPLETE:
(U) Development of active-passive mounts for reducing weapon machinery noise; commence demonstration of active-passive mount technologies with in-water torpedo testing.
(U) Complete in-water demonstration of Smart Skin for torpedo noise radiation control concepts. Active controller hardware will be implemented in Active Fiber Composites project.
(U) Development of broadband signal processing and intelligent torpedo control for dramatically improved single- and multi-ping detection of broadband signal processing and intelligent torpedo control advancements (including waveforms, algorithms, etc.) that will dramatically improve single- and multi-ping detection, classification and localization transition to MK-48 CBASS Program (PE 0205632N).

C. (U) PROGRAM CHANGE SUMMARY:

	FY 2001	FY 2002	FY 2003
FY 2002 President's Budget	**	76,510	
Adjustments from FY 2002 President's Budget:			
Section 8123 Mgmt Reform Initiative		-676	
FY 2003 President’s Budget Submission	**	75,834	71,294

**The Science and Technology PEs were restructured in FY 2002. FY 2001 efforts were funded in PEs 0602314N, 0602315N, and 0602633N.

(U) CHANGE SUMMARY EXPLANATION:

(U) Funding: Not Applicable.
(U) Schedule: Not Applicable.

D. (U) OTHER PROGRAM FUNDING SUMMARY:
(U) NAVY RELATED RDT&E:
(U) PE 0601153N (Defense Research Sciences)
(U) PE 0602114N (Power Projection Applied Research)
(U) PE 0602123N (Force Protection Applied Research)
(U) PE 0602435N (Ocean Warfighting Environment Applied Research)
(U) PE 0602782N (Mine and Expeditionary Warfare Applied Research)

(U) PE 0603114N (Power Projection Advanced Technology)
(U) PE 0603123N (Force Protection Advanced Technology)
(U) PE 0603506N (Surface Ship Torpedo Defense)
(U) PE 0603553N (Surface ASW)
(U) PE 0603747N (Undersea Warfare Advanced Technology)
(U) PE 0603758N (Navy Warfighting Experiments and Demonstrations)
(U) PE 0604221N (P-3 Modernization Program)
(U) PE 0604261N (Acoustic Search Sensors (ENG))
(U) PE 0604784N (Distributed Surveillance Systems)

(U) NON NAVY RELATED RDT&E:

(U) PE 0603763E (Marine Technology)
(U) PE 0603739E (Advanced Electronics Technologies)
(U) PE 0602702E (Tactical Technology)
(U) PE 0602173C (Support Technologies – Applied Research)

E. (U) SCHEDULE PROFILE: Not applicable.

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602782N
PROGRAM ELEMENT TITLE: Mine and Expeditionary Warfare Applied Research

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
Mine and Expeditionary Warfare Applied Research									
	**	57,158	56,813	56,354	54,599	53,284	56,306	CONT.	CONT.

**The Science and Technology PEs were restructured in FY 2002. FY 2001 efforts were funded in PE 0602315N.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This Navy program element (PE) provides technologies for naval Mine Countermeasures (MCM), U.S. Naval sea mines, Naval Special Warfare, and Department of Defense (DOD) Explosive Ordnance Disposal (EOD). It is strongly aligned with the Joint Chiefs of Staff Joint Warfighting Capabilities through the development of technologies to achieve military objectives (Power Projection from the Sea) with minimal casualties and collateral damage. The PE supports the Joint Littoral Warfare Mission Area by focusing on technologies that will provide the Naval Force with the capability to dominate the battlespace, project power from the sea, and support forces ashore with particular emphasis on rapid MCM operations. The MCM thrusts concentrate on the development and transition of technologies for organic mine countermeasures and Future Naval Capabilities supporting Ship to Objective Maneuver. These include technologies for clandestine minefield surveillance and reconnaissance, organic self-protection, organic minehunting, neutralization/breaching and clearance. The sea mining thrust emphasizes technologies for future sea mines. The Naval Special Warfare and EOD technology thrust concentrates on the development of technologies for near-shore mine/obstacle detection and clearance, mobility and survivability, as well as explosive ordnance disposal.

(U) MCM Technology: Nations that threaten the US have the capability to procure, stockpile and rapidly deploy all types of naval mines, including new generation mines having sophisticated performance characteristics, throughout the littoral battlespace. Advanced technologies are required to rapidly detect and neutralize all mine types, from deep water to the beach. This task has two major thrusts: (1) Mine/obstacle detection and (2) mine/obstacle neutralization. The detection thrust includes: remote sensing techniques to survey threat mining activities and mine/obstacle field locations; advanced acoustic/non-acoustic sensors and processing technologies (e.g. biomimetic, broadband, synthetic aperture) for rapid minefield reconnaissance and determination of the location of individual mines and obstacles. The neutralization thrust includes influence sweeping technologies for influence minefield clearance, explosive and non-explosive technologies for mine/obstacle field breaching, and advanced technologies to rapidly neutralize shallow water (SW) sea mines. The overall goal of the MCM technology thrust is the reduction of MCM tactical timelines and increased standoff.

(U) Mine Technology: The requirements for improved sea mine technologies has changed due to the reduced threat of the traditional modern submarines and surface ships. The elevated threats today are the third world submarines and surface ships, which may be encountered in the littoral waters of regional conflicts. Despite the diminished sophisticated threat, it is imperative that the US Navy maintains a broad-based and robust sea mining capability through advanced mine sensors, environmental characterization, and systems performance analysis technologies. Emphasis is placed on potentially high payoff advanced sensors for target detection and discrimination and on low cost, wide area sea mine system concepts, including positive command/control mechanisms and expanded weapon effectiveness for regional warfare.

(U) Special Warfare Technology: Naval Special Warfare (NSW) missions primarily support covert naval operations. The goal is to develop technology required to increase the combat range and effectiveness of Special Warfare units. A major current focus is to develop technologies to enhance the Sea-Air-Land mission of pre-invasion detection for clearance/avoidance of mines and obstacles in the very shallow water (VSW) and surf zone (SZ) approaches to the amphibious landing areas. Improvements to mission support equipment are needed to increase the probability of mission success, endurance and SEAL swimmer survivability.

(U) EOD Technology: Technology development for EOD needs addresses the DOD Joint Service and interagency responsibilities in EOD, including that required to counter and neutralize Weapons of Mass Destruction (WMD). The technologies developed are required for locating, rendering safe and disposing of Unexploded Explosive Ordnance (UXO). These operations typically occur in deep, poor-visibility water, in areas of high background noise, and in strategic operating areas contaminated by a variety of UXO. Advanced technologies are needed for gaining access to areas contaminated by sophisticated area-denial sensors and/or booby traps and for contending with WMD. These technologies are expected to transition to the Joint Service EOD Program, the Naval EOD Program or the DOD Technical Response Group.

(U) Due to the number of efforts in the PE, the programs described are representative of the work included in the PE.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the APPLIED RESEARCH Budget Activity because it investigates technological advances with possible applications toward solution of specific naval problems, short of a major development effort.

B. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 2001 ACCOMPLISHMENTS:

- (U) ($30,310) MINE/OBSTACLE DETECTION: (FY 01 accomplishments were funded in PE 0602315N)

  (U) Acoustic Sensor: Completed analysis of synthetic aperture sonar (SAS) Fleet Battle Experiment Hotel demonstration results showing good agreement with predicted resolution and excellent clutter rejection. Completed field-testing of broadband, low frequency synthetic aperture sonar (SAS) projector technology and integration into SAS testbed. Completed laboratory testing of small acoustic sensors. Began integration of acoustic sensors on small autonomous underwater vehicles, focusing on networking and adaptive sampling. Demonstrated the use of autonomous underwater vehicles (AUVs) technologies for bottom mapping and mine hunting in Kernal Blitz 2001, a 3rd Fleet training exercise.

  (U) Electro-Optic Sensors: Initiated development of sensor and predictive model for on-scene assessment of diver visibility. Continued development of advanced, multi-spectral mine identification sensor focusing on collection of multi-spectral, mine identification data. Collected electro-optic mine ID sensor data for development and assessment of automated mine ID algorithms.

  (U) Electro-magnetic Sensors: Completed laboratory testing of thin film, low temperature superconducting gradiometer. Completed documentation of test results quantifying expected performance in high speed, surface vessel operations.

  (U) Image Processing, Classification Algorithms, and Data Fusion: Continued development of broad band processing techniques/algorithm focusing on the application of Hidden Markov techniques to process spectral information. Continued development of environmentally adaptive processing techniques to extend detection/classification range of existing and emerging sensor systems. Continued development of data fusion techniques/algorithms focusing on fusion of multi-platform, multi-sensor data. Initiated transition of CAD/CAC algorithms to AQS-20 airborne mine countermeasures program. Initiated the development of mine burial prediction algorithms focusing on the development of a more accurate hydrodynamic model for the prediction of impact mine burial. Completed mine burial prediction field drop experiments focusing on the hydrodynamics of falling mines.

- (U)($8,600) MINE/OBSTACLE NEUTRALIZATION: (FY01 accomplishments were funded in PE 0602315N)
  (U) SZ Mine Neutralization: Demonstrated performance of High-Energy Low-Pressure explosive technology against tilt rod mines. Initiated study of vulnerability of magnetic influence mines obtained from Program Manager Naval Sea Systems Command (PMS-490). Developed estimates of these mines interactions with shock and bubble loading and provide pre-test predictions in support of Distributed Explosive Technology/Shallow Water Assault Breaching (DET/SABRE) tests. Continued nondeterministic modeling of mine vulnerability, extending the modeling to include chemical and reactive dart lethality.

  (U) Obstacle Breaching: Investigated innovative concepts for clearance and burial of SZ and beach obstacles. Developed supporting technologies that are critical to accurate and affordable delivery of high explosive packages from over the horizon. Developed a methodology that will provide a reliable prediction of explosive channeling effects produced by using arrays of bombs to provide a clear path in the surf and beach and craft landing zones. Completed assessments of sequential and simultaneous bomb detonations for obstacle clearance. Began development of segmented rod warhead concept for obstacle clearance on land.

  (U) Sea Mine Neutralization: Began development of mine jamming concepts using ship-degaussing coils. Began development of precise positional reference system using fixed land and sea beacon nodes.

- (U) ($3,000) SEA MINING: (FY01 accomplishments were funded in PE 0602315N)
  (U) Continued demonstrations of mine network concept for Distributed Autonomous Detection System (DADS) weapon. Completed field-testing of guidance sensors and signal processing algorithms. Completed documentation of field-test results. Initiated field test of command and control of DADS weapon. Continued development of command and control hardware/software for minefield control.

- (U) ($10,450) SPECIAL WARFARE/EOD: (FY01 accomplishments were funded in PE 0602315N)
  (U) Mission Mobility: Continued development of life support equipment technologies. Transitioned enhanced Stirling cycle engine technology to PMS-EOD for use in Very Shallow Water/Mine Countermeasures Detachment (VSWMCM DET). Initiated efforts to develop Diver Propulsion Vehicle subsystems with lower magnetic signature. Initiated investigation of technology options for Swimmer Delivery Vehicle (EOD) heating system. Continued autonomous search vehicle (EOD) development activities. Continued development of coordinated

behavior and mission execution by Unmanned Underwater Vehicles (UUVs) demonstrating hydrographic reconnaissance and mine hunting during Fleet Battle Experiment Hotel.

(U) Mission Support: Continued development of UUV technologies to support Naval Special Warfare reconnaissance and mine clearance missions. Transitioned underwater photo-curable adhesive technology to PMS-EOD. Continued development of broadband sonar technologies for diver and UUV deployment. Initiated development of advanced conformal side-looking acoustic sensors for diver and UUV deployment. Completed field tests and evaluation of buried mine hunting sonar.

(U) Clearance of UXO: Continued development of technologies to enable coordinated behavior and mission execution by unmanned underwater vehicles. Continued development of robotic manipulators and actuators based on artificial muscle materials. Initiated development of technologies to remotely jam or disable the functioning of Electronic Safed Armed fused devices. Evaluated promising techniques for detection of underwater radiation in a laboratory setting.

(U) FY 2001 Congressional Plus-ups: Not applicable

2. (U) FY 2002 PLAN:

- (U)($35,658) MINE/OBSTACLE DETECTION:

  (U) Acoustic Sensors: Initiate development of long range SAS motion compensation and beamforming. Conduct low frequency, broadband SAS field tests to acquire data for concept assessment and development of processing algorithms. Begin integration of low frequency, broadband SAS hardware onto an Autonomous Underwater Vehicle (AUV). Demonstrate the employment of reconnaissance and mine hunting autonomous underwater vehicles from a High Speed Vessel during Fleet Battle Experiment-Juliet.

  (U) Electro-optic Sensors: Initiate real-time processing for airborne LIDAR/multi-spectral minefield detection. Initiate collection/characterization of active/passive electro-optic mine signature data in coastal marine environments. Complete development of high pulse rate laser for minefield detection. Refine optical performance predictive model for on-scene assessment of diver visibility. Begin transition of sensor and predictive model for on-scene assessment of diver visibility.

(U) Image Processing, Classification Algorithms, and Data Fusion: Initiate development of environmental tactical decision aids. Initiate modeling and simulation for adaptive planning of amphibious operations. Continue development of environmentally adaptive processing techniques to extend detection/classification range of existing and emerging sensor systems. Continue development and refinement of automated mine identification algorithms. Initiate transition of automated mine identification algorithms to AQS-20/X airborne mine countermeasures program. Complete the transition of CAD/CAC algorithms to AQS-20 airborne mine countermeasures program. Refine broad band processing techniques/algorithms using at sea data acquired from low frequency, broadband SAS field-testing. Continue development of mine burial prediction algorithms, focusing on scour modeling and the incorporation of oceanographic data. Conduct mine burial prediction field experiment focusing on burial by wave induced scour.

- (U) ($9,900) MINE/OBSTACLE NEUTRALIZATION:

  (U) SZ Mine Neutralization: Extend mine vulnerability database to include damage from reactive and chemical darts for beach zone mines. Initiate development of computational tools to be used to predict the performance of dart dispenser mechanisms. Initiate development of a sand penetration model to be used to predict the performance of darts and fragments against buried mines. Initiate assessment of chemical and reactive dart lethality against common SZ and beach zone (BZ) mines.

  (U) Obstacle Breaching: Complete the assessment of explosive channeling as a mechanism for clearing mines and obstacles in the surf zone. Complete the development of the Surface Neutralization Bomblets (SNUBs) concept for obstacle clearance. Conduct initial analysis of the effectiveness of segmented rod warhead against light and beach obstacles. Initiate development of a fragmenting warhead concept for mine and obstacle clearance.

  (U) Sea Mine Neutralization: Initiate development of advanced laser targeting for Rapid Airborne Mine Clearance System (RAMICS). Conduct field test to determine accuracy, required self-survey time, and temporal stability of precise positional reference system using fixed land and sea beacon nodes. Conduct field demonstration and initiate assessment of mine jamming concepts utilizing ship-degaussing coils.

- (U) ($1,200) SEA MINING:

  (U) Complete analysis/documentation of guidance sensors and signal processing field tests.

Complete development of command and control hardware/software for minefield control. Field-test the command and control of DADS weapon.

- (U)($10,400) SPECIAL WARFARE/EOD

  (U) Mission Mobility: Continue development of life support equipment technologies.

  (U) Mission Support: Initiate development of hyperspectral polarometer prototype. Continue development of UUV technologies to support VSW reconnaissance missions. Continue development of virtual environment-based training aid and tactical decision aids for NSW missions. Complete field tests of synthetic aperture sonar integrated on a UUV. Begin development of onboard synthetic aperture sonar processing for AUV integration. Complete field tests of diver portable high frequency imaging sonar.

  (U) Clearance of UXO: Continue development of technologies to enable coordinated behavior and mission execution by unmanned underwater vehicles. Complete development of robotic manipulators and actuators based on artificial muscle materials. Continue development of technologies to remotely jam or disable the functioning of Electronic Safed Armed fused devices.

3. (U) FY 2003 PLAN:

- (U)($38,113) MINE/OBSTACLE DETECTION

  (U) Acoustic Sensors: Complete integration of low frequency, broadband SAS hardware onto AUV. Conduct initial at sea testing to quantify performance and collect data to refine low frequency, broadband-processing techniques. Complete development and assess performance of long range SAS motion compensation and beamforming techniques using existing SAS field data. Begin development of obstacle avoidance sonar for AUVs. Demonstrate autonomous reconnaissance and mine hunting technologies during Fleet exercise such as Kernal Blitz 2003.

  (U) Electro-optic Sensors: Complete the collection and characterization of active/passive electro-optic mine signature data in coastal marine sediments. Refine real-time processing algorithms for airborne LIDAR/multi-spectral minefield detection utilizing active/passive signature data. Demonstrate day/night airborne reconnaissance of minefields during a fleet exercise such as Kernal Blitz 2003. Complete transition of optical sensor and predictive model for on-scene assessment of diver visibility.

(U) Image Processing, Classification Algorithms, and Data Fusion: Complete the transition of automated mine identification algorithms to AQS-20/X airborne mine countermeasures program. Complete refinement of automated mine identification algorithms. Continue development of environmental tactical decision aids, focusing on the near shore environment. Continue modeling and simulation for adaptive planning of amphibious operations. Begin integration of mine burial predictive models into expert system tactical decision aid.

- (U)($9,100) MINE/OBSTACLE NEUTRALIZATION

  (U) SZ Mine Neutralization: Complete model development of shock interaction and propagation through the seabed. Complete assessment of chemical dart lethality against common SZ and BZ mines. Complete development of computational tools to be used to predict the performance of dart dispenser mechanisms. Begin assessment of performance of dart dispenser mechanisms. Complete development of dart and fragment sand penetration model. Expand mine vulnerability database to include damage from reactive and chemical darts against surf zone mines.

  (U) Obstacle Breaching: Complete analysis of the effectiveness of segmented rod warhead against light and medium beach obstacles. Complete development of a fragmenting warhead concept for mine and obstacle clearance. Continue assessment of advanced obstacle breaching technologies.

  (U) Sea Mine Neutralization: Continue development of advanced laser targeting and initiate development of advanced fire control algorithms for (RAMICS). Complete development of precise positional reference system using fixed land and sea beacon nodes. Complete assessment of mine jamming concepts utilizing ship-degaussing coils.

- (U)($1,100) SEA MINING

  (U) Initiate development of advanced sea mine concepts. Initiate technology assessment of advanced target detection and tracking sensors and algorithms.

- (U)($8,500) SPECIAL WARFARE/EOD

  (U) Mission Mobility: Continue development of life support equipment technologies.

(U) Mission Support: Continue development of hyperspectral polarometer prototype. Begin development of optimized search strategies for multiple, cooperating AUVs for reconnaissance. Continue development of AUV sensing, communications, and navigation technologies to support VSW reconnaissance missions. Begin integration of embedded synthetic aperture processing into AUV to communicate target information to a control authority. Complete development of virtual environment-based training aid and tactical decision aids for NSW missions.

(U) Clearance of UXO: Continue development of technologies to enable coordinated behavior and mission execution by unmanned underwater vehicles. Begin development of advanced robotic mobility actuators. . Initiate advanced robotic search strategies. Complete development of technologies to remotely jam or disable the functioning of Electronic Safed Armed fused devices.

C. (U) PROGRAM CHANGE SUMMARY:

	FY 2001	FY 2002	FY 2003
FY 2002 President's Budget	**	57,668	
Adjustments from FY 02 PRESBUDG:			
Section 8123 Management Reform Initiative		-510	
FY 2003 President's Budget Request:	**	57,158	56,813

**The Science and Technology PEs were restructured in FY 2002. FY 2001 efforts were funded in PE 0602315N.

(U) PROGRAM CHANGE SUMMARY EXPLANATION:

(U) Schedule: Not Applicable
(U) Technical: Not Applicable

D. (U) OTHER PROGRAM FUNDING SUMMARY:

(U) RELATED RDT&E:

(U) NAVY RELATED RDT&E:
(U) PE 0601153N (Defense Research Sciences)

BUDGET ACTIVITY: 2 PROGRAM ELEMENT: 0602782N
PROGRAM ELEMENT TITLE: Mine and Expeditionary Warfare Applied Research

(U) PE 0602131M (Marine Corps Landing Force Technology)
(U) PE 0602435N (Ocean Warfighting Environment Applied Research)
(U) PE 0603502N (Surface and Shallow Water Mine Countermeasures)
(U) PE 0603654N (Joint Service Explosive Ordnance Development)
(U) PE 0603782N (Mine and Expeditionary Warfare Advanced Technology)
(U) PE 0604654N (Joint Service Explosive Ordnance Development)
(U) PE 0603640M (Marine Corps Advanced Technology Demo)

(U) NON NAVY RELATED RDT&E:

(U) PE 0602712A (Countermine Systems)
(U) PE 0603606A (Landmine WF and Barrier Advanced Technology)
(U) PE 1160401BB (Special Operations Technology Development)
(U) PE 1160402BB (Special Operations Advanced Technology Development)

E. (U) SCHEDULE PROFILE: not applicable

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602805N
PROGRAM ELEMENT TITLE: Dual Use Science and Technology Program

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
	Dual Use Science & Technology Program								
	9,992	12,489	0	0	0	0	0	0	38,444

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The mission of the Dual Use Science and Technology (DUS&T) Program is to prototype and demonstrate new approaches for leveraging commercial research, technology, products, and processes for military benefit. These new approaches to working with industry, many of which were prototyped at DARPA, must become common throughout the Navy in order to take full advantage of the technological dynamism of the commercial sector. While acquisition reform has helped clear the path, and experience has shown leveraging can work; it has also shown that leveraging is still unfamiliar and not widely adopted. The challenge is to spread leveraging of the commercial sector into the Navy and make it a normal way of doing business throughout the entire acquisition spectrum. Specifically, DUS&T encourages the Navy to leverage commercial research and development to improve the performance, cost and/or readiness of military systems. Under this effort, the Navy solicits, evaluates, ranks, and nominates dual use S&T projects for Dual Use S&T funds. Each project is 50% cost shared with industry. 25% is cost shared with the Navy project funds and Dual Use S&T provides the remaining 25%. All projects are awarded using either Cooperative Agreements or Other Transactions. This is essentially learning by doing approach to Dual Use S&T in the Navy, with Dual Use S&T funds providing an incentive.

(U) Due to the number of efforts in the PE, the programs described are representative of the work included in the PE.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is funded under APPLIED RESEARCH because it investigates technological advances with possible applications toward solution of specific Naval problems, short of a major development effort.

BUDGET ACTIVITY: 2

PROGRAM ELEMENT: 0602805N

PROGRAM ELEMENT TITLE: Dual Use Science and Technology Program

B. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 2001 ACCOMPLISHMENTS: ($9,992) The following dual use S&T efforts were awarded:

- (U) 500kW Integrated Fuel Processor development
- (U Dual Use of Energy Transduction Materials
- (U) Processing of Biased Lead Zirconate Titanate Material for Use in High Power Sonar Transducers and High Strain Actuators
- (U) Design Optimization and Methodology for Stern Flaps
- (U) Hydraulic Systems Replacement Using Magnetostrictive Technology in the 50,000 Pound Linear Thrust Range
- (U) NAVAIR Technology Commercialization Initiative to transfer Navy developed technology to the commercial sector.
- (U) Qualification of Ausform Finishing Process for the Manufacturing of Aerospace Gearing
- (U) Very High Power Power Electronics Building Block Demonstration
- (U) A System for Distributed Registration for Mobile Augmented Reality in Urban Environment
- (U) Linear Wide-Band Vacuum Electronic Power Amplifier Multi-Frequency Design Codes for Linear High Power Amplifiers
- (U) Affordable Modular Digital Receiver
- (U) Low Defect Density GaN Substrates from GaN Boules
- (U) Band Pass Modulators Active Control of Combustion Processes
- (U) Magnetostrictive Actuators for Marine Propeller Pitch and Flow Control
- (U) Dynamically Reconfigurable and Scalable Distributed Shipboard Automation System for Improved Sustainability and Survivability
- (U) Thermal Barrier Coatings for Molybdenum Refractory Alloys Cost-Effective Fabrication Processes for Advanced Superalloy Disks
- (U) High Power Density Integrated Motor-Propulsors and Electric Machines
- (U) Intelligent Inference Systems Bio-Bots
- (U) Enhanced Bearing Materials
- (U) Nickel-Metal Hydride Aircraft Battery

FY 2001 Congressional Plus-up:

Energy and Environmental Technology

- (U) ($1,451) Opened the state of Hawaii's first fuel-cell test facility, to establish the islands as a center for hydrogen energy development and act as a magnet for additional research projects. The project is a collaboration between UTC Fuel Cells Inc. a division of Connecticut-based United Technologies; the University of Hawaii's (UH) Hawaii Natural Energy Institute; Hawaiian Electric; and the Department of Defense's Office of Naval Research

2. (U) FY 2002 PLAN: The following efforts were awarded or continued:
   - (U) Advanced Dual Use Propulsion technologies development for manned and unmanned vehicles
   - (U) Turbine Blade technologies development
   - (U) 500kW Integrated Fuel Processor development
   - (U) Qualification of Ausform Finishing Process for the Manufacturing of Aerospace Gearing
   - (U) A System for Distributed Registration for Mobile Augmented Reality in Urban Environment
   - (U) Linear Wide-Band Vacuum Electronic Power Amplifier Multi-Frequency Design Codes for Linear High Power Amplifiers
   - (U) High Power Silicon Carbide Transmitter
   - (U) Dynamically Reconfigurable and Scalable Distributed Shipboard Automation System for Improved Sustainability and Survivability
   - (U) High Power Density Integrated Motor-Propulsors and Electric Machines
   - (U) Intelligent Inference Systems Bio-Bots
   - (U) Reconfigurable Control and Fault Identification System
   - (U) Congressional Plus-Up: Fuel cell research utilizing deep sea methane hydrates as a in-situ fuel source.

FY 2002 Congressional Plus-up:

Energy and Environmental Technology

- (U) ($2,577) Test to examine engineering associated with optimal performance and durability. Will focus on making advances in durability performance and cost reduction and moving rapidly toward commercialization

3. (U) FY 2003 PLAN: N/A

B. (U) PROGRAM CHANGE SUMMARY:

	FY 2001	FY 2002	FY 2003
(U) FY 2002 President's Submission:	12,452	10,000	
(U) Congressional Plus-up		2,600	
(U) FY01 SBIR	-315		
(U) Execution Adjustment	-2,145		
(U) Section 8123 –Management Reform/ Initiative Reduction		-111	
(U) FY 2003 President's Submission	9,992	12,489	0

C. (U) PROGRAM CHANGE SUMMARY EXPLANATION:

(U) Schedule: N/A
(U) Technical: N/A

D. (U) OTHER PROGRAM FUNDING SUMMARY:

(U) RELATED RDT&E:

(U) NAVY RELATED RDT&E:
(U)Various S&T PE's supporting the 25% level dual use requirement
(U) NON NAVY RELATED RDT&E:
(U) 0602805A Dual Use Science and Technology
(U) 0602802F Dual Use Science and Technology

E. (U) SCHEDULE PROFILE: not applicable

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603114N
PROGRAM ELEMENT TITLE: Power Projection Advanced Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER/ TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
R2487 Aircraft Affordability Project DP-2	**	5,551	0	0	0	0	0	0	15,814
R2721 Vectored Thrust Ducted Propeller (VDTP)	**	3,370	0	0	0	0	0	0	12,167
R2821 Integrated Hypersonic Aeromechanics Tool Program (IHAT)	**	2,676	0	0	0	0	0	0	5,093
R2823 Precision Strike Navigator	**	1,784	0	0	0	0	0	0	6,139
R2911 Power Projection Advanced Technology		75,730	78,247	69,511	53,166	41,766	47,481	CONT.	CONT.
R3006 Affordable Weapons		6,938	0	0	0	0	0	0	6,938
R9008 HEL-Low Aspect Target Tracking		8,326	0	0	0	0	0	0	8,326
R9009 Aircraft Lightening Protection Applique System		1,487	0	0	0	0	0	0	1,487
R9010 Variable Deliverable Pump/Variable Engine Nozzle		1,487	0	0	0	0	0	0	1,487
R9011 Thermobaric Warhead Development		2,081	0	0	0	0	0	0	2,081
R9012 Magdalena Ridge Observatory		8,326	0	0	0	0	0	0	8,326
Total	**	117,756	78,247	69,511	53,166	41,766	47,481	CONT.	CONT.

**The Science and Technology Program Elements (PEs) were restructured in FY 2002. The work described in 2001 was funded in PEs 0602111N, 0603217N and 0603792N.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This program includes RDT&E,N funds to develop and demonstrate advanced technologies for naval weapon systems, including Directed Energy, and Electric Warship related efforts which provide enhanced lethality and enable new capabilities for locating, identifying and killing high-value, short-dwell military ground and undersea targets, and suppression of enemy defenses. These technologies will include those that minimize exposure of naval personnel to lethal fire (autonomous vehicles), reduce the total ownership cost of systems, and provide responsive/cost effective high-speed sealift.

In support of this overall mission the following specific areas are included:
Time Critical Strike: The specific mission of Time Critical Strike integrates surveillance, indications and warnings, target identification, targeting, fire order generation and dissemination, engagement and kill mechanisms, and damage assessment processes to address critical mobile targets, urban targets, short dwell targets and deeply buried targets. Time Critical Strike must address time sensitive targets in complex urban areas over crowded skies shared with civilian commercial and neutral country aircraft. High quality, timely sensor information, target identification, and course of action analysis is required to enable distributed collaborative planning and the generation of retargeting folders for strike platforms. Unmanned combat air vehicles will be investigated to effectively and affordably prosecute strike and surveillance missions. The approach must be responsive in that it can reduce the strike timeline against time critical targets. The support required to accomplish this also requires high-speed sealift. The technologies reduce the time to conduct strike in all functional areas of the kill chain: detect decide, engage, and battle damage assessment. Intelligence processing, execution speed, command decisions, and accuracy of strike are in constant tension.

Autonomous Operations: The autonomous operations program aims to enhance the mission capability of Naval forces by developing technologies that will dramatically increase the autonomy, performance, and affordability of Naval organic unmanned vehicle systems. By defining and focusing risk reduction overarching Intelligent Autonomy Science and Technology principles, transitional products will be developed in four areas: Unmanned Ground Vehicles (UGV) which focuses on the increasing utility of UGV systems to Marine Corps units in all environments but specifically in urban and littoral terrain; Unmanned Air Vehicles (UAV) which includes intelligent reasoning for autonomy, technologies to enhance “see and avoid” capabilities, object identification, vehicle awareness, and vehicle and mission management; Unmanned Undersea Vehicles (UUV) which will demonstrate the technical feasibility for a UUV system to effectively search, detect, track and trail undersea threats while maintaining a robust communications link to enable appropriate command, control and transmission of collected data; and UAV Propulsion: which will develop propulsion and power technologies unique to Naval UAVs operating from surface combatants. The project is related to on-going projects such as the Integrated High Performance Turbine Engine Technology program.

Total Ownership Costs: Specific technology efforts are associated with affordability and reduction of total ownership costs for power projection systems.

Due to the number of efforts in this PE, the programs described are representative of the work included in this PE.

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603114N
PROGRAM ELEMENT TITLE: Power Projection Advanced Technology

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the ADVANCED TECHNOLOGY budget activity because it encompasses design, development, simulation, or experimental testing of prototype hardware to validate technological feasibility and utility, and reduce technological risk prior to initiation of a new acquisition program or transition to an ongoing acquisition program.

C. (U) PROGRAM CHANGE SUMMARY:

	FY 2001	FY 2002	FY 2003
FY 2002 President's Submission:	**	76,410	
Adjustments from FY 2002 President’s Budget:			
Congressional Plus-ups		+42,400	
Section 8123 Management Reform Initiative Reduction		-1,049	
FFRDC Reduction		-5	
FY 2003 President’s Submission:	**	117,756	78,247

**The Science and Technology PEs were restructured in FY 2002. FY 2001 efforts were funded in PEs 0602111N, 0603271N and 0603792N.

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603114N
PROGRAM ELEMENT TITLE: Power Projection Advanced Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER/ TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
R2911 Power Projection Advanced Technology	**	75,730	78,247	69,511	53,166	41,766	47,481	CONT.	CONT.

**The Science and Technology Program Elements (PEs) were restructured in FY 2002. The work described in 2001 was funded in PEs 0602111N, 0603217N and 0603792N.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This program includes RDT&E,N funds to develop and demonstrate advanced technologies for naval weapon systems, including Directed Energy, and Electric Warship related efforts which provide enhanced lethality and enable new capabilities for locating, identifying and killing high-value, short-dwell military ground and undersea targets, and suppression of enemy defenses. These technologies will include those that minimize exposure of naval personnel to lethal fire (autonomous vehicles), reduce the total ownership cost of systems, and provide responsive/cost effective high-speed sealift.

In support of this overall mission the following specific areas are included:
Time Critical Strike: The specific mission of Time Critical Strike (TCS) integrates surveillance, indications and warnings, target identification, targeting, fire order generation and dissemination, engagement and kill mechanisms, and damage assessment processes to address critical mobile targets, urban targets, short dwell targets and deeply buried targets. Time Critical Strike must address time sensitive targets in complex urban areas over crowded skies shared with civilian commercial and neutral country aircraft. High quality, timely sensor information, target identification, and course of action analysis is required to enable distributed collaborative planning and the generation of retargeting folders for strike platforms. Unmanned combat air vehicles will be investigated to effectively and affordably prosecute strike and surveillance missions. The approach must be responsive in that it can reduce the strike timeline against time critical targets. The support required to accomplish this also requires high-speed sealift. The technologies reduce the time to conduct strike in all functional areas of the kill chain: detect decide, engage, and battle damage assessment. Intelligence processing, execution speed, command decisions, and accuracy of strike are in constant tension.

Autonomous Operations: The autonomous operations program aims to enhance the mission capability of Naval forces by developing technologies that will dramatically increase the autonomy, performance, and affordability of Naval organic unmanned vehicle systems. By defining and focusing risk reduction overarching Intelligent Autonomy Science and Technology principles, transitional products will be developed in four areas: Unmanned Ground Vehicles (UGV) which focuses on the increasing utility of UGV systems to Marine Corps units in all environments but specifically in urban and littoral terrain; Unmanned Air Vehicles (UAV) which includes intelligent reasoning for autonomy, technologies to enhance "see and avoid" capabilities, object identification, vehicle awareness, and vehicle and mission management; Unmanned Undersea Vehicles (UUV) which will demonstrate the technical feasibility for a UUV system to effectively search, detect, track and trail undersea threats while maintaining a robust communications link to enable appropriate command, control and transmission of collected data; and UAV Propulsion: which will develop propulsion and power technologies unique to Naval UAVs operating from surface combatants. The project is related to on-going projects such as the Integrated High Performance Turbine Engine Technology program.

Total Ownership Costs: Specific technology efforts are associated with affordability and reduction of total ownership costs for power projection systems.

B. (U) PROGRAM PLANS AND ACCOMPLISHMENTS:

1. (U) FY 2001 ACCOMPLISHMENTS:

- (U) ($14,200) Time Critical Strike: Conducted risk reduction in the areas of Surface Fire Support and real time retargeting for cruise missiles, as well as gun launched ordnance for the purpose of delivering ordnance to land targets. The Cruise Missile Real Time Retargeting (CMRTR) project successfully developed a Mercad Telluride detector for the advanced development seeker and determined that the 1.54 micron laser was too large and generated too much heat to be usable. This project initiated efforts with a 1.06 micron laser for planned advanced development. Various efforts in Naval Fire Support in 0602111N were focused on preliminary risk reduction in preparation for the advanced development TCS efforts. The Barrage Round project successfully completed projectile demonstrations, which proved the viability of an accurate, guided projectile in modern strike warfare. (FY-01 accomplishments were funded in PE 0602111N and PE 0603217N).

- (U) ($3,200) Autonomous Operations: The Advanced Linear Motor Technology project developed a prototype electromagnetic aircraft recovery system for carriers which has the ability to store energy. This has the potential of being used on current and future aircraft recovery systems, including those which would be used for UAV recovery. Component
- testing is completed and final testing of the prototype will be completed in FY-02. The Integrated High Performance Turbine Engine Technology (IHPTET) project, a phased approach to advanced turbine propulsion for UAVs and aircraft, demonstrated Phase II propulsion systems and initiated design and development of Phase III systems. (FY-01 accomplishments were funded in PE 0603217N and PE 0603792N).

- (U) ($4,100) Total Ownership Costs: This effort developed requirements for a cost effective reconfigurable rotor blade system, evaluated corrosion and durability of the thermal energy modules, and initiated development of a ¼ scale Shaped Memory Alloy actuator as well as initiation of integration efforts into a rotor blade system. In addition, a cost effective, enhanced air platform design and development of a Vectoring ESTOL Control Tailless Operation Research (VECTOR) project was initiated. (FY-01 accomplishments were funded in PE 0603217N).

2. (U) FY 2002 PLAN:

- (U) ($50,160) Time Critical Strike: This thrust continues with significant efforts associated with the Future Naval Capability (FNC) of Time Critical Strike(TCS) as well as other Discovery and Invention efforts. The TCS FNC is focused on delivering capability enhancements across detect, decide, engage and assess sub-systems to acquisition programs for transition to Fleet systems. The TCS FNC will execute:
  - (U) Naval-Unmanned Combat Air Vehicle (UCAV-N) Phase II: Refine operational system concept development, System Maturation Plans and Preliminary Designs initially developed in Phase I 6.2 program. Conduct sub-system development and test in critical technology areas, leading to simulations and flight demonstrations.
  - (U) Real Time Execution Decision Support System (REDS): Develop software methods for collaborative planning, options generation, and mission target folder generation.
  - (U) Conduct analysis of seeker alternatives and mission need assessment for a next generation mid-range, ship launched, precision strike weapon (Counterbattery Attack Munition-CBAM).
  - (U) Low Cost Active Terminal Seeker development for Cruise Missile Real Time Retargeting. Development includes: signal and image processing and weapon interface in accordance tactical TOMAHAWK performance requirements.
  - (U) Conduct image Analysis Survey and develop methods for target exploitation in image and video streams

- (U) Develop chemical and mechanical processes for low cost Fiber Optic Gyroscope inertial measurement unit fabrication as part of Precision Strike Navigator.
- (U) Integration studies of an advanced dual mode anti-radiation missile seeker incorporating a balljoint gimbals into a ramjet-powered missile airframe for a flight test demonstration of seeker Anti-Radiation Missiles effectiveness at high-speed.
- (U) Hyper-spectral Imaging System: Develop rugged, high through-put Infra-Red Spectrometer, optical train analysis, select position/ pointing system reference, and enhance detect algorithms for real time processor
- (U) Survey and develop targetable submunition warhead variant for Tomahawk while preserving unitary performance.
- (U) Develop digital secure weapon link for SLAM-ER.

The Discovery and Invention efforts for the Time Critical Strike thrust include advanced rocket motor technology for high-speed strike weapons, advanced weapons seeker and guidance programs, hypersonic dual-combustor laboratory testing for high-speed air-breathing strike weapon, and tactical targeting processors which will be demonstrated to quantify specific risks remaining to achieve accurate and lethal strike missions. Focused efforts on evaluation / assessment of high-speed vessel for long range, stable, affordable support of expeditionary operations will be conducted.

• (U) ($17,542) Autonomous Operations: This thrust continues with significant efforts associated with the Future Naval Capability (FNC) of Autonomous Operations as well as other efforts. Autonomous Operations FNC includes:

- (U) UAV Technology: For Situational Awareness, the development of sub-system self-awareness sensors to enable adaptation and independent action for detection (threats & terrain), display, and decision.
- (U) Intelligent Autonomy: Development of alternative designs and risk reduction assessments for intelligent vehicle self-management and fault tolerance targeting concepts.
- (U) UAV Propulsion: Development of an advanced propulsion system for reliable UAV systems. Development will be in conjunction with the IHPTET Phase III JETEC effort.
- (U) Unmanned Ground Vehicles (UGV): Design and development of mobility Unmanned Ground Vehicle (UGV) testbed for platform, sensor, and command & control sub-systems.
- (U) Unmanned Underwater Vehicles: Development and demonstration of undersea, autonomous operations for Undersea Search and Survey, and Communications/Navigation Aid utilizing a network of multiple, mobile nodes. Also, development and demonstration of undersea, autonomous operations for Maritime Reconnaissance utilizing a submarine launch-capable vehicle.

The Discovery and Invention efforts for the Autonomous Vehicles thrust completes the fabrication and demonstration of an advanced linear motor system intended for affordable recovery of air vehicles. It will demonstrate single-sided portion of linear motor recovery with a simulated aircraft recovery loading.

- (U) ($8,028) Total Ownership Costs: This thrust continues with significant efforts associated with the Future Naval Capability (FNC) of Total Ownership Cost as well as other projects. The Total Ownership Cost FNC will:
  - Complete the Reconfigurable Rotor Blade system requirements and concept trade studies. In addition subsystem development of shaped memory alloy ¼ scale actuator will continue, as well as plans for system design, development and demonstration of the cost effective actuator and blade assembly.

  The Discovery and Invention efforts for the Total Ownership Cost thrust will continue development and flight demonstration of enhanced Vectoring ESTOL Control Tailless Operation Research (VECTOR) air platform.

3. (U) FY 2003 PLANS:

- (U) ($58,928) Time Critical Strike: This thrust continues with significant efforts associated with the Future Naval Capability (FNC) of Time Critical Strike (TCS) as well as other Discovery and Invention efforts. The TCS FNC efforts are:
  - Initiate development of Weapons/Image Link: Develop high bandwidth digital secure weapon link for SLAM-ER.
  - Advanced gun projectile propulsion technology and associated advanced Gun-Barrel Technology.
  - Mission Responsive Ordnance technology will develop targetable submunition warhead variant for Tomahawk while preserving unitary performance.
  - Naval-Unmanned Combat Air Vehicle (UCAV-N) Phase II: Conduct simulated carrier and mission operations, perform subsystem demonstrations, and prepare for surrogate and demonstrator aircraft flight test. Continue refinement of operational system concept.
  - Real Time Execution Decision Support System (REDS): Develop software methods for collaborative planning, options generation, and mission target folder generation.
  - As part of the Counterbattery Attack Munition-CBAM, program analysis of seeker alternatives and mission need assessment for a next generation mid-range, ship launched, precision strike weapon.
  - Continue development of low cost terminal seeker for Cruise Missile Real Time Retargeting.
  - Conduct image Analysis Survey and develop methods for target exploitation in image and video streams.

- Within the Precision Strike Navigator program development of chemical and mechanical processes for low cost Fiber Optic Gyroscope inertial measurement unit will continue.
- Conduct Integration studies of an advanced dual mode anti-radiation missile seeker incorporating balljoint gimbals into a ramjet-powered missile airframe for a flight test demonstration of seeker for high-speed Anti-Radiation Missile effectiveness.
- Hyper-spectral Imaging System: Develop rugged, high through-put Infra-Red Spectrometer, optical train analysis, select position/ pointing system reference, and enhance detect algorithms for real time processor.

The Discovery and Invention efforts for the Time Critical Strike thrust include a continuation of the advanced rocket motor technology for high-speed strike weapons. In addition continued development and testing will be conducted for the National Aerospace Initiative (hypersonic missile development) and the advanced weapons seeker and guidance programs to reduce specific risks support Strike missions.

- (U) ($16,319) Autonomous Operations: This thrust continues with significant efforts associated with the Future Naval Capability(FNC) of Autonomous Operations. The Autonomous Operations FNC include:
  - UAV Technology: For Situational Awareness, the development of self-awareness sensors to enable adaptation and independent action for detection (threats, terrain), display, and decision development of sub-system self-awareness sensors to enable adaptation and independent action for detection (threats & terrain), display, and decision. For Communications & Networks, the development of multi-modal interface for humans to control autonomous vehicles using combination of control inputs, including speech, and touch screens. Using mixed-initiative model of autonomous control, development of the ability for a single human to control multiple vehicles. Design of a planning system that allows for autonomous vehicle to re-plan in real time based on current environmental and conditions and vehicle state.
  - (U) Intelligent Autonomy: Development of design definition and risk reduction for intelligent vehicle self-management and fault tolerance targeting concepts. Development of architecture for combining reactive and deliberative behaviors for autonomous vehicles. Development of architecture for dynamic autonomy, allowing autonomous system to adjust level of autonomy based on environment, vehicle state and Rules of Engagement (ROE).
  - (U) UAV Propulsion: Continued development of an advanced propulsion system for reliable UAV systems. Development will be in conjunction with the IHPTET Phase III JETEC effort.
  - (U) Unmanned Ground Vehicles (UGV): Continue design and development of mobility UGV test bed for platform, sensor, and command & control sub-systems

- (U) Unmanned Underwater Vehicles: Development and demonstration of undersea, autonomous operations for Maritime Reconnaissance utilizing a submarine launched capable vehicle. Development and demonstration of undersea, autonomous operations for Undersea Search and Survey, and Communications/Navigation Aid utilizing a network of multiple, mobile nodes.

• (U) ($3,000) Total Ownership Costs: This thrust continues with efforts associated with the Future Naval Capability (FNC) of Total Ownership Costs (TOC) as well as other Discovery and Invention efforts. The TOC FNC is: Continue the Reconfigurable Rotor Blade efforts of twist actuation design and fabrication of scale model system.

Discovery and Invention efforts for the Total ownership cost Thrust include continued development and testing for the Vectoring ESTOL Control Tailless Operation Research (VECTOR) air platform.

(U) PROGRAM CHANGE SUMMARY EXPLANATION:

(U) Schedule: Not Applicable
(U) Technical: Not Applicable

D. (U) OTHER PROGRAM FUNDING SUMMARY:

(U) Navy RELATED RDT&E:
(U) PE 0601153N Defense Research Sciences
(U) PE 0602114N Power Projection Applied Research
(U) PE 0602236N Warfighter Sustainment Applied Research
(U) PE 0603123N Force Protection Advanced Technology
(U) PE 0603782N Mine and Expeditionary Warfare Advanced Technology
(U) PE 0603236N Warfighter Sustainment Advanced Technology
(U) PE 0603790N NATO Research and Development
(U) PE 0305204N Tactical Unmanned Aerial Vehicles
(U) PE 0603502N Surface and Shallow Water Mine Countermeasures
(U) PE 0603654N Joint Service Explosive Ordnance Development
(U) PE 0602131M Marine Corps Landing Force Technology

(U) NON-NAVY RELATED RDT&E: These PEs adheres to Defense S&T Reliance agreements with oversight provided by the JDL.

- (U) PE 0603285E ASP-01 Advanced Aerospace Systems
- (U) PE 0603709D Joint Robotics Program
- (U) PE 0604709D Joint Robotics Program - EMD
- (U) PE 0602203F Aerospace Propulsion
- (U) PE 0603202F Aerospace Propulsion Subsystems Integration
- (U) PE 0603216F Aerospace Propulsion and Power Technology
- (U) PE 0603205F Flight Vehicle Technology
- (U) PE 0603245F Advanced Flight Technology Integration

E. (U) SCHEDULE PROFILE: Not applicable

CONGRESSIONAL PLUS-UPS

This section describes the following Congressional Plus-Ups appropriated in FY 2001 and FY 2002 whose efforts fall within the scope of this (restructured program), or which were appropriated in this program element:

Affordable Weapons
Aircraft Affordability Project DP-2
Aircraft Lightening Protection Applique System
Eye Safe Ladar
HEL-Low Aspect Target Tracking
Integrated High Performance Turbine Engine Technology (IHPTET)
Integrated Hypersonic Aeromechanics Tool Program (IHAT)
Magdalena Ridge Observatory
Precision Strike Navigator(PSN)
Synthetic Aperture Radar All Weather Precision Targeting System (AWPTS)
Thermobaric Warhead Development
Variable Deliverable Pump / Variable Engine Nozzle
Vectored Thrust Ducted Propeller (VTDP)

1. (U) FY 2001 Congressional Plus-Ups

- (U) ($4,343) Aircraft Affordability Project DP-2: Continued development of the half scale DP2 vertical takeoff aircraft. Successfully ground tested the existing half scale aircraft to insure integrity of the composite thrust vectoring system, completed development and improvement of the computer flight control system. Work is being performed by DuPont Aerospace in San Diego and Mississippi State Univ. (Funded in PE 0603217N)

- (U) ($4,842) Eye Safe Ladar: Funds were used to develop an advanced detector for use in a LADAR Seeker and to integrate an eye safe laser (developed by Acculyte, Seattle WA) into a LADAR seeker. The detector passed the milestones and will be considered as part of the Cruise Missile Real Time Retargeting (CMRTR) Time Critical Strike Future Naval Capability project. The integrating performer was Raytheon, Tucson AZ. (Funded in PE 0603217N)

- (U) ($966) Integrated High Performance Turbine Engine Technology (IHPTET): Continued the Phase II Joint Expendable Turbine Engine Concepts (JETEC) effort. The JETEC technology demonstrators are turbine engines with the potential capability of propelling missiles or unmanned air vehicles to speeds approaching Mach 4-5. Performer was Allison Advanced Development Company (AADC), Indianapolis, Indiana. (Funded in PE 0603217N)

- (U) ($2,417) Integrated Hypersonic Aeromechanics Tool Program (IHAT): Developed an architecture and middleware code for the purpose of supporting a hypersonic weapon configuration model and design optimization tool. This effort analyzed the development feasibility of a single hypersonic engine and airframe integration-modeling tool capable of analysis of hypersonic weapons configurations. This proved feasibility of such a modeling code. Performer included ADVANTECH Pacific Inc, Redlands Ca. (Funded in PE 0603217N)

- (U) ($4,355) Precision Strike Navigator(PSN): Developed the advanced production techniques and processes for potential automation of the currently manual process of assembling and integrating the components of a silicon-based Precision Strike Navigator (PSN) Inertial Measurement Unit (IMU). Purchased new micro-fabrication and metrology equipment, performed polymer development, performed microchip development for an automated system. Elements of this are being considered as part of the Time Critical Strike Future Naval Capability. Performers include AEgis Systems Inc., Huntsville, AL and support at the Naval Air Warfare Center China Lake (Funded in PE 0603217N)

- (U) ($3,867) Synthetic Aperture Radar All Weather Precision Targeting System (AWPTS): Developed a monopulse antenna adjunct for the high resolution Synthetic Aperture Radar (SAR) developed by Sandia National Laboratory and suitable for use on a tactical Unmanned Aerial Vehicle (UAV). Designed algorithms for precision tracking using this system and demonstrated them. Potential use as payload for UAVs. Primary performer was General Atomics, San Diego, CA. (Funded in PE 0603217N)

- (U) ($3,090) Vectored Thrust Ducted Propeller (VTDP): The VTDP is a multi-functional component that replaces a conventional tail rotor system in a helicopter. The VTDP provides anti-torque/yaw control capability with propulsion and thrust vectoring control. Developed flight control, power and propulsion system and H-60 airframe structural modification designs (conducted Preliminary Design Review). The prime contractor for VTDP is Piasecki Aircraft Corporation, Essington, PA. Navy efforts are focused at Naval Air Systems Command, Patuxent River, MD.(Funded in PE 0603792N).

2. FY 2002 Congressional Plus-Ups:

- (U) ($6,938) Affordable Weapons: Flight-test the Affordable Weapon from a short rail launcher using a new more powerful engine. Conduct flight duration tests of up to 6 hours. Test the GPS targeting system and demo it on a target range.

- (U) ($5,551) Aircraft Affordability Project DP-2: Continue development and evaluation of the half scale DP2 vertical takeoff aircraft. The advantage of the concept is to provide the only jet powered vertical and short takeoff multi-passenger aircraft.

- (U) ($1,487) Aircraft Lightening Protection Applique System: Apply composite protection technology to small air ehicles to enhance survivability/effectiveness. This is also applicable to surface and ground based composite structures.

- (U) ($8,326) HEL-Low Aspect Target Tracking: Investigate tracking techniques for target acquisition, background discrimination, and aim-point maintenance using the laser and beam director at the High Energy Laser Systems Test Facility (HELSTF) in New Mexico. Initiate laser/beam director system upgrade development and conduct test/demonstration to resolve issues associated with beam control in the negation of air threats to Surface ships. While the specific laser system of choice for the HEL ship defense application may be the electrically driven Free Electron Laser (FEL) or the Solid State Laser (SSL), this technology effort will provide essential technical data for the next phase of laser beam control at weapon power levels so laser device development can proceed with confidence.

- (U) ($2,676) Integrated Hypersonic Aeromechanics Tool Program (IHAT): Develop a multi-disciplinary optimization analysis tool for Navy use in design and evaluation of a hypersonic weapon system. Complete design and validation of Build One. Define requirements of next incremental Build.

- (U) ($8,326) Magdalena Ridge Observatory: Using a Naval Research Laboratory and New Mexico Technologic University team, develop an interferometric system for use in the Magdalena Ridge Observatory to be run by New Mexico Tech.

- (U) ($1,784) Precision Strike Navigator(PSN): Initiate integration of the Integrated Fiber Optic gyro components from the semi-automated fabrication facility with the goal of building and evaluating a complete Inertial Measurement Unit (IMU).

- (U) ($2,081) Thermobaric Warhead Development: Configure and demonstrate an advanced high-energy insensitive thermobaric explosive composition that will provide enhanced internal blast pressures and thermal effects in confined environments. The program will characterize and model existing foreign technologies related to thermobaric formulations, optimize compositions for US man portable munitions and determine material safety requirements. Selected compositions will be demonstrated in a variety of man portable munitions to verify concept effectiveness for final system down-selection.

- (U) ($1,487) Variable Deliverable Pump / Variable Engine Nozzle (VEN): Initiate design, fabrication and demonstration testing on a new pump concept, which can be transitioned to the F-18E/F. Current nozzle actuator fuel pumps, which provide high pressure fuel to control the VEN area on the F-14 engine, have a low degree of reliability. This new pump concept will demonstrate increased reliability and durability.

- (U) ($3,370) Vectored Thrust Ducted Propeller (VTDP): The VTDP is a multi-functional component that replaces a conventional tail rotor system in a helicopter. The VTDP provides anti-torque/yaw control capability with propulsion and thrust vectoring control. Continue design, analysis and engineering support of the aircraft systems. Continue aircraft modifications and drive system testing at the Helicopter Transmission Testing Facility (HTTF). The prime contractor for VTDP is Piasecki Aircraft Corporation, Essington, PA. Navy efforts are focused at Naval Air Systems Command, Patuxent River, MD.

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603123N
PROGRAM ELEMENT TITLE: FORCE PROTECTION ADVANCED TECHNOLOGY

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE		FY 2001 ACTUAL	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
R2706	Project M									
		2,775								2,775
R2711	Superconducting DC Motor									
		1,982								1,982
R2828	Advanced Water Jet AWJ-21									
		3,469								3,469
R2831	AC Synchronous Propulsion Motor									
		3,965								3,965
R2848	Hybrid Small Waterplane Area Catamaran (HYSWAC)									
		7,235								7,235
R2912	Force Protection Advanced Technology									
	**	92,108	50,942	42,321	44,573	42,865	43,414	CONT.		CONT.
R3049	Emerging Threats									
		0	6,662	9,452	11,914	3,469	3,958	CONT.		CONT.
R9013	Littoral Support Craft - Experimental									
		16,057								16,057
R9014	Curved Plate Technology									
		2,478								2,478
R9015	SMARTLINK System									
		1,487								1,487
R9016	Real Time Fire and Smoke Prediction Tool									
		991								991
R9017	Wireless Sensors for Total Ship Monitoring									
		2,775								2,775
R9018	Knowledge Projection for Fleet Maintenance									
		2,478								2,478
R9019	Wave Powered Electric Power Generating System									
		1,982								1,982
Total	**	139,782	57,604	51,773	56,487	46,334	47,372	CONT.		CONT.
Defense Emergency Response Fund (DERF)			36,000							

R-1 Line Item 24

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603123N
PROGRAM ELEMENT TITLE: FORCE PROTECTION ADVANCED TECHNOLOGY

** The Science and Technology PEs were restructured in FY 2002. FY 2001 efforts were funded in PE(s) 0602111N, 0602121N, 0603238N, 0603508N, 0603217N and 0603747N.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: Includes RDT&E funds to develop and demonstrate advanced technologies that support platform self-protection and theatre wide and missile defense of naval platforms and forces. The new capabilities include the areas of all-weather, day/night protection of naval platforms and forces against all weapon threats, counter-stealth and countermeasures. These new capabilities also include affordable technologies for platform structural systems as well as platform systems, sub-systems and components and aircraft vectoring technologies. Demonstrated capabilities support the ability to prevent or control platform damage while preserving operational capability.

(U) SURFACE SHIP & SUBMARINE HULL, MECHANICAL & ELECTRICAL (HM&E) thrusts include: signature reduction, hull life assurance, hydromechanics, distributed intelligence for automated survivability and advanced electrical power systems. Signature reduction addresses Electromagnetic (EM), infrared (IR) and acoustic signature tailoring, both topside and underwater. Hull life assurance addresses development of new structural system approaches for surface ships and submarines, including the management of weapons effects to control structural damage and the improvement of structural materials. Hydromechanics addresses hydrodynamic technologies, including the signature aspects of the hull-propulsor interface. Distributed control for automated survivability addressees both the basic technology of automating damage control systems as well as distributed auxiliary control with self-healing capability. Advanced electrical power systems area addresses electrical and auxiliary system and component technology to provide improvement in system energy and power density improvement, system operating efficiency and recoverability from casualties.

(U) SENSORS & ASSOCIATED PROCESSING thrust develops complementary sensor and processing technologies for 21st century warfighting success and platform protection. Current small platforms (both surface and airborne) have little to no situational awareness (SA) or self-protection against air, surface, and asymmetric threats. The goal of this effort is to provide these platforms with effective self-protection. The technology areas specific to platform protection will develop individual or multispectral (Electro-Optic (EO), IR, Radio Frequency (RF), EM, visual and acoustic) sensors and associated processing. To defend platforms from current and advanced threats in at-sea littoral environments and in port, these technologies must improve multispectral detection and distribution of specific threat information.

(U) MISSILE DEFENSE (MD) thrust develops Littoral Theater Air and Missile Defense (TAMD) technology enhancements for transition to acquisition programs, which will interact efficiently, effectively, and in time to detect, control, and engage projected anti-ship cruise missiles, overland cruise missiles, aircraft and theater ballistic threats. The Missile Defense S&T projects directly provide elements of the capability required by the Joint Requirements Oversight Council (JROC) TAMD Capstone Requirements Document (CRD) (2001). This PE includes those MD elements that perform risk reduction for Force Protection Capability. In addition, emerging S&T requirements in the area of Directed Energy and Strike Technology are also included under Missile Defense. In the terminology of the TAMD CRD, Attack Operations

(Strike) is a necessary element of Theater Air and Missile Defense in order to attack the air threat before they are launched.

(U) UNDERWATER (UW) PLATFORM SELF DEFENSE thrust develops technologies that will increase survivability of surface ship and submarine platforms against torpedo threats. Proposed technologies focus on defeating high priority threats including torpedoes (i.e. straight running, wake homing, acoustic homing, high speed torpedoes, air dropped torpedoes, and salvoes of torpedoes). The long-term goal of the UW Platform Self Defense effort is to develop technologies that will ultimately be placed on board ship. Technologies should be developed to minimize shipboard impact, allow automatic employment, and require no organizational maintenance. Specific technology includes two programs. The Next Generation Countermeasure (NGCM): A mobile adaptive acoustic countermeasure with acoustic communication links to enable countermeasure connectivity and group behavior to defeat threat torpedoes. The Anti-Torpedo Torpedo (ATT)/ Tripwire Demonstration: Technologies that improved passive shipboard detection, classification, and localization (DCL) of incoming torpedoes and an ATT to engage the threat torpedoes.

Due to the number of efforts in this PE, the programs described are representative of the work included in this PE.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is funded within the ADVANCED TECHNOLOGY DEVELOPMENT Budget Activity because it encompasses design, development, simulation, or experimental testing of prototype hardware to validate technological feasibility and concept of operations and reduce technological risk prior to initiation of a new acquisition program or transition to an ongoing acquisition program.

B. (U) PROGRAM CHANGE FOR TOTAL PE:

	FY 2001	FY 2002	FY 2003
FY 2002 President's Budget	**	85,297	-
Adjustments from FY 2002 President's Budget:			
Congressional Plus-ups		+48,100	
Section 8123 Management Reform Initiative Reduction		-1,247	
Increase for Force Protection Efforts		+7,632	
FY 03 PRESBUDG Submission	**	139,782	57,604

** The Science and Technology PEs were restructured in FY 2002. FY 2001 efforts were funded in PE(s) 0602111N, 0602121N, 0603238N, 0603508N, 0603217N and 0603747N.

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603123N
PROGRAM ELEMENT TITLE: FORCE PROTECTION ADVANCED TECHNOLOGY

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
R2912 Force Protection Advanced Technology	**	92,108	50,942	42,321	44,573	42,865	43,414	CONT.	CONT.

** The Science and Technology PEs were restructured in FY 2002. FY 2001 efforts were funded in PE(s) 0602111N, 0602121N, 0603238N, 0603508N, 0603217N and 0603747N.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: Includes RDT&E funds to develop and demonstrate advanced technologies that support platform self-protection and theatre wide and missile defense of naval platforms and forces. The new capabilities include the areas of all-weather, day/night protection of naval platforms and forces against all weapon threats, counter-stealth and countermeasures. These new capabilities also include affordable technologies for platform structural systems as well as platform systems, sub-systems and components and aircraft vectoring technologies. Demonstrated capabilities support the ability to prevent or control platform damage while preserving operational capability.

B. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 2001 ACCOMPLISHMENTS:

(U) ($20,800) SURFACE SHIP & SUBMARINE HM&E

- (U) Signature Reduction:

Initiated:
(U) Submarine condenser/discharge flanking path investigation within Advanced Machinery Support System Program (AMSS). (Funded in PE 0603508N).
Completed:
(U) AMSS submarine machinery support shock truss demo. (Funded in 0603508N)
(U) Identification of critical technologies and tradeoff studies for surface ship near field de-amping system. (Funded in PE 0603508N).

- (U) Hull Life Assurance:

Continued:
(U) Thermochemical combustion model for passive magazine protection. (Funded in PE 0602121N).

Completed:
(U) Anti-fratricide shielding reaction tests for passive magazine protection. (Funded in PE 0603508N).

- (U) Distributed Intelligence for Automated Survivability:

Continued:
(U) Sensor development and intermediate scale demo development for automated casualty flooding control. (Funded in PE 0603508N).
(U) Demonstrated automation technology to provide 85% reduction in damage control manning. (Funded in PE 0603508N).

- (U) Advanced Electrical Power Systems:

Continued:
(U) Ship service fuel cell diesel fuel reformer analytical dynamic performance model development.
(U) Development of Aircraft Electrical Servicing Station (AESS) demonstration using programmable Power Electronic Building Block (PEBB) and Power Node Control Center technologies. (Funded in PE 0603508N).
Completed:
(U) Transition of PEBB technology to industry. (Funded in PE 0603508N).

- (U) Electric Warship:

Initiated:
(U) Planning for Electric Warship and Combat Vehicles thrust area, including studies of superconducting generators, podded propulsors, and electric weapons. (Funded in PE 0603508N).

(U) ($4,974K) SENSORS & ASSOCIATED PROCESSING

- (U) Multifunction Infrared Distributed Aperture System:

Continued:
(U) For Naval aircraft, the Navy has undertaken an Advanced Technology Demonstration (ATD) for the Multifunction Infrared Distributed Aperture System (MIDAS). The goal of the MIDAS effort is the development of a seamless, real-time, Omni-directional situational awareness capability for Naval Aviation meeting the Joint Strike Fighter (JSF) transition criteria. In FY01, accomplishments included successful completion of the focal plane acceptance test and other required lab test meeting the program sensor and processor objectives. (Funded in PE 0603238N).

(U) ($7,679) MISSILE DEFENSE
Initiated:
(U) As part of the Missile Defense Future Naval Capability: The Reactive Warhead project initiated design of a dynamic test of an optimal reactive material warhead and initiated lethality analysis for testing against targets representative of both theater ballistic and cruise missiles. (Funded in PE 0602111N).

Continued:

(U) Development of preliminary algorithms for Composite Threat Evaluation/Weapon Assignment (TEWA) across the entire theater of operations. (Funded in PE 0602111N)
(U) Development of preliminary algorithms for Composite Combat Identification (CCID) to assess feasibility of building ID across a network. (Funded in PE 0603238N).

- (U) Total Ownership Costs:

Continued:
(U) Development and flight demonstration of Vectoring enhanced short takeoff and landing (ESTOL) Control Tailless Operation Research (VECTOR) air platform (Funded in PE 0603217N).

(U) ($1,197) UNDERWATER PLATFORM SELF DEFENSE

Continued:
(U) Development of ATT and Tripwire Torpedo Defense System (TDS) technology. (Funded in PE 0603747N).

2. (U) FY 2002 PLANS:

(U) ($67,395) SURFACE SHIP & SUBMARINE HM&E

- (U) Signature Reduction:

Initiate:
(U) Surface ship boundary element model development for near field de-amping.
(U) Physical model of surface ship for near field de-amping demonstration and model validation.
(U) Stable algorithm development of near field de-amping system.
Continue:
(U) Large scale truss element evaluation for AMSS.
Complete:
(U) AMSS condenser overboard discharge acoustic demo.

- (U) Hull Life Assurance:

Initiate:
(U) Ship test planning for passive magazine protection. (Transitions to Project R3049 in this PE in FY03)
Complete:
(U) Propellant characterization and thermochemical combustion model for passive magazine protection. Tools for predicting the total response of stowed ordnance in a magazine with and without protective elements of Anti-Fratricide Shielding and Explosive Load Reduction.

- (U) Distributed Intelligence for Automated Survivability:

Initiate:

(U) Advanced Damage Countermeasures - investigation of water mist firefighting application for electronic spaces. (Transitions to Project R3049 in this PE in FY03)

(U) Development of an advanced volume sensor for fire and smoke detection. (Transitions to Project R3049 in this PE FY03)

- (U) Electric Warship:

Continue:
(U) Electric Warship planning and studies leading to new efforts in FY 03.
(U) Ship Service Fuel Cell Demonstration and Quiet Electric Drive/Submarine Secondary Propulsion Unit (SPU) projects.
Compete:
(U) Including completion of the Aircraft Electrical Servicing Station (AESS) Demonstration

- (U) Advanced Ship Concepts:

Initiate:
(U) Development of the Littoral Surface Craft (Experimental), LSC (X). Develop technologies for small, fast craft in the 500-1000 ton range for missions such as littoral ASW and mine countermeasures. Complete detailed design and begin construction of the LSC(X) prototype craft.

(U) ($15,922) SENSORS & ASSOCIATED PROCESSING

- (U) Distributive Aperture System:

Initiate:
(U) For Surface Ships, the Navy will launch a technology program (FY02 through FY06) for a ship based Distributive Aperture System (DAS) Infrared Search and Track (IRST) for transition to DDX, CGX, and CVNX. The staring IRST system will enable a passive self-protection capability for U.S surface ships. The system will address the need for low radar cross-section sensor for surface naval ships. The system will provide 360-degree staring panoramic view and awareness at-sea and in port of the surface, air, and asymmetric target set. Each module of the staring system will consist of focal plane arrays, anemorphic optics, stabilization, and modularization techniques. The ship's combat center will control the DAS through a central computer high-speed processor. The DAS, consisting of eight modules for surface combatant ships will vary based on the size of ship. It will provide surface ships with a 360-degree panoramic staring view on the horizon to line of sight, and be able to detect, declare, and track air contacts and surface contacts within 2-3 seconds. The sensor modules will also be able to pan its view downward to view the surface from the ship to line of sight for in port counterterrorism awareness. DAS will address the surface naval ships needs for a passive fighting and in-port security ability. The Navy will demonstrate a three-module prototype with a high-speed central computer in FY06. It is critical to demonstrate the technique to seam stitch three sensors panoramic view.

Initiate:
(U) For Naval Aircraft - The Missile Warning System (MWS) project will perform technology demonstrations of missile warning system components that are effective in detecting and locating threat missiles with the fidelity required for current and future tactical aircraft. A key component of the system is the development of a two color sensor using a

solid state mercury cadmium telluride (MCT) focal plane array (FPA) that will demonstrate a 99% focal plane array operability with an increase in operating temperature from 90° Kelvin to 140° Kelvin and a 100% improvement in the FPA cryogenic cooling efficiency. This FPA will be laboratory tested along with the high efficiency cooler system.
(U) For Surface Ships - The Shipboard electro-optic (EO)/IR closed loop Self Protection project that develops and demonstrates an integrated threat detection and closed-loop laser jamming system to counter EO/IR/laser guided threats to Naval combatants started integration of hardware for both the closed loop Infrared Countermeasures (IRCM) and open loop Electro-optic Countermeasures (EOCM) laboratory testing. The system will ultimately be demonstrated to be effective against TV guided, laser designated, mid-wave IR and long-wave IR guided (both autonomous and man-in-the-loop) seekers from a land site over water.
(U) For Small Platforms - Work on the EO/IR self-protection for Small Surface Vehicles project is focusing on breadboard demonstration of optical waveguide assemblies and suitable missile warning receivers to provide an automatic response for small platform and local area protection against IR guided and laser designated missiles and munitions. This work will be continued within the Electronic Warfare Integrated System for Small Platforms (EWISSP) effort in PE 0603235N in FY03.

- (U) Multifunction Infrared Distributive Aperture System:

Completed:
(U) For Naval Aircraft, the MIDAS ATD effort will be completed. Efforts in FY02 include the delivery of an operational MIDAS system for flight-testing and demonstration of the airborne situational awareness capability and subsequent transition of the technology to the Joint Strike Fighter (JSF) program office.

(U) ($7,605) MISSILE DEFENSE

Initiate:
(U) As part of the Missile Defense Future Naval Capability: The Affordable Ground Based Radar (AGBR) project design and development of a sub-scale two High Mobility Multi-Purpose Wheeled Vehicle (HMMWV) -mounted radar system for surveillance, air control, and fire control as risk reduction leading to the Multi-Role Radar System (MRRS). The Littoral Affordability (LA) project will develop affordable elements of multi-spectral sensor and combat systems for the purpose of early detection through engage functions over-the-horizon from firing ships. The Advanced Area Defense Interceptor (AADI) project will initiate planning effort for a Navy - Marine Corps air-directed surface-to-air missile (ADSAM) live firing demonstration in FY 2006. Furthermore, it will coordinate with numerous Navy program sponsors and offices to formalize requirements, establish funding strategy, and prepare demonstration.
Continue:
(U) As part of the Missile Defense Future Naval Capability: The Reactive Warhead project will continue development of a warhead for STANDARD Missile using reactive materials. Test planning will commence for dynamic sled testing at Holloman AFB in FY 2004.

- (U) Total Ownership Costs:

Continue:
(U) Development and flight demonstration of VECTOR air platform.

(U) ($1,186) UNDERWATER PLATFORM SELF DEFENSE

Continue:
(U) Development of ATT and Tripwire TDS technology
(U) Classified program.

3. (U) FY2003 PLANS:

(U) ($14,942) SURFACE SHIP & SUBMARINE HM&E

- (U) Signature Reduction:

Continue:
(U) Stable algorithm development of near field de-amping system.
(U) Outfit and begin demonstration with physical model of surface ship for near field de-amping math model validation.
(U) Evaluation of large-scale truss elements for AMSS.

- (U) Electric Warship:

Initiate:
(U) New projects addressing critical technology needs such as advanced energy storage, high powered switching and distribution, superconducting generators, and electric weapons.
Continue:
(U) Ship Service Fuel Cell and Quiet Electric Drive projects.

(U) ($5,000) SENSORS & ASSOCIATED PROCESSING

- (U) Distributive Aperture System:

Continue:
(U) For Surface Ships, development and packaging the prototype sensor module (in FY04).
(U) For Naval Aircraft, the Missile Warning System (MWS) project will conduct laboratory common jam code demonstrations and pointer/tracker functional demonstrations. Missile signature data will be collected during live fire tests of opportunity. This live fire data will be coupled with recorded urban signature clutter to determine statistically significant system performance improvements such as probability of declaration and false alarm rates. This data will be used by the MWS to correctly identify the threat, determine the time-to-go accuracy necessary to track and engage the threat seeker with an Infrared Countermeasures (IRCM) system using common jam codes to cause the seeker to breaklock.
(U) For Surface Ships, the Shipboard EO/IR closed loop self-protection project, designed to increase platform survivability by the detection, classification and jamming of EO/IR/Laser guided threats, will conduct a functional demonstration of its mid-IR laser; receive and evaluate a Deuterium Fluoride pulsed chemical laser; and prepare for closed loop IRCM system demonstration in FY04.

(U) For the EO/IR Self Protection for Small Surface Vehicles project, work will continue on the fabrication of the off-axis laser detection system that provides wide area threat detection capability against laser-designated missiles and munitions. Fabrication and integration of the decoy subsystems will also continue using a lightguide capable of transmitting radiation from .04 um to 12 um from a mast height ranging from 3.5 to 8 meters.

(U) ($27,000) MISSILE DEFENSE

Initiate:
(U) The Navy portion of the tri-Service National Aerospace Initiative will design and fabricate 'flight weight' engine and airframe components of a hypersonic missile based on dual combustion ramjet engine technology.
Continue:
(U) As part of the Missile Defense Future Naval Capability: The AGBR project will continue design and assembly of an Advanced Development Model (ADM) sub-scale array for risk reduction of MRRS. The Reactive Warhead project will continue in its development of a reactive material warhead for STANDARD Missile, will conduct safety certification of warhead design for the Weapon Safety Evaluation System Review Board, and prepare a physics-based damage prediction model. The Advanced Area Defense Interceptor (AADI) project will continue with planning and coordination for a Navy - Marine Corps ADSAM live firing demonstration in FY 2006.
(U) As part of the Time Critical Strike Future Naval Capability: The Cruise Missile Real Time Retargeting project was previously funded in PE 0603114N. The low cost seeker task of the Cruise Missile Real Time Retargeting (CMRTR) task will flight test the build 3 seeker to verify performance and eye safe capabilities, develop detailed design of the tactical seeker, and demonstrate and evaluate the performance of the Automatic Target Recognition (ATR) algorithm.
Complete:

(U) Total Ownership Cost
Complete:
(U) Development and flight demonstration of VECTOR air platform.
(U) Classified Program

(U) ($4,000) UNDERWATER PLATFORM SELF DEFENSE

Continue:
(U) Development of ATT and Tripwire TDS technology.

C. (U) PROGRAM CHANGE SUMMARY EXPLANATION: See Program change total summary for PE.

Schedule: Not Applicable.

D. (U) OTHER PROGRAM FUNDING SUMMARY:

(U) NAVY RELATED RDT&E:
(U) PE 0601153N (Defense Research Sciences)

(U) PE 0602123N (Force Protection Applied Research)
(U) PE 0602131M (Marine Corps Landing Force Technology)
(U) PE 0602235N (Common Picture Applied Research)
(U) PE 0602271N (RF Systems Applied Research)
(U) PE 0603640M (Marine Corps Advanced Technology Demonstrations)
(U) PE 0603235N (Common Picture Advanced Technology)
(U) PE 0603271N (RF Systems Advanced Technology)
(U) PE 0603502N (Surface and Shallow Water Mine Countermeasures)
(U) PE 0603513N (Shipboard System Component Development)
(U) PE 0603553N (Surface ASW)
(U) PE 0603561N (Advanced Submarine Systems Development)
(U) PE 0603563N (Ship Concept Advanced Design)
(U) PE 0603564N (Ship Preliminary Design and Feasibility Studies)
(U) PE 0603573N (Advanced Surface Machinery Systems)
(U) PE 0603609N (Conventional Munitions)
(U) PE 0603721N (Environmental Protection)
(U) PE 0204152N (E-2 Squadrons)
(U) PE 0205601N (HARM Improvement)
(U) PE 0206313M (Marine Corps Communications Systems)
(U) PE 0604307N (Surface Combatant Combat System Engineering)
(U) PE 0604518N (Combat Information Center Conversion)
(U) PE 0604558N (New Design SSN)
(U) PE 0604561N (SSN-21 Developments)

(U) NON NAVY RELATED RDT&E:
(U) PE 0602270A (EW Technology)
(U) PE 0602204F (Aerospace Sensors)

E.(U) SCHEDULE PROFILE: Not Applicable.

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603123N
PROGRAM ELEMENT TITLE: FORCE PROTECTION ADVANCED TECHNOLOGY

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUALS	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
R3049 Emerging Threats	0	0	6,662	9,452	11,914	3,469	3,958	CONT.	CONT.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: Includes RDT&E funds to develop and demonstrate advanced technologies that support platform self-protection. The new capabilities include the areas of all-weather, day/night protection of naval platforms and forces against all weapon threats, counter-stealth and countermeasures. Demonstrated capabilities support the ability to prevent or control platform damage while preserving operational capability. Hull life assurance addresses development of new structural system approaches for surface ships and submarines, including the management of weapons effects to control structural damage and the improvement of structural materials. Distributed intelligence for automated survivability addressees both the basic technology of automating damage control systems as well as distributed auxiliary control with self-healing capability.

B. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 2001 ACCOMPLISHMENTS: Not Applicable.

2. (U) FY 2002 PLANS: Not Applicable.

3. (U) FY 2003 PLANS:

(U) EMERGING THREATS ($6,662)

- (U) Hull Life Assurance:

Initiate:
(U) Vertical Launch System passive magazine protection design.
Continue and complete
(U) Ship test preparation for passive magazine protection full-scale test.
Complete:
(U) Blast yield/propagation test for passive protection.

- (U) Distributed Intelligence for Automated Survivability:

Continue:
(U) Small scale testing of high efficiency water mist system for application to electronic spaces within advanced damage countermeasures program. Continue response strategy development and intermediate scale system development for casualty flooding control system.

(U) Support 3 RHIB units in NUWC demonstration of Unmanned Surface Vehicles to provide force protection, ISR and potential weapons platform for naval harbor and port facilities.

C. (U) PROGRAM CHANGE SUMMARY EXPLANATION: See Program change total summary for PE.

(U) Schedule: Not Applicable.
(U) Technical: Not Applicable.

D. (U) OTHER PROGRAM FUNDING SUMMARY:

(U) NAVY RELATED RDT&E:
- (U) PE 0601153N (Defense Research Sciences)
- (U) PE 0602235N (Common Picture Applied Research)
- (U) PE 0602123N (Force Protection Applied Research)
- (U) PE 0603235N (Common Picture Advanced Technology)
- (U) PE 0603502N (Surface and Shallow Water Mine Countermeasures)
- (U) PE 0603561N (Advanced Submarine Systems Development)
- (U) PE 0603563N (Ship Concept Advanced Design)
- (U) PE 0603564N (Ship Preliminary Design and Feasibility Studies)
- (U) PE 0604558N (New Design SSN)
- (U) PE 0604561N (SSN-21 Developments)

(U) NON NAVY RELATED RDT&E: Not Applicable

E. (U) SCHEDULE PROFILE: Not Applicable.

CONGRESSIONAL PLUS-UPS

This section describes the following Congressional Plus-Ups appropriated in FY 2001 or FY2002 whose efforts fall within the scope of this restructured program, or which were appropriated in this program element:

AC Synchronous High Temperature Superconductor Electric Motor
Advanced Water Jet (AWJ-21)
Composite Helo Hangar Door
Computational Engineering Design
Curved Plate Technology
DDG-51 Composite Twisted Rudder
Knowledge Projection For Fleet Maintenance
Littoral Support Craft-Experimental (LSC-X)
Modular Composite Hull
Non-Magnetic, Stainless Steel Advanced Double Hull
Project M
Real Time Fire And Smoke Prediction Tool
SES 2000 Modification Hydrofoil Small Waterplane Area Catamaran
Ship Service Fuel Cell Technology Verification & Training Program
Smartlink System
Superconducting DC Motor
Virtual Testbed For Reconfiguring Ships
Wave Powered Electric Power Generating System/Portable Hybrid Electric Systems
Wireless Sensors For Total Ship Monitoring

(U) FY 2001 Congressional Plus-Ups:

- (U) ($3,383) AC Synchronous High Temperature Superconductor (HTS) Electric Motor: Complete conceptual design of a 25 MW/120 RPM motor and preliminary design of a 5MW/230 RPM subscale demonstration motor to be built and tested. Pursued component development for HTS field windings, cryogenic cooling, torque transfer, stator and tooling. (Funded in PE 0603508N)

- (U) ($3,861) Advanced Waterjet-21 (AWJ-21): Demonstrate a large-scale unit of the advanced waterjet and subsequent technology on a scaled platform to lower acoustic cavitation signatures as well as to reduce other signatures associated with surface ship propulsion systems. (Funded in PE 0603508N)

- (U) ($3,887) Composite Helo Hangar Door: Develop a composite helicopter hangar door for a DDG-51 Flight IIA ship. (Funded in PE 0603508N)

- (U) ($3,862): Computational Engineering Design: Provide advanced technology support for a computation engineering design tool. (Funded in PE 0602633N)

- (U) ($4,852) Hybrid Small Waterplane Area Catamaran (HYSWAC): Demonstrate manufacturing technology to allow major structural modification of ships allowing application of new materials and enable life extension. Began modifying ship to serve as a test bed for advanced electric propulsion components. (Funded in PE 0603792N)

- (U) ($2,899) Modular Composite Hull: Investigate modular composite construction allowing for the use of more complex bow shapes and stern hull components that could improve hydrodynamic performance, as well as reduce magnetic ship signatures for Navy surface ships. (Funded in PE 0603508N)

- (U) ($3,887) Non-Magnetic, Stainless Steel Advanced Double Hull: Development of a stainless steel advanced double hull structure for Navy ships. Perform an assessment on the structural integrity of hybrid composite/stainless steel hull structures and explore the benefits gained through the combination of stainless steel advanced double hull technology with composite hull technology. (Funded in PE 0602121N)

- (U) ($2,423) Portable Hybrid Electric Power Systems: Demonstrate the viability of wave power as a source of electric power by designing a Wave Energy Conversion (WEC) Buoy that converts wave motion to hydraulic power, and then to electrical energy. (Funded in PE 0603508N)

- (U) ($2,897) Project M: Development of a closed-loop degaussing system to confirm derivatives of the control system for benefit of the Electric Drive program. Build a full-scale mount, including a closed-loop degaussing system for the mount, resolution of ship systems integration issues, and confirmation of the performance potential of control systems. (Funded in PE 0603508N)

- (U) ($1,931) Ship Service Fuel Cell: Examine fuel-reforming technologies for molten carbonate fuel cells. Fuel cells offer the potential to increase the fuel efficiency of electric power generation by a factor of two or better. (Funded in PE 0603508N)

- (U) ($7,249) Superconducting DC Motor: Complete sizing of 25MW motor, preliminary design of a 3.7 MW subscale motor, design of a subscale motor test stand and preliminary ship system studies. Pursue component development/testing of brushes, brush holders, magnetic modeling and high current joints. (Funded in PE 0603508N)

- (U) ($2,419) Virtual Testbed for Reconfiguring Ships: Develop distributed computing and advanced visualizations to provide a means to test new engineered systems even before all the parts of the system actually exist. (Funded in PE 0603508N)

(U) FY 2002 Congressional Plus-Ups:

- (U) ($3,965) AC Synchronous High Temperature Superconductor (HTS) Electric Motor: Begin construction of the HTS propulsion motor and power electronics, and design an HTS generator as part of an integrated system to be tested in 2004.
- (U) ($3,469) Advanced Waterjet-21 (AWJ-21): Test a 1/4 scale unit of the advanced waterjet and subsequent technology demonstration on a scaled platform. An engineering evaluation of the propulsive efficiency and signature characteristics of the advanced design would be accomplished.

- (U) ($2,478) Curved Plate Technology: Development of curved plate technology in the construction of double hull vessels using steel and alloy metals with low magnetic, anti-corrosive properties.

- (U) ($2,478) Knowledge Projection for Fleet Maintenance: Provide advanced technology for better management of fleet maintenance.

- (U) ($16,057) Littoral Support Craft-Experimental (LSC-X): Design and construction for a Littoral Surface Craft - Experimental (LSC(X)) which will be a small, fast, experimental ship designed to operate in the littorals. The ship will be designed to carry a variety of mission modules, and will serve as a testbed for new technologies and new operational concepts.

- (U) ($2,775) Project M: Demonstrate derivatives of Project M active control technology for active degaussing (reduction of electromagnetic signatures) of naval motors and for mitigation of shock on small naval craft.

- (U) ($991) Real Time Fire and Smoke Prediction Tool: Develop advanced technology to better model fire and smoke spread in a shipboard environment.

- (U) ($7,235) SES 2000 Modification Hydrofoil Small Waterplane Area Catamaran (HYSWAC): Support modification of SES platform to HYSWAC configuration. Support at-sea testing for evaluation of the HYSWAC concept.

- (U) ($1,487) Smartlink System: Advanced technology application to a Smart link System.

- (U) ($1,982) Superconducting DC Motor: Advanced technology supporting preliminary design and construction of a 3.7 MW subscale motor.

- (U) ($1,982) Wave Powered Electric Power Generating System: Provide advanced technology support for the development of a power generating system driven by ocean wave motion.

- (U) ($2,775) Wireless Sensors for Total Ship Monitoring: Develop wireless sensor technology for monitoring all shipboard systems and providing situational awareness.

- (U) ($991) DDG-51 Composite Twisted Rudder: Develop a process for the manufacture of large Composite Twisted Rudders for the DDG-51 class ship, as well as those of other ships and other large ship components. Development of this process could enable the manufacture of affordable composite rudders and other large articles for DDG-51 and other vessels. (Funded in PE 0603508N)

- (U) ($1,982) Ship Service Fuel Cell Technical Verification & Training Program: Develop a dynamic simulation and validation capability for a diesel fuel cell. (Funded in PE 0603508N)

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603217N
PROGRAM ELEMENT TITLE: Air Systems and Weapons Advanced Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE
R0446 Advanced Avionics Subsystems	2,943	*
R0447 Weapons Advanced Technology	27,278	*
W2014 Integrated High Performance Turbine Engine Technology (IHPTET)	5,849	*
R2455 Vectoring Extremely Short Take-off and Landing (ESTOL) Control Reduced Tail Operation Research (VECTOR)	5,438	0
R2487 DP-2 Thrust Vectoring System Proof of concept demonstration	4,666	0
R2820 IHPTET Integrated High Performance Turbine Engine Technology	966	0
R2821 Integrated Hypersonic Aeromechanics Tool Engine Technology	2,417	0
R2822 Eye safe LADAR	4,842	0
R2823 Precision Strike Navigator	4,355	0
R2824 SAR All Weather Precision Targeting	3,867	0
TOTAL	62,621	

*This Program Element (PE) was restructured in FY 2002. FY2001 efforts are described in PE 0602114N, 0603114N, 0603123N, and 0603236N.

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603217N
PROGRAM ELEMENT TITLE: Air Systems and Weapons Advanced Technology

FY 2001 Congressional Plus-ups appropriated in this PE are described under the following restructured PE.

TITLE	PE Number	FY 2001
DP-2 Thrust Vectoring System	0603114N	$4,339
Eye Safe LADAR	0603114N	$4,842
IHPTET (Integrated High Performance Turbine Engine Technology)	0603114N	$966
Integrated Hypersonic Aeromechanics Tool Technology	0603114N	$2,417
Precision Strike Navigator	0603114N	$4,355
SAR All Weather Precision Targeting	0603114N	$3,867

FY 2003 RDT&E, N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603235N
PROGRAM ELEMENT TITLE: Common Picture Advanced Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
R2919 Communications Security	**	48,122	37,753	44,022	63,556	64,066	61,295	CONT.	CONT.
R9020 National Cargo Tracking Program		1,685	0	0	0	0	0	0	1,685
TOTAL	**	49,807	37,753	44,022	63,556	64,066	61,295	CONT.	CONT.
Defense Emergency Response Fund (DERF)			7,000	7,000	7,000	6,000	4,000	CONT.	CONT.

**The Science and Technology (S&T) Program Elements (PEs) were restructured in FY 2002. FY 2001 efforts were funded in PEs 0603238N, 0603794N and 0603707N.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION:

(U) This PE includes funds for the advanced technology development, test and evaluation of a dynamic distributed common picture based on leading edge technologies that will improve situational awareness across Command echelons from the Commander in Chief (CINC) to tactical units afloat and war-fighters ashore. This effort will demonstrate a capability for building and maintaining a seamless secure, common operational and tactical picture of the total battlespace, thereby providing Naval Forces a capability for self-synchronization, increased speed of command, and optimized resource allocations. The Common Picture Program supports the following Future Naval Capabilities (FNCs): Knowledge Superiority and Assurance (KSA); Missile Defense; Littoral Anti-Submarine Warfare (ASW); and Platform Protection. Advanced technologies to be developed, tested and demonstrated include: (1) communication protocols and networks for secure data link operation; (2) information networks for cooperative target tracking; (3) information and knowledge management tools; (4) exploitation, extraction and distribution tailored information; (5) communication security and information assurance technologies; (6) decision support tools for use in network-centric operations and collaborative environments; (7) multi-source integration for composite combat identification (ID) and target tracking; (8) small platform situational awareness and protection; and (9) cross-platform data fusion for formulating a common tactical/environmental picture in support of littoral ASW.

(U) Due to the number of efforts in this PE, the programs described are representative of the work included in this PE.

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603235N
PROGRAM ELEMENT TITLE: Common Picture Advanced Technology

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the ADVANCED TECHNOLOGY DEVELOPMENT Budget Activity because it encompasses design development, simulation, or experimental testing of prototype hardware to validate technological feasibility and concept of operations and reduce technological risk prior to initiation of a new acquisition program or transition to an ongoing acquisition program.

B. (U) PROGRAM CHANGE SUMMARY:

	FY 2001	FY 2002	FY 2003
(U) FY 2002 President's Budget	**	48,583	
(U) Adjustments from FY 02 PRESBUDG:			
Section 8123 Management Reform Initiative Reduction		-444	
FFRDC Reduction		-32	
Congressional Plus up		1,700	
(U) FY 2003 President's Budget Request:	**	49,807	37,753

**The Science and Technology PEs were restructured in FY 2002. FY 2001 efforts were funded in PEs 0603238N, 0603794N and 0603707N.

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603235N
PROGRAM ELEMENT TITLE: Common Picture Advanced Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
R2919	Communication Security								
	**	48,122	37,753	44,022	63,556	64,066	61,295	CONT.	CONT.

**The Science and Technology (S&T) Program Elements (PEs) were restructured in FY 2002. FY 2001 efforts were funded in PEs 0603238N, 0603794N and 0603707N.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION:

(U) This PE includes funds for the advanced technology development, test and evaluation of a dynamic distributed common picture based on leading edge technologies that will improve situational awareness across Command echelons from the Commander in Chief (CINC) to tactical units afloat and war-fighters ashore. This effort will demonstrate a capability for building and maintaining a seamless secure, common operational and tactical picture of the total battlespace, thereby providing Naval Forces a capability for self-synchronization, increased speed of command, and optimized resource allocations. The Common Picture Program supports the following Future Naval Capabilities (FNCs): Knowledge Superiority and Assurance (KSA); Missile Defense; Littoral Anti-Submarine Warfare (ASW); and Platform Protection. Advanced technologies to be developed, tested and demonstrated include: (1) communication protocols and networks for secure data link operation; (2) information networks for cooperative target tracking; (3) information and knowledge management tools; (4) exploitation, extraction and distribution tailored information; (5) communication security and information assurance technologies; (6) decision support tools for use in network-centric operations and collaborative environments; (7) multi-source integration for composite combat identification (ID) and target tracking; (8) small platform situational awareness and protection; and (9) cross-platform data fusion for formulating a common tactical/environmental picture in support of littoral ASW.

B. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 2001 ACCOMPLISHMENTS:

- (U) ($3,300) DECISION SUPPORT SYSTEMS: Decision Support System supports the KSA FNC. The emphasis is on developing information and knowledge technologies in the area of computer assisted decision aids. This technology development is based on the Fleet's need to build and maintain a timely operational/tactical picture of the total battlespace across all Command echelons from the CINC to tactical units afloat as well as warfighters ashore. In FY 01, the Enterprise Workstation was delivered to United States Commander in Chief Pacific (USCINCPAC), United States Commander in Chief Strategic (USCINCSTRAT) Command and Defense Threat Reduction Agency (DTRA).

The Enterprise Workstation enables an operator to simultaneously operate on two separate local area networks with a single workstation. This capability improves an operator's ability to correlate information and reduces equipment and maintenance costs by 60 percent. Also, the Defense Collaboration Tool Suite (DCTS) was delivered to USCINCPAC. Along with this a six-panel large screen display was delivered to USCINCSTRAT with software that enables the Command and Control (C2) Concept Development laboratory at Strategic Command (STRATCOM) to develop tactics, techniques, and procedures for the effective display of summarized C2 information. Completed the formal assessment of the FY01 demonstration, establishing the potential military application of CINC21 developed integrated services. (FY 2001 accomplishments were funded in PE 0603707N.)

- (U) ($5,000) SURFACE/AEROSPACE SURVEILLANCE MULTI-SOURCE INTEGRATION AND COMBAT IDENTIFICATION: The Surface/Aerospace Surveillance Multi-source Integration and Combat Identification Advanced Technology program in FY 2001 conducted system studies to define overall system architectures in the E-2C Airborne Early Warning (AEW) aircraft and the Navy’s EP-3 aircraft. The E-2C Multi-Source Integration (MSI) studies focused on the total sensor and avionics system architecture with emphasis on defining electrical and mechanical interfaces including signal levels and timing to enable the integration of multiple sensor data streams on-board the aircraft. This technology significantly reduces crew/operator workload and enhances the ability of the aircraft to rapidly determine combat threat identification for hand-off/cueing via the Cooperative Engagement Capability (CEC) network/tactical data links to other warfighting participants. Laboratory demonstrations were conducted in FY01, which validated system level input/output functionality and demonstrated fusion and correlation of Electronic Support Measures (ESM) and radar track algorithms were highly effective in reducing multiple redundant tracks. EP-3 system efforts focused on determining the mix and fidelity of available sensor parameters and their contribution to the determination of high confidence combat identification. The EP-3 studies also focused on development of system level interfaces to facilitate networking of Story Maker system combat identification products to other warfighting units. The program completed System studies to quantify the impact of distributing real time Composite Combat Identification (CCID) information to battle group and other theater users on available network and data link bandwidths. (FY 2001 accomplishments were funded in PE 0603238N.)

- (U) ($14,808) EXTENDING THE LITTORAL BATTLESPACE: Extending the Littoral Battlespace (ELB) is an Advanced Concept Technology Demonstration (ACTD) intended to extend high throughput wireless networking across a Naval Expeditionary Task Force including an embarked Marine Air-Ground Task Force (MAGTF), as part of a overall Joint Task Force. The ACTD demonstrated enhanced integrated command, control/fires, and targeting capability in support of joint dispersed units, enabling common situational awareness, enhanced access to joint fires, facilitating dynamic maneuver and reducing fratricide. In FY01 a partial ELB ACTD, equipment suite successfully completed an operational deployment with the USS TARAWA ARG/13th MEU to the Arabian Gulf. Additionally, the ACTD successfully completed Full Systems Test 3 followed by Major Systems Demonstration Two (MSD II) as part of Exercise Kernal Blitz (Experimental). A Military Utility Assessment (MUA) was completed as part of MSD II. The draft MUA strongly endorsed the capabilities demonstrated during MSD-II. USCINCPAC is expected to be release the final draft of the MUA by late January 2002. (FY 2001 accomplishments were funded in PE 0603238N.)

- (U) (3,000) GLOBAL POSITIONING SYSTEM (GPS) & NAVIGATION TECHNOLOGY: GPS is essential for many modern naval and maritime systems, and generally speaking it is essential that GPS-derived navigation and timekeeping services be made available to platforms and weapons at the highest level of accuracy and with the highest possible confidence at reasonable cost. Unfortunately, the GPS signal is a low-power signal that is susceptible to interference. Therefore, there is a need for developing GPS anti-jam technology and non-GPS navigation devices and systems. The emphasis of this thrust is in the following three areas: Integration of the GPS and Inertial Navigation System (INS), relative navigation system using GPS and other existing position location systems such as Link 16/Joint Tactical Information Distribution System (JTIDS) and Enhanced Position Location Reporting System (EPLRS), and non-GPS navigation system (Atom Interferometer Gravity Gradiometer for submarines. The first effort deals with the development of integrated GPS and INS system, which draws upon the commercially available INS with GPS when the GPS is jammed. The second effort deals with the development of a relative navigation system with GPS and Link 16/JTIDS and EPLRS. A prototype system was developed for aircraft using a Kalman filter and a track integration system. The third effort deals with alternatives to GPS and to relative navigation. The cooled atom was used to detect the gravity gradient, thereby, developing a collision avoidance system for submarines. Another alternative effort was concerned with the development of a Rubidium (Rb) atomic clock using the coherent population trapping (CPT) technology. The technical objective of an Rb atomic clock is to eliminate a maser cavity, thereby, reducing the size of the clock. A small, accurate and affordable atomic clock can be used as a timekeeping device for various naval platforms when GPS-derived clock is denied by jamming. (In FY01, work was funded in PE 0603794N.)

2. (U) FY 2002 PLANS:

(U) ($12,884) KNOWLEDGE SUPERIORITY AND ASSURANCE (KSA) Combined FY01 Thrust entitled Decision Support Systems and Secure Networked Information System under the thrust title KSA. The KSA Future Naval Capability (FNC) enables warfighters to plan and execute operations that are coordinated across organizations and command echelon, including coalition partners. The KSA FNC addresses warfighter needs in four areas: a) Secure Networked Information Systems, b) 21st Century Command, c) Common Picture, and d) Time Sensitive Decision Making. Secure Networked Information Systems emphasize developing technologies supporting secure heterogeneous wireless communication networks for data (e.g. voice, multi-media) links and interconnecting air, ship, submarine and land platforms. In the area of the 21st Century Command, the objective is to develop a capability to correlate and present information from diverse sources such as news, messages, voice reports, and briefings in near real time. Common Picture addresses developing software tools as aid to the planning, monitoring, and re-planning cycle of combat operations. The last area, Time Sensitive Decision Making, addresses the real time and quality of information technology issues. Examples of Time Sensitive Decision Making technology area include: automatic image registration in support of geo-locating targets, course of action simulation, projection, and assessment, and visualization of the planned battlespace. In FY02, the emphasis continues towards developing information and knowledge management technologies for use in building and maintaining a timely common operational and tactical picture of the total battlespace. Technology demonstrations include: (1) Knowledge based operations with intuitive visualization for Command Center operations; (2) multi-source integration; situational assessment decision aids that reduces operator workload and optimize resource allocation; (3) interactive distributed planning, monitoring and re-planning software; and (4) collaborative technologies to support distributed operations and time sensitive decision making.

- (U) ($4,600) INTEGRATED ASW: Integrated ASW (IASW) supports the Littoral Anti-Submarine Warfare (LASW) FNC. The emphasis is on developing a common ASW tactical and environmental picture to improve detecting, tracking, and classifying subsurface platforms. Technologies that will be developed and demonstrated include; cross platform data fusion, common sensor performance predictions across platforms, and capturing sensor performance uncertainty. In FY 2002 Integrated ASW builds on the efforts from the previous year (under PE 0603747N Cooperative ASW) and begins extending the technology previously developed for inter-platform fusion between surface combatant ships and Maritime Patrol Aircraft (MPA). In addition, the technology for fusion of data from MPA radar data and Extended Echo Ranging (EER) data will be initiated. In support of these algorithm developments, data collections and sea-tests will be performed. The algorithms will be assessed using recorded data and taken to sea on appropriate platforms. In FY 2002, IASW will also begin focusing on the Common Environmental Picture phase of the program. The new effort builds on the previous work in improved fusion to incorporate up-to-date environmental information into sensor performance prediction capability. It will leverage “through-the-sensor” in-situation measurements to enable tactically useful planning and performance prediction. The value-added of the improved sensor performance capability will be assessed using the previously developed capability.

- (U) ($7,500) SURFACE/AEROSPACE SURVEILLANCE MULTI-SOURCE INTEGRATION AND COMBAT IDENTIFICATION: Surface/Aerospace Surveillance Multi-Source Integration & Combat ID supports the Missile Defense FNC. The emphasis of this thrust is on development of advanced technologies for Multi-source Integration, Cooperative Target Tracking, Improving Combat Identification and extending Naval Capabilities to engage air targets near point of origin by using all source data to formulate a common operational and tactical picture of the total battle space. In FY 2002, the program initiated advanced development efforts to fabricate a field test model of the Affordable Ground Based Radar (AGBR). AGBR is being developed as a multimode/multi-mission radar specifically for US Marine Corps expeditionary warfare operations. AGBR technology developed in this Program Element (PE) is planned for insertion into the Marine Corps Multi-Role Radar System (MRRS) development in the Fiscal year 2004/2005 time frame. MRRS when fielded in the Fiscal year 2007/2008 time frame is intended to replace and perform the functions of three current battlefield radars (TPS-63, TPS-73, MPQ-62). (This project will move to PE 0603271N in FY 2003.) Following the successful initial laboratory demonstrations of the E-2C multi-source integration and data fusion technologies, development and assessment of algorithms to fuse and correlate off-board satellite communications information (SATCOM) with on-board ESM information will be conducted. Fusion and correlation of on-board and off-board ESM information contributing to Composite Combat Identification (CCID) information will continue.

- (U) ($1,000) PLATFORM AWARENESS & PROTECTION/ELECTRONIC WARFARE SYSTEMS: Platform Awareness & Protection supports the Platform Protection FNC. Current small platforms (both surface and airborne) have little to no Situational Awareness (SA) capability that can significantly increase their battlefield effectiveness and combat survivability. The focus of this effort is on developing a compact, small platform SA capability that is particularly suited for smaller ships, amphibious assault vehicles, and surveillance aircraft. This PE integrates successful proof-of-concept hardware/software developed under PE0602235N, into systems suitable for capability demonstration under naval environments and tactical conditions. The SA system, a subset of the Electronic Warfare Integrated System for Small Platforms (EWISSP) program, addresses several small surface platform self protection system integration requirements and employs miniature millimeter-wave integrated circuit (MMIC) devices and a new antenna to form an extremely compact, low volume/light weight system that provides very accurate hemispheric direction finding and self-protection capability against threat missile systems. EWISSP is being executed in four phases. During Phase I (FY02-FY03) the EWISSP program will continue to review the candidate platforms' concept of employment (COE) and tradeoffs leading to the definition of performance requirements for an affordable Electronic Warfare (EW) system capable of providing substantially increased platform survivability will be conducted. Advanced prototypes of the Compact Small Platform SA projects within the EWISSP program are specifically addressed under this PE. Planned tasked under this PE include top-level investigations of approaches to integrate the EWISSP into defined platforms and development of demonstration plans.

- (U) ($15,000) COMMUNICATION SECURITY - Classified Program

- (U) ($1,000) INFORMATION SECURITY RESEARCH: The goal of the Navy Information Security Thrust is to ensure the continued protection of Navy and Joint information and information systems from hostile exploitation and attack. The rapid rate of change in the underlying commercial and government information infrastructures makes the provision of security an increasingly complex and dynamic problem. Information Assurance (IA) technologies and deployment strategies must evolve quickly to meet the rapidly evolving threats and vulnerabilities. No longer can information security be separate from the information infrastructure. The program develops frameworks, architectures, and products based on mission threats, information criticality, exploitation risks, common criteria, and integrated Joint information system efforts in close cooperation with Office of the Chief of Naval Operations and National Security Agency. The FY02 work includes: (1) Determination of vulnerabilities to information security resulting from legacy Naval information systems, their insertion into networked environments, their systems management, and their modernization; and (2) Development of IA tools and techniques to assist system administrators and software developers in the rapid and effective IA evaluation of IT products.

- (U) ($1,000) EXTENDING THE LITTORAL BATTLESPACE: Extending the Littoral Battlespace (ELB) is an Advanced Concept Technology Demonstration (ACTD) to extend high throughput wireless networking across a Joint Task Force. The ACTD will demonstrate enhanced integrated command, control/fires, and targeting capability in support of joint dispersed units, enabling common situational awareness, enhanced access to joint fires, facilitating dynamic maneuver and reducing fratricide. In FY02, the effort will focus on transition of proven technologies to multiple acquisition programs, and refinement/system tests of the ELB ACTD equipment and application suite in preparation for calendar year (CY) 2003 deployment with Joint Task Force elements including a Navy Carrier Battle Group, Amphibious Readiness Group, Marine Air-Ground Task Force, Army Brigade Combat Team and Air Force Air Operations Center.

- (U) (3,638) GLOBAL POSITIONING SYSTEM (GPS) & NAVIGATION TECHNOLOGY: Three approaches are being pursued under this effort: The development of tightly coupled GPS and INS, the development of the relative navigation concept using GPS and other existing organic navigation systems in the fleet, and non-GPS navigation technology such as the atom interferometer gravity gradiometer. The first effort is to develop an integrated GPS and INS system, which draws upon the capability presently available in a GPS receiver with a tightly coupled micro-electronic mechanical system (MEMS). The second effort is to develop relative navigation efforts, which draw upon the capabilities presently available in the fleet that use Link 16/JTIDS and EPLRS systems. This approach attempts to locate elements in the battle group through RF signal time-of-flight. Over all, the relative navigation approach draws upon a wide range of navigation and precision clock capabilities available in the navy battle group and extends their availability through available communications links. The third efforts are to develop an alternative navigation system (Atom Interferometer Gravity Gradiometer) for submarines and to develop a miniaturized Rubidium atomic clock. In FY01, a prototype Gravity Gradiometer was constructed with an optical laser device and an electronic control device to prove the principle of the concept. In FY02, this effort will be concerned with the miniaturization of the Gravity Gradiometer. Likewise, in FY01 a prototype Rb atomic clock was constructed with an optical laser device and an electronic control device to prove the principle of the concept. In FY02, this effort will be concerned with the miniaturization of the Rb atomic clock.

- (U) ($1,500). MARINE MAMMALS: This area of effort provides both data and models for decision making regarding interactions of naval activities with protected marine life and habitats (marine mammals, birds, turtles, fish, fish habitat, etc.). In keeping with Navy environmental stewardship policies laid out in National Environmental Policy Act (NEPA), Executive Order (E.O) 12114, SECNAVINST 5090.1.b. and related documents, these common tactical picture advanced technologies are needed to ensure Navy compliance with appropriate environmental laws while maintaining full operational and exercise capabilities. The program provides hardware and software solutions that are uniquely suited to the marine environment in which Navy operates, and which are uniquely compatible to existing tactical and METOC (meteorological and oceanographic) assets used by Navy. No other agency or service is capable of providing the unique combination of biological information for a marine environment, placed in the context of other common tactical picture assets unique to the Navy's mission and arena of operation. This area of effort is new to PE 0603235N in FY01. Prior-year Basic and Applied Research programs (PE 0601153N and PE 0602121N) demonstrated new hardware and software systems capable of demonstration in this PE: the selected FY02 projects follow: 1) Marine Mammal Monitoring on Navy Instrumented Test Ranges (M3R), a project of the Naval Undersea Warfare Center in Newport RI, is demonstrating the capability of Navy instrumented test ranges to self-monitor for protected marine life. Test ranges can use existing tactical sensing and signal processing assets, and minimal additional hardware and software for picking out biological signals, localizing and tracking them in the same way a tactical target of interest would be monitored, thus making the information readily accessible to staff trained only for the tactical mission of the range (no additional specialized training for environmental compliance monitoring). The initial test is sited at the AUTEC test range, and an additional demonstration is being set up for FY02-03 at the Pacific Missile Range Facility (PMRF). 2) Prediction of Acoustic Safety Criteria for Marine Mammals, developed by the Space and Naval Warfare Center in San Diego, and the University of California at Santa Cruz, provides an empirical database and predictive model for safe sound exposure levels for marine life, comparable to National Institute of Occupational Safety and Health (NIOSH) hearing safety standards for humans in the workplace. The interim database and model is now used in all Navy environmental compliance documents, and a final version anticipated in 12-24 months.

3. (U) FY 2003 PLANS:

- (U) ($17,500) KNOWLEDGE SUPERIORITY AND ASSURANCE (KSA): KSA Future Naval Capability (FNC) enables warfighters to plan and execute operations that are coordinated across organizations and command echelon, including coalition partners. The KSA FNC addresses warfighter needs in four areas: a) Secure Networked Information Systems, b) 21st Century Command, c) Common Picture, and d) Time Sensitive Decision Making. Secure Networked Information Systems emphasize developing technologies supporting secure heterogeneous wireless communication networks for data (e.g. voice, multi-media) links and interconnecting air, ship, submarine and land platforms. In the area of the 21st Century Command, the objective is to develop a capability to correlate and present information from diverse sources such as news, messages, voice reports, and briefings in near real time. Common Picture addresses developing software tools as aid to the planning, monitoring, and re-planning cycle of combat operations. The last area, Time Sensitive Decision Making, addresses the real time and quality of information technology issues. Examples of Time Sensitive Decision Making technology area include: automatic image registration in support of geo-locating targets, course of action simulation, projection, and assessment, visualization of the planned battlespace. In FY03, the emphasis continues towards developing information and knowledge management technologies for use in building and maintaining a timely common operational and tactical picture of the total battlespace. Specific projects include: (1) sea combat commanders' module for embarked staff; (2) common undersea picture architecture; (3) course of action analysis tool for identifying mobile time sensitive targets; and (4) comprehensive, analytic, real-time execution in joint air operations.

- (U) ($4,600) INTEGRATED Anti-Submarine Warfare: Integrated ASW supports the Littoral Anti-Submarine Warfare (ASW) FNC. The emphasis is on developing a common ASW tactical and environmental picture to improve detecting, tracking, and classifying subsurface platforms. Technologies that will be developed and demonstrated include; cross platform data fusion, common sensor performance predictions across platforms, and capturing sensor performance uncertainty. In FY 2003, Integrated ASW concludes the development and assessment of the advanced fusion engines and documents the results of the assessments and sea tests. A final sea test will be completed early in FY03. The Common Environmental Picture phase of the program will concentrate on data collection events and the initial architecture for sharing environmental data within a tactical timeline. Critical areas for improvement in sensor performance prediction will be identified and tasks initiated or accelerated.

- (U) ($3,300) SURFACE/AEROSPACE SURVEILLANCE MULTI-SOURCE INTEGRATION AND COMBAT IDENTIFICATION: Surface/Aerospace Surveillance Multi Source Integration & Combat ID supports the Missile Defense FNC. The emphasis of this thrust continues to be on development of advanced technologies for Multi-Source Integration, Cooperative Target Tracking, Improving Combat Identification and extending Naval Capabilities to engage air targets near point of origin by using all source data to formulate a common operational and tactical picture of the total battle space. The Affordable Ground Based (AGBR) was moved to PE 0603271N in FY 2003. In FY 2003, the program of platform (E-2C) Multi-Source Integration (MSI) project, that is developing advanced technology to improve combat system efficiencies and to reduce operator workload, will continue in the development and optimization of information fusion and correlation techniques including optimization of algorithms to fuse and correlate off-board satellite communication information with on-board Electronic Support Measures (ESM) information. The project will initiate the development of interfaces and fusion algorithms to enable the integration and fusion of E-2C Infrared Search and Track sensor information with information from the on-board radar, Identification Friend or Foe (IFF) and the Electronic Support sensor. Complete development and laboratory/hardware in the loop evaluation of on-board/off-board ESM Composite Combat Identification algorithms.

- (U)($3,800) PLATFORM AWARENESS & PROTECTION/ELECTRONIC WARFARE SYSTEMS: Platform Awareness & Protection supports the Platform Protection FNC. Current small platforms (both surface and airborne) have little to no SA capability that can significantly increase their battlefield effectiveness and combat survivability. The focus of this effort will be to develop a compact, small platform SA capability that is particularly suited for smaller ships, amphibious assault vehicles, and surveillance aircraft. The SA system, a subset of the EWISSP program, will address several small surface platform requirements and will employ MMIC devices, a new antenna to form an extremely compact, low volume and light weight system that can provide very accurate hemispheric direction finding and a self-protection capability against threat missile systems. During Phase I (FY02-03) the threat to small Navy and Marine combat platforms will be defined, individual vehicle integration and installation requirements/limitations will be determined, and measurements of the platform signature (RF/Milli-Meter Wave (MMW)/IR) will be conducted. The platforms' Concept of Employment (COE) are reviewed and trade-offs leading to the definition of performance requirements for an affordable EW system capable of providing substantially increased platform survivability will be conducted. Following this, top-level system requirements and the system and subsystem designs will be developed. In FY03, EWISSP EO/IR efforts previously funded in PE 0603123N will migrate into this PE to facilitate the consolidation of EW related efforts. In Phase II (FY03-05) detailed EWISSP subsystem designs will be developed and the various component modules fabricated and integrated within the system. Interfaces between the various subsystems (both hardware (HW) and software) will also be defined and developed. Subsystem hardware and software performance will be successfully demonstrated to defined levels in a laboratory/field environment at the end of this phase. In addition, they will be compatible with existing and/or planned basic physical and electrical designs and features of host platforms. For the EO/IR Self-Protection for Small Surface Vehicle project, work will continue on the fabrication of the off-axis laser detection system that provides wide area threat detection capability against laser-designated missiles and munitions. Fabrication and integration of the decoy subsystem will also continue using a lightguide capable of transmitting radiation from 0.4 um to 12 um from a mast height ranging from 3.5 to 8 meters.

- (U) ($1,553) INFORMATION SECURITY RESEARCH: The goal of the Navy Information Security Thrust is to ensure the continued protection of Navy and Joint information and information systems from hostile exploitation and attack. The rapid rate of change in the underlying commercial and government information infrastructures makes the provision of security an increasingly complex and dynamic problem. Information Assurance (IA) technologies and deployment strategies must evolve quickly to meet the rapidly evolving threats and vulnerabilities. No longer can information security be separate from the information infrastructure. The program develops frameworks, architectures, and products based on mission threats, information criticality, exploitation risks, the common criteria, and integrated Joint information system efforts in close cooperation with OPNAV and NSA. The FY03 work includes: (1) continuing the determination of vulnerabilities to information security resulting from legacy Naval information systems, their insertion into networked environments, their systems management, and their modernization; and (2) continuing the development of IA tools and techniques to assist system administrators and software developers in the rapid and effective IA evaluation of IT products.

- (U) ($1,000) EXTENDING THE LITTORAL BATTLESPACE: Extending the Littoral Battlespace (ELB) is an Advanced Concept Technology Demonstration (ACTD) to extend high throughput wireless networking across a Joint Task Force. The ACTD will demonstrate enhanced integrated command, control/fires, and targeting capability in support of joint dispersed units, enabling common situational awareness, enhanced access to joint fires, facilitating dynamic maneuver and reducing fratricide. In FY03, the effort will focus on transition of proven technologies to multiple acquisition programs, and system tests of the ELB ACTD equipment and application suite in preparation for CY03 workup, exercise and deployment with Joint Task Force elements including a Navy Carrier Battle Group, Amphibious Readiness Group, Marine Air-Ground Task Force, Army Brigade Combat Team and Air Force Air Operations Center.

- (U) (4,500) GLOBAL POSITIONING SYSTEM (GPS) & NAVIGATION TECHNOLOGY: Three approaches will be pursued under this effort: The development of tightly coupled GPS and Inertial Navigation System (INS), a relative navigation concept using GPS and other existing organic navigation assets in the fleet and non-GPS navigation technology such as the Atom Interferometer Gravity Gradiometer for submarines. The first effort is to develop an integrated GPS and INS system. This effort will replace the existing GPS receiver, a Costas loop filter, with a new Kalman filter tracking system. This will increase the anti-jamming (AJ) mitigation capabilities of the system. The second effort is to develop the relative navigation system by improving the precision time transfer with a more accurate clock, thereby, reducing the accuracy margin of the JTIDS. This will improve the relative navigation accuracy from 100 meters to about 30 meters. The third effort is to develop alternatives to GPS navigation. This category draws upon wide-ranging physical principles and phenomena. One aspect is concerned with the development of an atom gravity gradiometer, which will be transportable on aircraft such as P3-C. The other aspect is also concerned with the development of field test unit (FTU) Rubidium atomic clocks. The current Rubidium atomic clock is housed in a 19-inch rack. The FTU clock will be compact (about the size of a beer can).

- (U) ($1,500) MARINE MAMMALS: This area of effort provides both data and models for decision-making regarding interactions of naval activities with protected marine life and habitats (marine mammals, birds, turtles, fish, fish habitat, etc.). In keeping with Navy environmental stewardship policies laid out in NEPA, E.O. 12114, SECNAVINST 5090.1.b. and related documents, these common tactical picture advanced technologies are needed to ensure Navy compliance with appropriate environmental laws while maintaining full operational and exercise capabilities. The program provides hardware and software solutions that are uniquely suited to the marine environment in which Navy operates, and which are uniquely compatible to existing tactical and METOC (meteorological and oceanographic) assets used by Navy. No other agency or service is capable of providing the unique combination of biological information for a marine environment, placed in the context of other common tactical picture assets unique to the Navy's mission and arena of operation. This area of effort is new to PE 0603235N in FY01. Prior-year Basic and Applied Research programs (PE 0601153N and PE 0602121N) demonstrated new hardware and software systems capable of demonstration in this PE. In FY03 M3R will complete testing of automated signal processing algorithms that will enable the automatic collection of marine mammal data during usage of Navy test ranges, thus providing an integral, non-interfering self-monitoring capability for environmentally compliant test range operations. In addition, M3R data will be ground-truth against visual and other, standardized acoustic monitoring assets, in order to calibrate M3R data with estimated numbers of marine mammals on the range. This ability to convert range detection rates to a numerical estimate of total animals present is required for environmental compliance documentation under NEPA and EO12114. Prediction of Acoustic Safety Criteria will prepare for demonstration a synthesized model that will be able to predict safety thresholds for any Navy sound source operated under any specified set of conditions. The result will be a set of consistent, standardized impact assessment criteria for all naval activities emitting underwater sound. An additional planned FY03 project would extend M3R capabilities to deployable sensing technologies for field application outside Navy instrumented test ranges, anywhere in the world, e.g. sonabuoys, or easily deployed towed or 'pop-up' instruments. The sensors and M3R-like processing would be rendered compatible with existing ship and helicopter-deployed tactical sensors used for ASW or similar missions, rendering the environmental compliance aspect of any operation or exercise transparent to existing operational and exercise hardware and protocols, resulting in environmental compliance capability with little or no impact on the tactical mission.

C. (U) PROGRAM CHANGE SUMMARY EXPLANATION:

(U) Schedule: Not Applicable.
(U) Technical: Not Applicable.

D. (U) OTHER PROGRAM FUNDING SUMMARY:

(U) RELATED RDT&E: The Navy's 6.1 program contributes to this effort.

(U) NAVY RELATED RDT&E:

(U) PE 0601153N (Defense Research Sciences)
(U) PE 0602114N (Power Projection Applied Research)
(U) PE 0602123N (Force Protection Applied Research)
(U) PE 0602131M (Marine Corps Landing Force Technology
(U) PE 0602235N (Common Picture Applied Research)
(U) PE 0602271N (RF Systems Applied Research)
(U) PE 0204152N (E-2 Squadrons)
(U) PE 0205601N (HARM Improvement)
(U) PE 0206313M (Marine Corps Communications Systems)
(U) PE 0603123N (Force Protection Advanced Technology)
(U) PE 0603271N (RF Systems Advanced Technology)
(U) PE 0603609N (Conventional Munitions)
(U) PE 0603640M (Marine Corps Advanced Technology Demonstrations
(U) PE 0603658N (Cooperative Engagement)
(U) PE 0604307N (Surface Combatant Combat System Engineering)
(U) PE 0604518N (Combat Information Center Conversion)

(U) NON NAVY RELATED RDT&E: Not Applicable

E. (U) SCHEDULE PROFILE: Not Applicable.

CONGRESSIONAL PLUS-UPS

This section describes the following Congressional Plus-Ups appropriated in FY 2001 or FY 2002 whose efforts fall within the scope of this Common Picture Advanced Technology program, or were appropriated in this program element;

Dominate Battlespace Command Initiative
National Cargo Tracking Program
National Technology Alliance

1. (U) FY 2001 Congressional Plus-ups:

- (U) ($5,795) DOMINATE BATTLESPACE COMMAND INITATIVE: The Dominant Battlespace Command project established a state-of-the-art battlespace visualization environment to advance Joint Vision 2020 objectives and the United States Navy's "Forward from the Sea" strategy. Dominant Battlespace Command integrates commercial technologies with emerging Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) capabilities, specifically to support situation awareness and planning for Navy and Marine Corps battlefield commanders and their staffs. In the absence of proven data correlation and information fusion algorithms, Dominant Battlespace Command visually represented the positions and tracks of ships, aircraft, and ground-based units, along with threat envelopes in a whole earth, scalable, multi-resolution virtual display linked to intelligence and operational databases. Therefore, Dominant Battlespace Command presented the commander with the battlespace that closely approximates what one sees in their "mind's eye." This realization of the mind's eye view is expected to result in intuitive actions that transform the 2-D battlespace into a 4-D battlespace so that the warfighter can view events in near-real time and fold in operational aspects associated with time - the 4^{th} dimension. In 2001, this capability was demonstrated using a Naval Fires context during Fleet Battle Experiment India and Global Wargame 2001 in order to collect user feedback on the utility of viewing battlefield information in this way. (Appropriated in PE 0603794N.)

- (U) ($9,659) NATIONAL TECHNOLOGY ALLIANCE (NTA): The NTA has successfully demonstrated the automatic registration of tactical video (10 frames per second) of national imagery for supporting Time Critical Targeting. They have also successfully integrated Moving Target Indication technologies with this capability. In addition, they have produced several enhancements to current capabilities to include registration and display of meteorological data, ocean bathymetric data, surface temperature data, wind speed and direction, and wave action data. Additional enhancements include the ability to access meta data on various sites, targets, weapons, and sensors. All of this capability is being integrated in a testbed at the Naval Coastal Systems Station, Panama City, FL to provide continued development, integration, and evaluation of hardware, software, and communications systems in support of littoral warfare, disadvantaged tactical users, as well as future C4ISR architectural studies. (Appropriated in PE 0603794N.)

2. (U) FY 2002 Congressional Plus-ups:

- (U) ($1,685) NATIONAL CARGO TRACKING PROGRAM: The National Cargo Tracking Program will enable the Navy to track containerized cargo in support of Homeland Defense. The program will allow the Navy to merge disparate data sources into a central database, allowing for the expeditious analysis of cargo related data. Work would include data warehouse development; integration of advanced analytical tools; and deployment of analytical tools for use by analysts to track cargo.

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603236N
PROGRAM ELEMENT TITLE: Warfighter Sustainment Advanced Technology

TEST (U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
R2915 Warfighter Sustainment Advanced Technology	**	54,660	57,542	54,950	60,146	69,624	72,508	CONTINUE	CONTINUE
R3008 High Speed Vessel			25,000					0	25,000
R9021 Low Volume Production Program		3,469						0	3,469
R9022 National Center for Remanufacturing and Resource Recovery		991						0	991
R9023 Commercial Off The Shelf (COTS) Carbon Fiber Qualification Program		991						0	991
R9024 Distance Learning Information Technology (IT) Center		12,687						0	12,687
TOTAL	**	72,798	82,542	54,950	60,146	69,624	72,508	CONTINUE	CONTINUE

** The Science and Technology PEs were restructured in FY 2002. FY 2001 efforts were funded in PEs 0602122N, 0603217N 0603707N and 0603792N.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION:

R2915 Warfighter Sustainment Advanced Technology supports: a) the Integrated Warfare Architecture (IWAR) Support Areas for Manpower and Personnel, Training, and Readiness; b) the IWAR Mission Areas; c) the Future Joint Warfighting Capabilities identified by the Joint Chiefs of Staff; and d) the Future Naval Capabilities (FNC) for Capable Manpower, Total Ownership Cost, and Expeditionary Logistics. It develops technologies that enable the Navy to recruit, select, classify, assign and manage its people; to train effectively and affordably in classroom settings, in simulated environments and while deployed; and to effect human systems integration into weapon systems. Other technologies developed in this PE enable reduced operating costs through life-extension of legacy systems, increased efficiency of future propulsion systems and improved diagnostic tools. The Expeditionary Logistics investment improves Naval surface distribution/replenishment and the situational awareness of readiness and operating logistics status.

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603236N
PROGRAM ELEMENT TITLE: Warfighter Sustainment Advanced Technology

R3008 The High Speed Vessel develops technology to enable a future generation of fast ships for rapid movement of military payloads from CONUS to theater as well as within theater. Speeds of up to 70 knots will be considered. Increased payload fraction and reduced friction drag are key technical objectives. Technologies to be demonstrated include advanced hull forms, drag reduction, power dense propulsion, high strength-to-weight ratio structural materials, and rapid cargo handling.

(U) Due to the number of efforts in the PE, the programs described are representative of the work included in this PE.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the ADVANCED TECHNOLOGY Budget Activity because it encompasses design, development, simulation, or experimental testing or prototype hardware to validate technological feasibility and concept of operations and reduce technological risk prior to initiation of a new acquisition program or transition to an ongoing acquisition program.

B. (U) PROGRAM CHANGE SUMMARY:

	FY 2001	FY 2002	FY 2003
FY 2002 President's Submission:		57,685	
Adjustments from FY 2002 PRESBUDG:			
FFRDC		-38	
Congressional Reduction (Navy Transformation Priorities)		-2,500	
Congressional Plus Ups		18,300	
8123 Management Reform Initiative Reduction		-649	
FY 2003 President's Submission	**	72,798	82,542

** The Science and Technology PEs were restructured in FY 2002. FY 2001 efforts were funded in PEs 0602122N, 0603217N 0603707N and 0603792N.

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603236N
PROGRAM ELEMENT TITLE: Warfighter Sustainment Advanced Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
R2915 Warfighter Sustainment Advanced Technology									
TOTAL	**	54,660	57,542	54,950	60,146	69,624	72,508	CONTINUE	CONTINUE

** The Science and Technology PEs were restructured in FY 2002. FY 2001 efforts were funded in PEs 0602122N, 0603217N 0603707N and 0603792N.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This PE supports: a) the Integrated Warfare Architecture (IWAR) Support Areas for Manpower and Personnel, Training, and Readiness; b) the IWAR Mission Areas; c) the Future Joint Warfighting Capabilities identified by the Joint Chiefs of Staff; and d) the Future Naval Capabilities (FNC) for Capable Manpower, Total Ownership Cost, and Expeditionary Logistics. It develops technologies that enable the Navy to recruit, select, classify, assign and manage its people; to train effectively and affordably in classroom settings, in simulated environments and while deployed; and to effect human systems integration into weapon systems. Other technologies developed in this PE enable reduced operating costs through life-extension of legacy systems, increased efficiency of future propulsion systems and improved diagnostic tools. The Expeditionary Logistics investment improves Naval surface distribution/replenishment and the situational awareness of readiness and operating logistics status.

B. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 2001 ACCOMPLISHMENTS:

• (U) ($4,280) Manpower and Personnel Development: (FY01 accomplishments were funded in PE 0603707N.)

— (U) Initiated the Models of Navy Compensation and Personnel Behavior (MODCOMP). Conducted a comprehensive feasibility study of Bayesian estimation to predict retention behavior.

— (U) Continued the development of the Comprehensive Officer Force Management Environment (CHROME) information management system. Completed officer loss projection model.

— (U) Continued the development of the Enlisted Manpower and Personnel Integrated Planning System (EMPIPS). Enabled the web development of Minimal Statistical Summary Reports (MiniStats), Web Target, and Skilled Personnel Projection for Enlisted Retention (SKIPPER). Demonstrated proof of concept integration portal.

— (U) Continued the development of the Rating Identification Engine (RIDE) algorithms and the Jobs and Occupational Interest in the Navy (JOIN) interest profiles. Beta-tested RIDE classification algorithm on 400 recruits at Military Entrance Processing Station, San Diego CA.
— (U) Completed the Training Continuum and Readiness Modeling (TCARM).

• (U)($13,333) Training Systems: (FY01 accomplishments were funded in PE 0603707N.)
— (U) Initiated the development of the Deployable Sonar Operator Trainer (DSOT).
— (U) Continued development of the stand-alone training delivery system, Synthetic Cognition for Operational Team Training (SCOTT), for aviation team members.
— (U) Completed the development of prototype curriculum for the Computer Simulation Based Training System with Intelligent Tutoring Components (CSITS)
— (U) Completed the Tactical Decision Making (TDM) project.
— (U) Completed the integration and simulation components required for mission rehearsal in the single Transportable Strike/Assault Rehearsal (TSTARS) system.
— (U) Completed the integration of training technologies into the Conning Officer Virtual Environments (COVE) simulation-based application.

• (U) ($10,400) Integrated High Performance Turbine Engine Technology (IHPTET): (FY01 accomplishments were funded in PEs 0602122N and 0603217N.)
— (U) Continued the Phase II Joint Technology Demonstrator Engine (JTDE): Design and fabrication of General Electric (GE)/Allison Advanced Development Company (AADC) goal demonstrator engine.
— (U) Continued the Phase II Joint Turbine Advanced Gas Generator (JTAGG): Fabrication, assembly, instrumentation and initial testing of Honeywell Engines and Systems (HES) demonstrator engine.
— (U) Continued the Phase II Joint Expendable Turbine Engine Concepts (JETEC): Assembly, instrumentation and initial testing of both Williams International (WI) and AADC supersonic demonstrator engines.
— (U) Continued the Phase III JTDE: Design and fabrication of Pratt & Whitney (P&W) and GE/AADC demonstrator engines.
— (U) Continued the Phase III JTAGG: Design of HES/GE demonstrator engine.
— (U) Continued the Phase III JETEC: Design and fabrication of HES and AADC demonstrator engines.

• (U) ($5,100) Advanced Shipboard Crane Motion System Advanced Technology Demonstration (ATD): (FY01 accomplishments were funded in PE 0603792N.)
— (U) Initiated a pendulation control system demonstration for shipboard cranes at pierside and at anchor permitting ship-to-shore transfer of logistics through sea state three.
— (U) Continued to design, procure/fabricate the sensor and control package. Installed crane simulator/trainer for military operator training and conducted a demonstration of test ship roll simulation system.

2. (U) FY 2002 PLAN:

- (U) ($2,900) Manpower and Personnel Development:
— (U) Initiate Attrition Reduction Technologies. Test measures and modify indices aimed at reducing attrition during the first year of service.
— (U) Initiate Distribution Incentive System. Develop a baseline of various distribution incentive pay using simulations, experimental economics and surveys.
— (U) Continue the development of the Rating Identification Engine (RIDE) algorithms and the Jobs and Occupational Interest in the Navy (JOIN) interest profiles.
— (U) Continue Enlisted Manpower and Personnel Integrated Planning System (EMPIPS). Integrate the following: Minimal Statistical Summary Reports (MiniStats); Web Target; and Skilled Personnel Projection for Enlisted Retention (SKIPPER). Demonstrate a manpower and personnel planning tool as a single integrated system.
— (U) Complete the Models of Navy Compensation and Personnel Behavior (MODCOMP). Deliver retention forecasting tool to Assistant Chief of Naval Personnel for Military Personnel Policy and Career Progression, Code N13.
— (U) Complete the Comprehensive Officer Force Management Environment (CHROME). Deliver in-year and out-year behavioral loss models to N13.

- (U) ($17,700) Training Systems:
— (U) Initiate the Prototype Authoring Capabilities for Developing Pedagogically Sound Advanced Distributed and Distance Learning (ADL-AUTHOR).
— (U) Initiate the Intelligent Instructional System for Identifying and Managing Objective-Based Mentoring Partnerships (OJT - MENTOR).
— (U) Initiate the Computer-Aided System for Supporting Fleet Personnel in Generating Measures of Performance (OJT - MEASPERF).
— (U) Initiate the Prototype Virtual Technology/Environments for realistic Landing Craft Air Cushion (LCAC) and Advanced Amphibious Assault Vehicle (AAAV) simulators for coordination among crew for driving and fighting vehicles to maintain and enhance combat readiness (VIRTE - DEMO I).
— (U) Initiate the Visualization of Environmental Effects on System Performance (VISTRA - ENV).
— (U) Continue the development of the Deployable Sonar Operator Trainer (DSOT).
— (U) Continue the development of the Synthetic Cognition for Operational Team Training (SCOTT).

- (U) ($400) Human Systems Integration:
— (U) Initiate the development of a prototype advanced land attack weapons system interface employing human-centric design principles.
— (U) Initiate the development of functional software requirements and Unified Modeling Language (UML) code for the Tomahawk, Land Attack, Naval Guns (TLN) human interface design.

• (U) ($10,409) Integrated High Performance Turbine EnginTechnology (IHPTET):
— (U) Continue the Phase II Joint Technology Demonstrator Engine (JTDE): Fabrication, assembly, and instrumentation of General Electric (GE)/Allison Advanced Development Company (AADC) demonstrator engine.
— (U) Continue the Phase II Joint Turbine Advanced Gas Generator (JTAGG): Component optimization and second build of Honeywell Engine and Systems (HES) demonstrator engine to meet Phase II goals.
— (U) Continue the Phase III JTDE: Design, component development, integration and fabrication of Pratt & Whitney (P&W) and GE/AADC Phase III demonstrator engines.
— (U) Continue the Phase III JTAGG: Design, component development, integration and fabrication of HES Phase III demonstrator engines.
— (U) Complete the Phase II Joint Expendable Turbine Engine Concepts (JETEC): Assembly, instrumentation and initial testing of both Williams International (WI) and AADC supersonic demonstrator engines.
— (U) Complete the Phase III JETEC: Design and fabrication of HES and AADC demonstrator engines.

• (U) ($3,144) Airframe Corrosion:
— (U) Initiate development of a single coat system for ship tanks (ballast tank).
— (U) Airframe Corrosion effort to begin.
— (U) Initiate development of a modular hybrid pier (demo hull section).
— (U) Initiate development of an advanced coating and inhibitor applied washdown system for USMC vehicles, contract award for road test facility.

• (U) ($2,494) Smart Wiring:
— (U) Initiate the development of updated requirements document for smart wiring system.
— (U) Initiate an award and execute a contract to develop safety-of-flight qualified hardware for smart wiring system. Intent is to develop and implement diagnostic wiring system for aircraft. System will detect and isolate wiring gaults with minimal off-aircraft test equipment.
— (U) Initiate a test of the Total Oil Monitoring System (TOMS) with actual lubricants from host system.
— (U) Initiate an engine stand test for the Total Oil Monitoring System-Advanced Amphibious Assault Vehicle (TOMS-AAAV) integration. Intent is to provide capability to analyze fluids onboard the vehicle as would be done at an established oil lab. Onboard analysis increases readiness, reduces maintenance cost and reduces quantity of hazardous materials requiring disposal (old oil samples).

• (U) ($15,000) Expeditionary Logistics:

— (U) Initiate shipboard strike up/down for carriers and logistics ships developing advanced weapons elevators, linear electric drive transport, omni-directional vehicle technology, conformal robots, and blast mitigation technologies for naval ammunition storage.
— (U) Initiate underway replenishment development of a 12K system including station keeping and load control technologies employing relative motion compensation, transfer load control and advanced materials.
— (U) Initiate logistic battlefield sensor array architecture to support the utilization of on-board vehicle suites to the rear area battlefield support command decision process.
— (U) Initiate the development of decision support technologies and algorithms for Logistics command and control course of action generation.
— (U) Initiate and complete participation in joint experimentation with high speed vessels, particularly supporting instrumentation and analytical performance data collection aboard a leased aluminum hull planning vessel.
— (U) Initiate and complete the FY02-07 Program Planning for surface distribution including development of metrics, exit criteria and technology risk management.

• (U) ($2,613) Advanced Shipboard Crane Motion System ATD:
— (U) Complete a pendulation control system demonstration for shipboard cranes at pierside and at anchor permitting ship-to-shore transfer of logistics through sea state three.
— (U) Complete the design, procurement/fabrication of the sensor and control package. Install crane simulator/trainer for military operator training and conduct a demonstration of test ship roll simulation system. Demonstrate pendulation control system at pierside and at anchor.

3. (U) FY 2003 PLAN:

• (U) ($4,576) Manpower and Personnel Development: This effort provides Navy personnel system managers with the ability to attract and retain the right people and to place them in jobs that best use their skills, training, and experience. Fleet readiness is enhanced and personnel costs reduced via technologies such as modeling and simulation, mathematical optimization, advanced testing, statistical forecasting, information visualization, data warehousing, data cleansing, web-based knowledge management, and human performance measurement.
— (U) Initiate Non-Cognitive Measures of Personality and Social Competency Related to Teamwork. Fully integrate psychometrics of measures into test plan.
— (U) Initiate Naval Job Classification Interface and integrate the Rating Identification Engine (RIDE) algorithms and the Jobs and Occupational Interest in the Navy (JOIN) interest profiles.
— (U) Initiate Career Case Manager Technologies. Baseline career milestones (promotion, training, assignment) associated with each Navy enlisted community.
— (U) Initiate Personnel Force Threat Detection System. Integrate database, statistical models and graphical user interface into decision support system.

— (U) Initiate Artificial Intelligence Data Quality Tool Set. Test data quality technologies.
— (U) Initiate Web-Based Marketplace for Sailors/Jobs. Integrate intelligent agents into prototype virtual personnel mall.
— (U) Continue Attrition Reduction Technologies. Demonstrate person-organization fit model and integrate into attrition reduction model.
— (U) Continue Distribution Incentive System: Develop incentive management prototype and analyze data associated with Sailor preference and propensities to volunteer for chronically difficult-to-fill locations and jobs.
— (U) Continue the Enlisted Manpower and Personnel Integrated Planning System (EMPIPS). Complete the decision support systems, database, and documents integration efforts in EMPIPS. Incorporate the compensation models from the Models of Navy Compensation and Personnel Behavior (MODCOMP) into EMPIPS.
— (U) Complete the Rating Identification Engine (RIDE) algorithms and the Jobs and Occupational Interest in the Navy (JOIN) interest profiles. Complete the aptitude interest model and transition algorithm to Navy Recruiting Command.

• (U) ($20,330) Training Systems: This effort improves mission effectiveness and safety by applying both simulation and instructional technology to the design of affordable education and training methods and systems. Focus is on the development and evaluation of systems to improve basic through advanced individual and team training, skill maintenance, and mission rehearsal capability. Improved training efficiency and cost-effectiveness is achieved by applying operations research, modeling and simulation, and instructional, cognitive, and computer sciences to the logistics, development, delivery, evaluation, and execution of training.
— (U) Initiate the development of Multi-platform Distributed Team Training (ADL - TEAM).
— (U) Initiate the development of Multi-media Visualization for Sensor-Operations Training (VISTRA - SENSOR).
— (U) Initiate the development of Battle Group Level Advanced Under Sea Warfare (USW) Visualization (VISTRA - BG) systems.
— (U) Continue the development of prototype Authoring Capabilities for Developing Pedagogically Sound Continue Advanced Distributed and Distance Learning (ADL - AUTHOR).
— (U) Continue the development of the Intelligent Instructional System for Identifying and Managing Continue Objective-Based Mentoring Partnerships (OJT - MENTOR).
— (U) Continue the development of Computer-Aided System for Supporting Fleet Personnel in Generating Measures of Performance (OJT - MEASPERF).
— (U) Continue the development of Visualization of Environmental Effects on System Performance (VISTRA - ENV).
— (U) Continue the development of Synthetic Cognition for Operational Team Training (SCOTT).
— (U) Complete the development of a Prototype Virtual Technology/Environments for realistic Landing Craft Air Cushion (LCAC) and Advanced Amphibious Assault Vehicle (AAAV) simulators for coordination among crew for driving and fighting vehicles to maintain and enhance combat readiness (VIRTE - DEMO I).
— (U) Complete the development of the Deployable Sonar Operator Trainer (DSOT).

• (U) ($1,192) Human Systems Integration: This effort supports the design of affordable warfighter-centered systems, organizations and jobs by applying knowledge of human capabilities, limitations and needs. Focus is on the development of selection/training criteria, validation and the development of engineering support tools to enable human-centered design.

— (U) Continue the development of a prototype advanced land attack weapons system interface employing human-centric design principles.
— (U) Continue the development of functional software requirements and Unified Modeling Language (UML) code for the Tomahawk, Land Attack, Naval Guns (TLN) human interface design.

• (U) ($10,000) Integrated High Performance Turbine Engine Technology (IHPTET): This effort provides integration and experimental engine testing of new gas turbine engine technologies to demonstrate readiness and reduce technical risk for entering engineering development. IHPTET is a Tri-Service program in which each Service contributes established shares of Advanced Technology funding and laboratory resources to meet specified goals of doubling thrust-to-weight ratio, halving fuel consumption by the year 2005 (relative to a 1987 baseline) and reducing acquisition and maintenance costs. Additional emphasis has been incorporated to address High Cycle Fatigue issues, which may be associated with propulsion system design system deficiencies. This project covers the Navy's share of the demonstrator engine efforts under the Department of Defense (DoD)/National Aeronautics and Space Administration (NASA) Industry IHPTET program, ensuring that Navy unique design and operational requirements are met. Full scale integrated technology demonstration is essential to validate and transition technologies from applied research through advanced development, program design review, and system development. Without technology demonstrators, system acquisition cost and schedule risk would increase to unacceptable levels or weapons systems would have degraded operational performance. The lack of technology demonstrator efforts could result in system development schedule increases of five or more years along with the associated increase in cost.

(U) The technology sets integrated into and demonstrated in the IHPTET demonstrator engines are closely related to the system requirements for the Joint Strike Fighter (JSF), F-18E/F, Common Support Aircraft (CSA), Multi-mission Maritime Aircraft (MMA), Tactical Tomahawk, SH-60R, and other future Navy platforms, so that the transition of these high risk and high payback technologies may be effectively accomplished. In addition, IHPTET technologies can transition to current legacy systems via engine Component Improvement Programs (CIP). A strong and viable U.S. propulsion program also provides a dual-use benefit to our country by enhancing our competitiveness in the international commercial engine market. This long term project, coordinated through Reliance, will provide for the future needs in air battlespace dominance and expeditionary forces support (Littoral Warfare Joint Mission Area (JMA)). Increased platform mission endurance (Intelligence, Surveillance, and Reconnaissance JMA) and provide technology for increased affordability and platform survivability and increased mission effectiveness (Strike JMA). The program funds three demonstrator engine classes. Each engine class has specific performance goals that are divided into multiple phases. Phase I has been completed and demonstrated for each of the three classes of demonstrators. Phase II is currently underway in the engine demonstration phase, for all of the advanced component and system technologies. The Phase III concepts were developed and design, integration and component technology efforts are being executed. The phase goals of each engine class are listed as follows and are referenced to a 1987 baseline (additional affordability goals have been developed for fighter/attack and turboprop/shaft classes):

(U) Fighter/attack (Joint Technology Demonstrator Engine (JTDE)):
Phase I - 1991: +30% thrust/weight (Fn/Wt), +100 °F combustor inlet temperature (CIT), +300 °F turbine inlet temperature (TIT), -20% fuel burn.
Phase II - 1997: +60% Fn/Wt, +200 °F CIT, +600 °F TIT, -20% acquisition cost, -20% maintenance cost, -30% fuel burn.
Phase III - 2005: +100% Fn/Wt, +400°F CIT, +900°F TIT, -35% acquisition cost, -35% maintenance cost, -40% fuel burn.
(U) Turboprop/shaft (Joint Turbine Advanced Gas Generator (JTAGG)):
Phase I - 1991: +40% shaft horsepower/weight (SHP/Wt), -20% specific fuel consumption (SFC), +300 °F TIT.
Phase II - 1997: +80% SHP/Wt, -30% SFC, +600 °F TIT, -20% acquisition cost, -20% maintenance cost.
Phase III - 2003: +120% SHP/Wt, -40% SFC, +1000 °F TIT, -35% acquisition cost, -35% maintenance cost.
(U) Missile/expendable engines (Joint Expendable Turbine Engine Concepts (JETEC)):
Phase I - 1991: +35% thrust/airflow (Fn/Wa), -20% SFC, +1100 °F CIT, +500 °F TIT, -30% Cost.
Phase II - 1997: +70% Fn/Wa, -30% SFC, +1200 °F CIT, +900 °F TIT, -45% Cost.
Phase III - 2003: +100% Fn/Wa, -40% SFC, +1400 °F CIT, +1400 °F TIT, -60% Cost.

(U) Each engine company (Allison Advanced Development Company (AADC) (IN), Honeywell Engines and Systems (HES) (AZ), General Electric (GE) (OH & MA), Pratt & Whitney (P&W) (CT & FL), Teledyne Continental Motors Engine Division (formerly Teledyne Ryan Aeronautical) (OH) and Williams International (WI) (MI)) attempts to utilize at least two engine builds or demonstrator tests within each Phase to demonstrate the performance and cost goals. The JETEC goals are divided into demonstrating SFC and Cost for a subsonic demonstrator and Fn/Wa, CIT, TIT and Cost for a supersonic demonstrator.

— (U) Continue the Phase II JTDE: Demonstration of Phase II goals with GE/AADC demonstration engine.
— (U) Continue the Phase III JTDE: Component development, integration, fabrication, assembly and instrumentation of GE/AADC and P&W demonstrator engines and demonstration of P&W progress toward Phase III goals.
— (U) Continue the Phase III JTAGG: Component development, integration, fabrication and initial test of HES demonstrator to meet Phase III goals.
— (U) Complete the Phase II JTAGG: Component optimization and second build of HES demonstrator to meet Phase II goals.

• (U) ($1,500) Airframe Corrosion: This effort includes an integrated approach for the control of the effects of external and internal corrosion in Naval weapon systems. The work develops advanced, cost effective prevention and lifecycle management technologies. This is particularly significant to life extension for the aging fleet.
— (U) Initiate the development of single coat system for ship tanks (potable water tank).
— (U) Initiate the development of the road test development for USMC vehicle.
— (U) Initiate the development of modular hybrid pier (Demo joint modules).
— (U) Continue the development of single coat systems for ship tanks (ballast tank).
— (U) Continue Airframe Corrosion efforts.
— (U) Continue the development of modular hybrid pier (Demo hull section).

— (U) Continue the development of advanced coatings and inhibitor applied washdown system for USMC vehicles; contract award for road test facility.

• (U) ($2,200) <u>Smart Wiring:</u> Smart Wiring is a subset of the Total Ownership Cost (TOC) Future Naval Capability (FNC). Smart Wiring focuses will develop a flight-qualified smart aircraft wiring system hardware and perform required flight demonstration. Smart wiring embeds diagnostic and prognostic technologies into aircraft wiring systems to manage wiring system health. The goals of smart wiring are (1) reduce wiring maintenance man-hours by 20%, (2) reduce wiring induced mission aborts and non-mission capable hours by 20%, and (3) reduce in-flight electrical fires and subsequent loss of aircraft by 80%. Total Oil Monitoring System (TOMS) will develop an oil system for in-situ oil analysis of a mechanical component, with Advanced Amphibious Assault Vehicle (AAAV) being the specific transition target. The “total” aspect of the system combines oil debris and oil condition monitoring with a wireless intra-vehicle data/information delivery capability. Benefits of the technology program will be increased readiness, reduced system TOC, reduction in Hazardous Materials (HAZMAT), and reduction in maintenance tasks.
— (U) Initiate the development of smart wiring hardware, perform bench test and aircraft integration testing. Intent is to develop and implement an aircraft wiring diagnostic and prognostic system.
— (U) Initiate complete vehicle - Total Oil Monitoring System (TOMS) integration.
— (U) Initiate a test of Total Oil Monitoring System (TOMS) on Advanced Amphibious Assault (AAA) prototype.
— (U) Complete the development of updated requirements documents for smart wiring system.
— (U) Complete the award and execution of a contract to develop safety-of-flight qualified hardware for smart wiring system.
— (U) Complete the test of the Total Oil Monitoring System (TOMS) with actual lubricants from host system.
— (U) Complete the engine stand test for the Total Oil Monitoring System-Advanced Amphibious Assault Vehicle (TOMS-AAAV) integration.

• (U) ($17,000) <u>Expeditionary Logistics</u>: This effort represents the Advanced Technology investment strategy supporting the Expeditionary Logistics Future Naval Capability (FNC). The FNC is broken into three enabling capabilities covering distribution, Command and Control, and readiness. Work areas encompass surface replenishment and activities within ship-to-shore material distribution. Additionally, Command and Control of ground logistics is addressed including decision support and battlefield sensor arrays. This program supports the technology maturation, demonstration and transition line.
— (U) Continue shipboard strike up/down for carriers and logistics ships developing advanced weapons elevators, linear electric drive transport, omni-directional vehicle technology, conformal robots, and blast mitigation technologies for naval ammunition storage.
— (U) Continue development of a 12K underway connected replenishment capability including station keeping and load control technologies employing relative motion compensation, transfer load control and advanced materials.

— (U) Continue logistic battlefield sensor array architecture to support the utilization of on-board vehicle suites to the rear area battlefield support command decision process.
— (U) Continue the development of decision support technologies and algorithms for Logistics command and control course of action generation.

• (U) ($744) Advanced Shipboard Crane Motion System Advanced Technology Development (ATD): The Advanced Shipboard Crane Motion Control System ATD demonstrates a crane control system that combines recent advances in nonlinear control system technologies with existing strategic Auxiliary Crane Ship electro-hydraulic cranes. The control scheme will control load pendulation through sea state three by applying nonlinear control algorithms, appropriate to the ship motion environment, to the shipboard crane control system and the crane operator commands. This technology will extend the capability for ship to lighterage transfer of expeditionary warfare logistics to at least 300 containers per day in sea state three.
— (U) Initiate and complete an at sea demonstration during military exercise.

C. (U) PROGRAM CHANGE SUMMARY EXPLANATION:
(U) Funding: Not Applicable.
(U) Schedule: Not Applicable.

D. (U) OTHER PROGRAM FUNDING SUMMARY:

(U) RELATED RDT&E:

(U) NAVY RELATED RDT&E:
(U) PE 0601152N In-House Laboratory Independent Research
(U) PE 0601153N Defense Research Sciences
(U) PE 0602123N Force Protection Applied Research
(U) PE 0602236N Warfighter Sustainment Applied Research
(U) PE 0604703N Personnel, Training, Simulation, and Human Factors
(U) PE 0605152N Studies and Analysis Support - Navy

(U) NON NAVY RELATED RDT&E:
(U) PE 0601102A Defense Research Sciences
(U) PE 0602211A Aviation Technology
(U) PE 0603003A Aviation Advanced Technology
(U) PE 0603007A Manpower, Personnel and Training Advanced Technology
(U) PE 0601102F Defense Research Sciences

(U) PE 0602203F Aerospace Propulsion
(U) PE 0603216F Aerospace Propulsion and Power Technology
(U) PE 0603216F Advanced Turbine Engine Gas Generator
(U) PE 0601103D8Z University Research Initiatives

E. (U) SCHEDULE PROFILE: Not applicable.

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603236N
PROGRAM ELEMENT TITLE: Warfighter Sustainment Advanced Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
R3008 High Speed Vessel									
TOTAL			25,000						25,000

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION:

The High Speed Vessel develops technology to enable a future generation of fast ships for rapid movement of military payloads from CONUS to theater as well as within theater. Speeds of up to 70 knots will be considered. Increased payload fraction and reduced friction drag are key technical objectives. Technologies to be demonstrated include advanced hull forms, drag reduction, power dense propulsion, high strength-to-weight ratio structural materials, and rapid cargo handling.

B. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 2001 ACCOMPLISHMENTS: N/A

2. (U) FY 2002 PLAN: N/A

3. (U) FY 2003 PLAN:

- (U) ($25,000) <u>High Speed Vessel:</u>
  - Initiate the development of a hydrodynamic testing system for high speed vessels, capable of conducting hydrodynamic drag and lift testing at appropriate fluid velocities and Reynolds number, and of evaluating potential drag reduction approaches. Downselect to preferred testing approach and complete detailed design. Order materials and begin assembly of hydrodynamic testing system. Begin development of drag reduction system concept, including polymer and micro-bubble approaches. Conduct Concept of Operations study to develop requirements and metrics. Begin ship conceptual design studies. Assess state of the art in ship structural materials, establish materials technology requirements, and establish technical approach. Assess state of the art in high speed, power dense propulsion systems and establish technical approach.
  - Initiate the award of several contracts for conceptual design of hydrodynamic testing systems, including water tunnel and towed body approaches and for structural and propulsion component demonstrations.

C. (U) PROGRAM CHANGE SUMMARY EXPLANATION:
(U) Funding: Not Applicable.
(U) Schedule: Not Applicable.

D. (U) OTHER PROGRAM FUNDING SUMMARY:

(U) RELATED RDT&E:

(U) NAVY RELATED RDT&E:
(U) PE 0602123N Force Protection Applied Research
(U) PE 0603123N Force Protection Advanced Technology
(U) PE 0603758N Navy Warfighting Experiments and Demonstrations

E. (U) SCHEDULE PROFILE: Not applicable.

CONGRESSIONAL PLUS-UPS

This section describes the following congressional Plus-Ups appropriated in FY2001 and/or FY2002 whose efforts fall within the scope of this restructured program, or which were appropriated in this PE.

R2496 Advanced Distributed Learning (ADL)
R9023 Commercial Off The Shelf (COTS) Carbon Fiber Qualification Program
R2715 Distributed Simulation, Warfighting Concepts (WARCON)
R9024 Distance Learning Information Technology (IT) Center
R2841 Geotrack Positioning Technology Program
R9021 Low Volume Production Program
R9022 National Center for Remanufacturing and Resource Recovery
R2839 Ocean Power Technology
R2739 Rochester Institute of Technology (RIT) Center for Integrated Manufacturing
R9006 Sustainable Readiness Center
R2498 Visualization of Technical Information

1. (U) FY 2001 CONGRESSIONAL PLUS-UPS:

- (U)($9,654) Advanced Distributed Learning (ADL): Established and operated a collaboration and coordination laboratory environment and continued the effort to standardize distance learning courseware. (Appropriated in PE 0603707N.)
- (U)($6,172) Distributed Simulation, Warfighting Concepts (WARCON): Examined warfighting and weapon system design concepts and their relationship to future aircraft carrier designs through linking the operational simulations at Naval Warfare Development Command, Newport, RI, to the smart product design model at Newport News Shipbuilding, Newport News, VA. (Appropriated in PE 0603707N.)
- (U)($5,791) Geotrack Positioning Technology Program: Initiated the development of ultra-wideband (UWB) pulse radio frequency (RF) technology capable of transmitting secure voice and/or data across multiple simultaneous users. (Appropriated in PE 0603712N.)
- (U)($2,907) Ocean Power Technology: Study conducted on the issues critical to the success of wave power generating system. Study focused on the scientific issues affecting the development of multiple buoy systems, system survivability and life cycle costs. (Appropriated in PE 0603712N.)

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603236N
PROGRAM ELEMENT TITLE: Warfighter Sustainment Advanced Technology

- (U)($2,898) Rochester Institute of Technology (RIT) Center for Integrated Manufacturing: Pilot program demonstrated remanufacturing as a discipline to extend Navy oriented remanufacturing process research into condition assessment and technology insertion during system midlife. (Appropriated in PE 0603707N.)
- (U)($1,931) Visualization of Technical Information (VTI): Initiated the use of visualization to integrate data from sensors deployed on shipboard systems (with the appropriate diagnostics and prognostics) with the decision making process, and with the resulting maintenance and training actions. (Appropriated in PE 0603712N.)

2. (U) FY 2002 CONGRESSIONAL PLUS-UPS:

- (U)($991) Commercial Off The Shelf (COTS) Carbon Fiber Qualification Program: Assess the viability of using new low-cost, commercially available, intermediate modulus carbon fibers on Navy aircraft and Joint Strike Fighter (JSF) weapons platforms. Demonstrate the performance of the carbon fibers on brake disks. Could lower the price of intermediate modulus fibers and put the US in a more competitive position since most of the graphite fiber manufacturers are in Japan.
- (U)($12,687) Distance Learning Information Technology (IT) Center: In FY01 this effort was entitled "Advanced Distributed Learning (ADL)". Continue the effort to standardize distance learning courseware and initiate an ADL certification process.
- (U)($3,469) Low Volume Production Program: Develop the capability to repair massive defective parts (possibly no longer manufactured or available as spares) without the need for expensive and time-consuming reverse engineering. Could increase the life cycle and performance of expensive new parts via protective claddings using laser weld technology.
- (U)($991) National Center for Remanufacturing and Resource Recovery: Develop the methodology for military remanufacturing and resource recovery. Implement a pilot study project by applying the military remanufacturing concept in a military environment.
- (U) Rochester Institute of Technology (RIT) Center for Integrated Manufacturing: Continue the effort started in FY01 to extend Navy oriented remanufacturing process research into condition assessment and technology insertion during system midlife. Develop a number of technology assessment and costing tools from private industry to more systematically deploy new technology in older systems, beginning with the design process. (Appropriated in PE 0603707N, $1,982.)
- (U) Sustainable Readiness Center: A center will be established that will study and evaluate the effect of environmental, cultural, urban, natural resource, and other constraints on critical defense activities. The center will be a national focal point to ensure continued access and use of naval exercise ranges and facilities. The Center will develop a science-based approach to environmental stewardship. Using remote sensing, web-enabled data sharing, Geographic Information Systems, and modeling and analysis, the center will establish a framework for military, public and regulatory stakeholders to reach consensus on sustainability. (Appropriated in PE 0603712N, $1,388.)

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603238N
PROGRAM ELEMENT TITLE: Precision Strike and Air Defense Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER/ TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE
R0834 Naval Science Assistance Program (NSAP)		
	7,018	*
R2145 Global Surveillance/Precision Strike and Air Defense Technology		
	64,764	*
R2371 Littoral Airborne Sensor/Hyperspectral (LASH)		
	9,690	0
R2701 LASH Study		0
	8,721	0
TOTAL	90,193	

*This Program Element (PE) was restructured in FY 2002. FY 2001 efforts are described in PEs 0603123N, 0603235N, 0603271N, 0603747N, 0603758N, and 0205658N

Congressional Plus-ups appropriated in this PE are described under the following PE:

TITLE	PE Number	FY 2001
Littoral Airborne Sensor/Hyperspectral (LASH)	0205658N	$9,690
Range Airship/Lash Study for Range Enhancements	0205658N	$8,721

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603270N
PROGRAM ELEMENT TITLE: Advanced Electronic Warfare Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE
E2194 Electric Warfare Advanced Technology	7,865	*
R2875 Tactical A/C Directed Infrared Countermeasures	4,794	
R2090 Functional Recognition and Response	12,144	*
TOTAL	24,803	*

*This PE was restructured in FY 2002. FY 2001 efforts are described in PE 0603271N.

Congressional Plus-up in this PE is described under the following restructured program element. Funding was appropriated in PE 0604216N and realigned to PE 0603270N in FY 2001.

Title	PROGRAM ELEMENT	FY 2001
Tactical Aircraft Directed Infrared Countermeasures	0603271N	$4,794

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 3 PROGRAM ELEMENT:0603271N
PROGRAM ELEMENT TITLE: RF Systems Advanced Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
R2913 RF Systems Advanced Technology	**	76,171	65,098	60,991	53,253	58,941	59,104	CONT.	CONT.
R9025 Multi-Function, Multi-Band, Multi-Beam Communications Antenna System (M3CAS)	0	4,262	0	0	0	0	0	0	4,262
TOTAL	**	80,433	65,098	60,991	53,253	58,941	59,104	CONT.	CONT

**The Science and Technology (S&T) Program Elements (PEs) were restructured in FY 2002. FY 2001 efforts were funded in PEs 0603270N, 0603238N, and 0603794N.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: Work in this Program Element is addressing technologies critical to enabling the transformation to network centric warfare which utilizes multiple, simultaneous and continuous communications/data links between platforms while simultaneously performing the functions of Electronic Warfare (EW) and radar surveillance. The Radio Frequency (RF) Systems Advanced Technology Program addresses RF technology for Surface and Aerospace Surveillance Sensors and systems, Directed Energy, Electronic Combat Sensors and Systems, RF Radio Communications Systems, Multi-Function (integrated surveillance/electronic combat/communications) RF concepts and Electric Warship. The program emphasizes near to mid-term technology transition opportunities by developing and demonstrating advanced RF Systems technologies that enable new options for increased Time Critical Strike, Missile Defense and Platform Protection, and Knowledge Superiority and Assurance Future Naval Capabilities (FNCs). RF Surveillance Technology developments emphasize advanced sensors and sensor systems for continuous high volume theater wide air and surface surveillance, battle group surveillance, real time reconnaissance and ship defense. Major technology goals include long-range target detection, discrimination, target identification and fire control quality target tracking in adverse weather, background clutter and electronic countermeasure environments. RF Electronic Combat Technology developments emphasize passive sensors and active and passive RF countermeasure systems which exploit, and counter, a broad range of electromagnetic threats. Program focus is on maintaining perfect real-time knowledge of the enemy and of the Electronic Order of Battle (EOB). The program also addresses the threat of cruise missiles to deployed naval forces and precision identification and location of threat emitters. This includes the development of threat warning and self-protection technology for tactical aircraft for Tactical Air Directed Infrared Countermeasures (TADIRCM) technologies. Radio Communications Technology developments address critical naval communications technology deficiencies and needs that are not addressed by the commercial technology sector. The program emphasis is on high-bandwidth, reliable interoperable communications at all levels of command and on technology to enable rapid and reliable utilization of government and commercial telecommunication assets worldwide. Advanced Multi-Function RF (AMRF) Technology emphasizes development, demonstration and transition of wideband, high performance RF apertures capable of transmitting and receiving multiple, simultaneous, independent RF beams and front ends optimized to Navy-unique needs for reduced radar cross section, and significant reduction in the numbers of apertures required to provide RF Surveillance, RF Electronic Combat and RF Radio Communications functions on Navy Combatants. Advanced RF Systems Technology developments directly support the Department of Defense Joint Warfighter Science and Technology Plan and the Defense Technology Area Plans. Projects within this program element have attributes that focus on enhancing the affordability of warfighting systems.

(U) Due to the number of efforts in this PE, the programs described are representative of the work included in this PE.

JUSTIFICATION FOR BUDGET ACTIVITY: This program is funded within the ADVANCED TECHNOLOGY Budget Activity because it encompasses design, development, simulation, or experimental testing of prototype hardware to validate technological feasibility and concept of operations and reduces technological risk prior to initiation of a new acquisition program or transition to an ongoing acquisition program.

B.(U) PROGRAM CHANGE SUMMARY:

	FY 2001	FY 2002	FY 2003
(U) FY 2002 President’s Budget	**	76,876	
(U) Adjustments from FY 02 PRESBUDG:			
Congressional Increase: M3CAS		4,300	
Section 8123 Management Initiative Reduction		-717	
PBD 630 FFRDC		-26	
U) FY 2003 President’s Budget Request:	**	80,433	65,098

**The Science and Technology (S&T) PEs were restructured in FY 2002. FY 2001 efforts were funded in PEs 0603270N, 0603238N, and 0603794N.

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 3 PROGRAM ELEMENT:0603271N
PROGRAM ELEMENT TITLE: RF Systems Advanced Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
R2913 RF Systems Advanced Technology	**	76,171	65,098	60,991	53,253	58,941	59,104	CONT.	CONT.

**The Science and Technology (S&T) Program Elements (PEs) were restructured in FY 2002. FY 2001 efforts were funded in PEs 0603270N, 0603238N, and 0603794N.

A.(U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: Work in this Program Element is addressing technologies critical to enabling the transformation to network centric warfare which utilizes multiple, simultaneous and continuous communications/data links between platforms while simultaneously performing the functions of Electronic Warfare (EW) and radar surveillance. The Radio Frequency (RF) Systems Advanced Technology Program addresses RF technology for Surface and Aerospace Surveillance Sensors and systems, Directed Energy, Electronic Combat Sensors and Systems, RF Radio Communications Systems, Multi-Function (integrated surveillance/electronic combat/communications) RF concepts and Electric Warship. The program emphasizes near to mid-term technology transition opportunities by developing and demonstrating advanced RF Systems technologies that enable new options for increased Time Critical Strike, Missile Defense and Platform Protection, and Knowledge Superiority and Assurance Future Naval Capabilities (FNCs). RF Surveillance Technology developments emphasize advanced sensors and sensor systems for continuous high volume theater wide air and surface surveillance, battle group surveillance, real time reconnaissance and ship defense. Major technology goals include long-range target detection, discrimination, target identification and fire control quality target tracking in adverse weather, background clutter and electronic countermeasure environments. RF Electronic Combat Technology developments emphasize passive sensors and active and passive RF countermeasure systems which exploit, and counter, a broad range of electromagnetic threats. Program focus is on maintaining perfect real-time knowledge of the enemy and of the Electronic Order of Battle (EOB). The program also addresses the threat of cruise missiles to deployed naval forces and precision identification and location of threat emitters. This includes the development of threat warning and self-protection technology for tactical aircraft, for Tactical Air Directed Infrared Countermeasures (TADIRCM) technologies. Radio Communications Technology developments address critical naval communications technology deficiencies and needs that are not addressed by the commercial technology sector. The program emphasis is on high-bandwidth, reliable interoperable communications at all levels of command and on technology to enable rapid and reliable utilization of government and commercial telecommunication assets worldwide.

Advanced Multi-Function RF (AMRF) Technology emphasizes development, demonstration and transition of wideband, high performance RF apertures capable of transmitting and receiving multiple, simultaneous, independent RF beams and front ends optimized to Navy-unique needs for reduced radar cross section, and significant reduction in the numbers of apertures required to provide RF Surveillance, RF Electronic Combat and RF Radio Communications functions on Navy Combatants. Advanced RF Systems Technology developments directly support the Department Of Defense Joint Warfighter Science and Technology Plan and the Defense Technology Area Plans. Projects within this program element have attributes that focus on enhancing the affordability of warfighting systems.

B. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 2001 ACCOMPLISHMENTS:

(U) ($16,302) Surface and Aerospace Surveillance RF Systems Advanced Technology Thrust develops and demonstrates advanced RF surveillance sensors, processing technologies, and systems for transition into new and existing naval platforms. The Technology program focus is on providing the Navy with high performance affordable surveillance systems that are responsive to identified naval needs for real time situational awareness, long range target detection, discrimination, identification, tracking and targeting of air and surface threats in all operating conditions. Major drivers include sensor performance in complex target areas, Electronic Counter Measures (ECM), and adverse environmental conditions, including weather and background clutter conditions typical of littoral operations. The program includes: Advanced Airborne Early Warning (AEW) Radar system technology, including Ultra-High-Frequency (UHF) Electronically Steered Array (UESA) development and demonstration, for the Navy’s E-2C aircraft; an affordable pod configured Precision Surveillance and Targeting (PS&T) Radar for the F/A-18 aircraft; and highly digitized large scale arrays for future surface combatants. In FY 2001 the program initiated development of PS&T Radar system technology in support of identified Navy Time Critical Strike needs. The PS&T technologies include electronically steered arrays, advanced waveform generators and algorithms to provide adaptive mode and operating characteristics in littoral operating environments. The program continued development and fabrication of the Ultra-High Frequency Electronically Steered Array (UESA) Advanced Technology Demonstration (ATD) unit which is form, fit and function compatible with the Navy’s carrier based E-2C AEW aircraft. Fabrication of the ATD unit is approximately seventy five percent complete and on schedule for delivery to the Navy in the second quarter of FY 2002. The program completed the development and prototyping of the Tactical Air Directional Infrared Countermeasures (TADIRCM) system and conducted initial captive flight testing of the prototype TADIRCM system. (FY 2001 accomplishments were funded in PE 0603238N and PE 0603270N.)

(U) ($24,607) Radio Communications RF Systems Advanced Technology Thrust develops and demonstrates new RF communications sub-system, and systems’ technologies for integration into naval air, surface, sub-surface and ground platforms. The program focuses on RF communications technologies and systems that provide new enabling capability for network-centric operations, including high-bandwidth connectivity for mobile platforms/forces and interoperability with coalition/allied forces. Technologies pursued in this thrust are specific to naval operations and platforms and as such are not available from Commercial Off The Shelf (COTS) or other service sources without adaptation and tailoring for naval capability needs and applications. Advanced radio communications system technologies developed in this program element provide reliable, and enduring high data rate, two way radio communications between naval operational forces and all levels of command in all operating conditions and environments including electronic countermeasures. In FY 2001 the program completed development of a Very High Frequency (VHF), Ultra High Frequency (UHF)/L-Band Physical Layer Open Systems Interconnect (OSI) Reference Model to enable non-line of sight communications between Navy surface combatants and other battle force and theater warfighting elements, and subsequently initiated prototype hardware development. The program initiated development of an X/Ku-Band Physical Layer and an OSI Reference Model for an advanced dual frequency X/Ku-Band RF Communications Link. (FY 2001 accomplishments were funded in PE 0603794N.)

(U) ($14,582) Advanced Multi-Function RF Concept (AMRF-C)technologies are needed to enable the integration of critical mission functions (Radar, Electronic Warfare and Communications) into a common set of RF apertures that operate efficiently over a broad spectral bandwidth. Significant reductions in the numbers of antennas required to support platform level RF Surveillance, RF Electronic Combat and RF Radio Communications functions are needed to improve combat system performance, reduce life cycle costs, and to reduce platform electromagnetic signatures resulting in significant increases in warfighting effectiveness and survivability. This phase of the AMRF-C testbed is specifically aimed at integrating communications/data links and EW functionality into common apertures such that multiple, simultaneous, independent RF beams are possible. This situation is in contrast to the objective of the Navy’s multifunction radar (MFR, AN/SPY-3) acquisition program that uses earlier technology that provides only sequential radar beams. While most radar functionality can be accomplished with sequential beams due to the pulsed character of the radar surveillance waveform, this is totally unacceptable for communications/data links and electronic warfare that require continuous waveforms that cannot be accomplished with an architecture design for sequential pulsed mode operation. As a result the underlying AMRF-C architecture is significantly more complex than that for MFR with its sequential transmit and receive beams. The AMRF-C program is developing the required new architecture and associated unique electronics which include true time delay vice phase shift beam steering; ultra-high power, wide band-gap amplifiers; tunable filters, digital beam-forming, and ultra-high frequency direct digital synthesizers. In addition the open system architecture of AMRF-C utilizes proven middle-ware that provides modular software-defined functionality that has demonstrated the ability to enable affordable, rapid upgrades in response to the ever-changing threat environment. The AMRF-C program must next address technical issues such as electromagnetic interference; control of multiple, simultaneous, independent beams; and dynamic allocation/reconfiguration of the aperture. This technology is very applicable to future Naval systems such as DDX, Virginia Class Submarines, Cruiser Conversion, CVNX, JCCX, and AIEWS Increment II. The current AMRF-C program is scheduled to demonstrate the ability to simultaneously support many simultaneous transmit and receive communication/data link and electronic warfare beams in 2003. In FY 2001 the program continued development of both the High Band Multifunction Receiver and the Multifunction Radio Frequency (AMRF) High Band Transmitter units both critical elements of the Advanced Multi-Function RF Systems Technology Testbed. The program also continued development and initiated software build for the testbed System Resource Allocation Manager (SRAM). The SRAM subsystem when complete will function as the system controller where it will automatically, and on demand, adapt and schedule system operating characteristics resources in response to operational and environmental dynamics. Initial testing of the Aperture Beam Steering/Control and Signal Generator sub-systems was conducted. Design, fabrication, testing and characterization of the V1 Low Band Transmit Array output power and performance was completed in FY 2001. (FY 2001 accomplishments were funded in PE 0603270N, PE 0603238N and PE 0603794N.)

(U) FY 2002 PLAN:

- (U) ($22,968) Surface and Aerospace Surveillance Advanced RF Systems program will initiate development of a flyable UESA antenna that is optimized for integration with the E-2C Radar Modernization Program (RMP) system. The flyable UESA subsystem design is specified to meet or exceed existing E-2C rotating antenna RF gain characteristics, while being electronically steered through the full 360 degree surveillance and track volume. The unit is also being designed and built to be fully compatible with the E-2C aircraft operating environment, avionics and flight control systems. The program continues development of a Precision Surveillance & Targeting (PS&T) radar system that can be implemented in a pod configuration for in-flight captive carry on a Navy F/A-18 aircraft. The PS&T advanced technology system will enable Naval F/A-18 and other strike aircraft to simultaneously execute surveillance, discrimination and geo-location/tracking of both stationary and moving ground targets in complex background clutter and electronic countermeasure environments. The UESA Advanced Technology Demonstration project completes in FY 2002 with a demonstration of the brassboard UESA system installed and operating from a land based tower. Development and demonstration of the TADIRCM technology will complete at the end of FY 2002.

- (U) ($27,203) The Radio Communications RF Advanced Technology program designs and develops advanced technology that is ready for Naval acquisition programs. Advanced wireless communications and networked systems enable Navy and Marine Corps warfighters to achieve rapid, accurate, and consistent situational understanding using command and combat systems; and to plan and execute operations that are coordinated across all involved organizations and echelon levels, including coalition partners. Further, these technology efforts will provide basic system level components (antennas and networking) that are necessary for the network infrastructure, in order to support evaluation of network centric concepts within the Navy. The FY 2002 Radio Communications RF Advanced Technology program will initiate development of a K/Ka/Q-Band Physical Layer (OSI Reference Model) to aid in development of a wideband, electronically steered array for an advanced K/Ka/Q-Band RF Communications Link that supports up to three mega bits per second communications data rates between communication satellites and Naval Surface Combatants. This product will provide ship and submarine designers with the ability to incorporate antenna technology into the design of surface and subsurface platforms. The K/Ka/Q band array provides Naval combatants with the ability to access Wideband Gapfiller Satellites (WGS), MILSTAR and Commercial satellite constellations to support beyond line-of-sight connectivity needed for Network Centric Warfare. The Naval Battleforce Network (NBN), which is an organic network to enable Battle Groups (BG) and Amphibious Ready Groups (ARG) to provide local connectivity among their ships, emphasizes aerial communications relays, littoral mobile wireless networking, and composite routing. This area will continue development of an integrated VHF/UHF/L-Band aperture that is capable of merging five Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) functions into a highly integrated federation of antennas for initial application to Navy surface combatants; an X/Ku-Band electronically steered array with multiple, simultaneous transmit/receive beams to provide Tactical Common Data Link (TCDL) connectivity to theater assets; and an S-Band Receive Phased Array prototype which will begin testing this year and is expected to continue testing through fiscal year 2003. The S-Band receive phased array will provide Naval tactical forces with ready access to selected national assets.

- (U) ($26,000) Multi-Function RF Concept Technology will initiate a Test Bed Integration and Preliminary Testing program of the AMRF-C Test Bed. It is continuing the integration and demonstration of: high band multi-function receiver system for AMRF; a beam former and signal generator with the high band AMRF subsystem; (construction and testing of the AMRF test bed receiver and digital beam former; and performance characterization tests of the low band transmit array and its isolation parameters at a laboratory field site.) The program will complete the design, development, evaluation and documentation of the system resource allocation manager software; and development and implementation of the realtime system network into the system technology testbed.

3. (U) FY 2003 PLAN:

- (U) ($13,800) The Surface and Aerospace Surveillance RF Advanced Technology Thrust will continue development of UESA Radar technology for application to the E-2C RMP Integration and Airborne Demonstration. The UESA demonstration array is comprised of fifty-four UHF elements, co-aligned with 108 Identification Friend or Foe (IFF) L-band elements, integrated into an E-2C rotodome. This will provide the E-2C with full 360 degree electronic scanning in the azimuth dimension and fixed beam coverage for both UHF surveillance and IFF in the elevation dimension. The program will continue development of the pod configured airborne Precision Surveillance and Targeting Radar with emphasis on its performance in Time Critical Strike (TCS) operations against stationary and slow moving ground targets in complex clutter and electronic countermeasure environments. In FY 2003 elements of the Affordable Ground Based Radar (AGBR) move from PE 0603758N, 0603235N, 0602131M, and 0602235N into this program element. The AGBR project is developing enabling technologies such as light weight, high power, high efficiency wide band radio frequency systems technology for application to the USMC Multi-Role Radar System (MRRS) program. Agreements are in place with the MRRS program to transition the ONR AGBR technology to the MRRS program in Fiscal Year 2006.

- (U) ($23,700) The Radio Communications RF Advanced Technology program designs and develops advanced technology that is ready for Naval acquisition programs. Advanced wireless communications and networked systems enable Navy and Marine Corps warfighters to achieve rapid, accurate, and consistent situational understanding using command and combat systems; and to plan and execute operations that are coordinated across all involved organizations and echelon levels, including coalition partners. Further, these technology efforts will provide basic system level components (antennas and networking) that are necessary for the network infrastructure, in order to support evaluation of network centric concepts within the Navy. The Radio Communications RF Technology Thrust will initiate development of an Extremely Low Frequency (ELF) on Hull Antenna development to improve submarine at-depth communications. The program is continuing development of: the Naval Battleforce Network (NBN), which is a network to enable Battle Groups (BG) and Amphibious Ready Groups (ARG) to provide local communications relays, littoral mobile wireless networking, and composite routing; advanced multi-frequency and multi-function electronically steered apertures covering the frequency bands of K/Ka/Q to provide Naval combatants with connectivity to MILSTAR, Wideband Gapfiller Satellite (WGS) and commercial satellites. The program is also conducting testing and evaluation of: an S-Band receive phased array, and an X/Ku-Band electronically steered array with multiple transmit/receive beams to provide Tactical Common Data Link connectivity to theater assets; and the integrated VHF/UHF/L-Band aperture that is capable of merging five Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) functions into a single multiple antenna for initial applications.

- (U) ($27,598) The Advanced Multi-Function RF Technology Thrust will complete Integration and initial performance testing and characterization of the AMRF High Band testbed. The thrust will initiate preliminary demonstrations of multiple simultaneous communication/data link and electronic warfare receive and transmit beams and functions to evaluate test bed functionality and to quantify an initial set of performance metrics and characteristics such as: system efficiencies when executing simultaneous transmit/receive functions; system resource management to include system scheduling, conflict resolution and adaptive response to changing operations and environments; and determination of isolation characteristics and interference issues that occur when conducting simultaneous functions using shared/common system elements. Metrics resulting from the testbed evaluations will serve as design guidelines for Multi-function RF system architectures.

C. (U) PROGRAM CHANGE SUMMARY EXPLANATION:

(U) Schedule: Not Applicable.
(U) Technical: Not Applicable.

D. (U) OTHER PROGRAM FUNDING SUMMARY:
(U) RELATED RDT&E:
(U) NAVY RELATED RDT&E:
(U) PE 0601152N (In-House Laboratory Independent Research)
(U) PE 0601153N (Defense Research Sciences)
(U) PE 0602271N (RF Systems Applied Research)

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 3 PROGRAM ELEMENT:0603271N PROJECT NUMBER: R2193
PROGRAM ELEMENT TITLE: RF Systems Advanced Technology PROJECT TITEL: RF Systems Advanced Technology

(U) PE 0602114N (Power Projection Applied Research)
(U) PE 0603114N (Power Projection Advanced Technology)
(U) PE 0602123N (Force Protection Applied Research)
(U) PE 0603123N (Force Protection Advanced Technology)
(U) PE 0602235N (Common Picture Applied Research)
(U) PE 0603235N (Common Picture Advanced Technology)
(U) PE 0603729N (Warfighter Protection Advanced Technology)
(U) PE 0603236N (Warfighter Sustainment Advanced Technology)

(U) NON-NAVY RELATED RDT&E:
(U) PE 0602702F (Command, Control and Communications)
(U) PE 0602204F (Aerospace Sensors)
(U) PE 0602782A (Command, Control and Communications (C^3) Technology)
(U) PE 0602705A (Electronics and Electronic Devices)
(U) PE 0602270A (Electronic Warfare Technology)
(U) PE 0603270A (Electronic Warfare Technology)
(U) PE 0603270F (Electronic Combat Technology)

E. (U) SCHEDULE PROFILE: Not Applicable.

CONGRESSIONAL PLUS-UPS

This section describes the following Congressional Plus-Ups appropriated in FY 2001 and FY 2002 whose efforts fall within the scope of this (restructured program), or which were appropriated in this program element:

Multi-Function, Multi-band, Multi-Beam Communications Antenna System (M3CAS)
Tactical Aircraft Directed Infrared Countermeasures (TADIRCM)

1. FY 2001 Congressional Plus-ups:
   - (U) ($4,794K), The Tactical Aircraft Directed Infrared Countermeasures (TADIRCM) effort focused on the successful completion of the live missile firing program. A QF-4 drone aircraft with a podded TADIRCM system onboard successfully protected the aircraft against an advanced surface-to-air missile and an advanced air-to-missile. TADIRCM's impressive demonstrated performance is building strong support towards the establishment of a FY04 systems Development Demonstration (SDD) program. (This plus up was appropriated in PE 0604216N and realigned to PE 0603270N.

2. FY 2002 Congressional Plus-ups:
   - (U) ($4,262), Multi-Function, Multi-Band, Multi-Beam Communications Antenna System (M3CAS) – Funds provided will enable the Navy’s S&T RF communications programs that are developing multi-function, multi-band, multi-beam phased array apertures for Naval surface combatants to determine and address risk factors associated with platform integration and electromagnetic compatibility issues in the early stages of development. The M3CAS funding will also provide Navy developers and acquisition planners with engineering models for use in optimizing aperture placement aboard the host platform to maximize operational utility and effectiveness in all operating environments.

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603508N
PROGRAM ELEMENT TITLE: Ship Propulsion System

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE		FY 2001 ACTUAL	FY 2002 ESTIMATE
R2224	Ship and Sub Hm&E Advanced Technology	39,674	0
R2373	Composite Helicopter Hanger Door	3,887	0
R2705	Virtual Testbed for Reconfigurable Ships	2,149	0
R2706	Project M	2,897	0
R2708	Electromagnetic Propulsion Systems	1,931	0
R2711	Superconducting DC Motor	7,249	0
R2826	Ship Service Fuel Cell	1,931	1,982
R2827	Modular Composite Hull	2,899	0
R2828	Advanced Waterjet (AWJ-21)	3,861	0
R2829	Laser Welding and Cutting	1,938	0
R2830	Portable Hybrid Electric Power System	2,423	0
R2831	AC Synchornous High Temperature Superconductor (HTS) Electric Motor	3,383	0
R9026	DDG-51 Composite Twisted Rudder	0	991
Total		74,222	2,973

This PE was restructured in FY 2002. FY2001 efforts are described in PEs 0603123N.

Congressional Plus-ups appropriated in this PE are described under the following restructured program elements:

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603508N
PROGRAM ELEMENT TITLE: Ship Propulsion System

Title	PE Number	FY 2001	FY 2002
AC Synchronous High Temperature Superconductor (HTS) Electric Motor	0603123N	$3,383	$ 0
Advanced Waterjet (AWJ-21)	0603123N	$3,861	$ 0
Composite Helicopter Hanger Door	0603123N	$3,887	$ 0
DDG-51 Composite Twisted Rudder	0603123N	$ 0	$ 991
Electromagnetic Propulsion Systems	0602123N	$1,931	$ 0
Laser Welding and Cutting	0602271N	$1,938	$ 0
Modular Composite Hull	0603123N	$2,899	$ 0
Portable Hybrid Electric Power System	0603123N	$2,423	$ 0
Project M	0603123N	$2,897	$ 0
Ship Service Fuel Cell	0603123N	$1,931	$1,982
Superconducting DC Motor	0603123N	$7,249	$ 0
Virtual Testbed for Reconfigurable Ships	0603123N	$2,419	$ 0

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603640M
PROGRAM ELEMENT TITLE: Marine Corps Advanced Technology Demonstrations

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
C2297 Marine Corps Warfighting Lab-Core	35,064	42,545	33,050	33,563	34,893	38,428	36,506	CONT.	CONT.
C2996 Remote Precision Gun Aiming Platform	971	0	0	0	0	0	0	0	971
R2362 Extending the Littoral Battlespace	8,293	948	951	0	0	0	0	0	44,283
R2223 Marine Corps ATD	11,680	17,061	17,605	19,099	22,266	23,573	24,417	CONT.	CONT.
R2295 California Central Coast Research Partnership (C3RP) Initiative	1,448	1,289	0	0	0	0	0	0	2,737
TOTAL	57,456	61,843	51,606	52,662	57,159	62,001	60,923	CONT.	CONT.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: As the land warfare component of Naval Expeditionary Forces, the Marine Corps has unique and technologically stressing requirements resulting from its amphibious mission, Marine Air-Ground Task Force (MAGTF) organizational structure, reliance on maneuver, logistic sustainability, and intensive tempo of operations in diverse environments. Critical Marine Corps requirements being addressed in this program element (PE) are: Mobility; Weapons; Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR); Logistics; and Training and Education. These are ongoing efforts to develop and demonstrate advanced technologies and system concepts in an operational environment. Multiple transitions into the Sub-system/Component Advanced Development phase are planned, as well as fieldable prototyping to reduce risk in System Concept Development and Demonstration. Joint service efforts are in line with Defense Technology Objectives (DTOs) and Joint Warfighting Objectives (JWOs). In addition, Marine Corps warfighting experimentation in conceptual operational assessment of emerging technologies is funded. This PE also provides Extended Littoral Battlespace efforts in the area of command, control, communications, computers and intelligence, and fires and targeting. Efforts focus on connectivity between MAGTF and Fleet organizations and naval sea-based fire support. Specifically, this PE supports the following capabilities: promptly engaging regional forces in decisive combat on a global basis; responding to all other contingencies and missions in the full spectrum of combat operations (high, mid and low intensity), in Military Operations in Urban Terrain (MOUT), and in operations other than war (OOTW), and warfighting experimentation. By providing the technologies to enable these capabilities, this PE primarily supports the goals and objectives of the Strike, Littoral Warfare and Surveillance Joint Mission Areas. This PE supports all of the Marine Corps mission areas. Due to the number of efforts in this PE, the programs described are representative of the work included in this PE.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the ADVANCED TECHNOLOGY Budget Activity because it encompasses design, development, simulation, or experimental testing or prototype hardware to validate technological feasibility and concept of operations and reduce technological risk prior to initiation of a new acquisition program or transition to an ongoing acquisition program.

B. (U) PROGRAM CHANGE SUMMARY FOR TOTAL PE:

	FY 2001	FY 2002	FY 2003
FY 2002 President's Submission	60,122	51,310	
Adjustments from FY 2002 President's Budget:			
SBIR Reduction	-1,081		
Execution Adjustments	-1,585		
8123 Management Reform Initiative Reduction		-550	
FFRDC Reduction		-117	
Congressional Plus-Ups		+11,200	
FY 2003 President’s Submission	57,456	61,843	51,606

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603640M
PROGRAM ELEMENT TITLE: Marine Corps Advanced Technology Demonstrations

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
C2297 Marine Corps Warfighting Lab-Core	35,064	42,545	33,050	33,563	34,893	38,428	36,506	CONT.	CONT.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The Marine Corps Warfighting Laboratory (MCWL) is the centerpiece experimental test bed for the operational enhancement of the Marine Corps. Using the Special Purpose Marine Air-Ground Task Force (Experimental) (SPMAGTF(X)), augmented by other Marine units, as its "test bed" organization, MCWL demonstrates the usefulness and necessity of integrating new technological developments and advanced concepts into the Operational Forces of the Marine Corps. MCWL focuses on developing and field testing future operational and technological concepts and serves as the focal point for the enhancement/refinement of future warfighting capabilities. The organizational thrust is to provide an institutional mechanism for continuously generating new ideas for warfighting capabilities. Concepts of operation are validated by means of various Warfighting Experiments.

(U) Through a process of experimentation, which is designed as an ongoing mechanism to insure the relevance of Marine forces in the face of change, MCWL experimentation encompasses inquiries into multiple technology and warfighting areas, including: Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) and Information Technology; Reconnaissance, Surveillance, and Target Acquisition (RSTA); Fires; Medical, Biological, Chemical, and Non-Lethal Technologies; Expeditionary Logistics; and Advanced Training and Education Techniques.

(U) MCWL develops tactics, techniques, and procedures (TTPs) and evaluates advanced technologies that create or enhance future warfighting capabilities, and integrates them into the Marine Corps Expeditionary Force Development System. MCWL also provides all the efforts for the Marine Corps Combat Development Command (MCCDC) Wargaming in support of the Expeditionary Force Development System and Experimentation.

(U) Using experimental operational forces, beginning with the SPMAGTF(X) as the forward element of a future Naval Expeditionary Force (NEF), MCWL conducts a number of Advanced Warfighting Experiments (AWEs) supported by several Limited Objective Experiments (LOEs), Limited Technology Assessments (LTAs), Wargames, and Studies. LOEs, LTAs, and AWEs examine discrete variables in as much isolation as can be achieved. Technologies used in LTAs are gathered for use in larger LOEs while LOEs are building blocks from which resulting AWEs are constructed. Detailed descriptions are provided below:

-(U) An AWE is defined as a larger scale operational experiment where advanced warfighting capabilities and enabling technologies are evaluated to determine the military utility, operational effectiveness, and operational suitability in as realistic an environment as possible. These AWEs examine an operational concept that envisions a greatly expanded, lethal, fluid, chaotic, and more opportunistic battlefield within a maneuver warfare approach. An AWE answers experimental issues under conditions most closely approximating war using the Advanced Warfighting Concept under examination. It further serves as a venue for integrating all warfighting functions for the purpose of integrated experimentation. All experimentation conducted during a phase builds toward the AWE.

-(U) LOEs are considerably smaller in scope than AWEs and focus on a discrete set of closely related experiment objectives. These experimental forces will be highly trained, technologically infused, highly lethal, and intellectually prepared to fight in this chaotic and opportunistic environment. LOEs are designed to answer questions that, if left unanswered, would have a significant adverse impact on the successful execution of experimental operations in the related AWE.

-(U) LTAs are oriented on the performance characteristics of specific technologies and equipment to assess their usefulness by means of analysis or experimentation. MCWL conducts LTAs in cases where the performance characteristics of developing technology are insufficiently documented to conduct operational planning necessary for experimentation. MCWL plans and conducts LTAs to effectively incorporate a technology into follow-on experiments.

-(U) A Wargame is a broad discipline manifested in a range of activities from a few individuals conducting Action-Reaction-Counteraction drills to a significant commitment from Operating Forces Staff or SPMAGTF(X) Command Element (CE) to execute a Command Post Exercise (CPX) supported by extensive modeling and simulation (M&S). A Wargame is integral to MCWL's experimental process and precedes the execution of each LOE/AWE to refine the LOE/AWE Experimentation Plan.

-(U) A Study is a low-cost (relative to operational experimentation) technique designed to result in broader or deeper research into an Experimental Issue. MCWL undertakes a study when a literature search reveals that existing studies are inadequate to support experiment objectives and synthesis is required and is focused on one or a few closely related Experiment Issues. A Study can contribute to any stage of the Innovation and Experimentation Process, but is most useful during experiment planning.

(U) Under the guidance of the Experimental Campaign Plan (ECP) (formerly known as Five Year Experimentation Plan (FYEP)), MCWL's prior accomplishments and current plans include seven AWE "build-up" phases culminating in actual AWE execution:

-(U) Hunter Warrior: (March 1996 through April 1997) Experimented with advanced operational concepts and technologies on an extended and dispersed battlefield, in open and mountainous terrain at the mid-intensity operational level.
-(U) Urban Warrior: (April 1997 through June 1999) Focused on developing new TTPs and supporting technologies for operations in urban, close terrain, and near urban littoral areas.
-(U) Joint Contingency Force (JCF) (also known as Millennium Dragon): (October 1999 through September 2000) Designed to identify, study, and improve new concepts and tactics for the Marine Corps under the auspices of the Operational Maneuver from the Sea (OMFTS) concept. In support of these concept-based experiments, new enabling technologies were developed, tested, and evaluated for operational use in a combat environment.
-(U) Capable Warrior: (June 1999 through FY 2001) Used lessons learned in Hunter Warrior and Urban Warrior to integrate the full capability of a Marine Air-Ground Task Force (MAGTF) with naval units operating at the numbered fleet level of a Joint Task Force from the sea. Developed initial TTPs for an OMFTS force. Capable Warrior concluded with an experiment referred to as Kernel Blitz Experimental (KBX).
-(U) Millennium Challenge 2002 (MC02): (FY 2001 through FY 2002) Congressionally mandated, Secretary of Defense directed, United States Joint Forces Command (USJFCOM) sponsored joint field experiment. MC02 will be a large-scale, live, virtual, and constructive joint field experiment and demonstration, incorporating elements of all the Services and Special Operations Command critical future warfighting capabilities and forces at the operational level of war.
-(U) Olympic Challenge 2004 (OC04): (FY 2002 through FY 2004) Major joint exercise encompassing all services. Follow-on experimental effort to MC02, that will continue to explore the implementation of the Rapid Decision Operations concept. Experimentation will explore dynamic tasking from the joint headquarters directly to service forces bypassing service component headquarters.
-(U) Olympic Challenge 2006 (OC06): (FY 2004 through FY 2006) Follow-on experimental effort to OC04.

B. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 2001 ACCOMPLISHMENTS:

- (U)($3,972) Project Albert: (Congressional Enhancement) The Project Albert goal is to generate data to support warfighting hypotheses with emphasis on questions relating to urban warfare. Project Albert provides design and development of new tools to capture emergent behavior in synthetic environments that over time will lead to more effective maneuver warriors. Project Albert will continue efforts to support decision-making in a co-evolving world through developing data, concepts, and tools of 21st Century Operations Analysis especially in the areas of non-linear and asymmetric warfare. During FY 2001, Project Albert accomplishments included: 1) Design and implementation of a more realistic agent-based model of combat, to include enhanced command and control and communications features, as well as the implementation of "intangible" quantities such as morale, leadership, and unit cohesion; 2) Design and implementation of a Parallel Execution System (PES) which achieves a massively parallel and efficient approach to executing the large number of runs required by Project Albert models; 3) Beginning automation of data farming methodology through enhancements to the PES; 4) Researching and implementing innovative ideas to data visualization; 5) Making extensive use of the SOCRATES and MANA models to gather data and conduct analyses in counter terrorist and peace support operations; 6) Implementing an evolutionary computation platform which searches the space of "all possible inputs" to a combat model; 7) Performing research in the area of co-evolutionary dynamics (the dynamics of competition); 8) Beginning development of an experimental framework within which specific operational scenarios can be studied more fully; and 9) Development of a scenario translation capability from the ISAAC model to the MANA model, in order to demonstrate the feasibility of validating operational concepts across levels of resolution.

• (U)($6,070) MCWL Operations (Support): Provided technical and strategic direction to MCWL and Marine Corps Science and Technology (ST) program to improve transition into Marine Corps acquisition. Began MC02 AWE Experimentation planning and technology investigations. Continued Strategic Planning through the location, development, and evaluation of advanced warfighting operational and organizational concepts and related enabling technologies. Synthesized results and lessons learned into proposed Tactics, Techniques, and Procedures (TTPs) for the Marine Corps. Continued research; planning; modeling and simulation (M&S), concept, and wargame development; preparation; execution; and analysis and assessment to extend exploration of critical components. This includes investigations into Operations Other Than War (OOTW). Continued providing technical and managerial support to the Marine Corps in matters relating to development and integration of new Marine Corps Tactics, Techniques, Technologies, and Procedures (TTTPs) in order to provide future Marine Corps capabilities in the areas of Doctrine, Organization, Training and Education, and Equipment and Support (DOTES). Continued to provide for Marine Forces (Atlantic and Pacific) Battle Laboratories to conduct experimentation. Completed Capable Warrior Experimentation Planning and technology investigations. Terminated stratagem development for future Marine Corps technological capabilities.

• (U)($12,806) Command, Control, Communications, Computers, and Intelligence (C4I): Initiated experiment pre-planning and C4I development to support the MC02 AWE. Evaluated the effectiveness of commercially available (off-the-shelf) technology for providing wireless connectivity from Marine squads into Integrated Marine Multi-Agent Command and Control System (IMMACCS). Investigated alternatives to IMMACCS/C4I Lab (formerly titled Experimental Command Operations Center (ECOC)). Initiated Marine Communications Interface Module (Airborne) research/experimentation efforts. Continued to develop information processing and to further integrate capabilities into the IMMACCS and the C4 Lab facility. Continued to develop enhanced capability for Shared Net and IMMACCS Graphical User Interface (GUI) (formerly titled Battlefield Visualization Tool (BVT)) efforts. Continued to develop/expand capability for the IMMACCS Agent Engine. Conducted experiments and evaluated the performance of advanced command and control investigations and experiments for sea based fire support. Continued/expanded Multi-Path, Beyond Line of Sight Communications Technology (MUBLCOM) and voice translation efforts. Continued to conduct and investigate red teaming concepts and technologies. Completed experimental planning and C4ISR development in support of the Capable Warrior AWE. Incorporated lessons learned from Millennium Dragon into ongoing technical development efforts and conducted LOEs planned for the build up to the Capable Warrior AWE. Evaluated performance of information management systems to provide the Common Tactical Picture at all levels (squad leader to Commander) of the MAGTF.

- (U)($5,847) Drones, Aviation, Sensors, and Vehicles: Initiated Dragon Eye Unmanned Aerial Vehicle (UAV) development/experimentation effort. Initiated M3M machine gun air experimentation by mounting the system on three helicopter platforms (UH-1N, CH-53E, and CH-46E). Continued small payload development for Dragon Warrior UAV. Continued Unmanned Ground Vehicle (UGV) payload and micro UAV/UGV payload development efforts. Continued development of a class of large population, autonomous robots capable of collecting and reporting on battlefield intelligence. Continued sensor technology investigations/experimentation focusing on ground based magnetic sensors. Continued investigations/experimentation in aviation technologies that could lead to increasing accuracy and effectiveness of Close Air Support missions and also reduce the possibility of fratricide. Continued aviation experimentation in the urban environment and aviation based simulation/instrumentation efforts. Continued to search for new and emerging technologies.

- (U)($2,069) Fires and Targeting: Repaired and incorporated minor improvements to the Mobile Fire Support System (MFSS) (formerly titled Dragon Fire) concept demonstrator. Continued development of a precision-targeting device that includes a laser rangefinder that will provide ground forces with accurate target acquisition. Continued experimentation with/development of small precise munitions. Continued rapid target system exploration/demonstration/development. Continued Combined Arms Coordination Simulation efforts. Continued thermal weapons technology search/developmental efforts. Continued to identify, purchase, and experiment with technologies/concepts to enhance the effectiveness of the warfighter. Expanded investigations into emerging fires and targeting technologies, to include, combat identification. Completed conceptual development of Mobile Counter-Fire System (MCFS).

- (U)($3,008) Seabasing, Logistics, Combat Service Support (CSS), and Combat in Cities (to include Training and Education): Reduced Guided Parafoil Aerial Delivery System (GPADS) efforts to include spare parachute canopies and attachments, as well as, C-130 flight clearance. Expanded Night Integrated Training Environment (NITE) Lab support, an indoor, year-round, multi-environment training facility. Initiated Project Rifleman efforts to evaluate concepts that will enhance the combat abilities of the individual Marine in expeditionary combat environments (i.e. Military Operations in Urban Terrain (MOUT)). Initiated Land Warrior efforts, an integrated computer/weapon system worn by the individual Marine. Established Joint Experimentation Cell program to facilitate MCWL's expanded joint experimentation role. Initiated investigations/experimentation in Urban Ground Reconnaissance TTPs. Initiated Ground Command and Control (GLC2) concept that generates accurate, real-time, mission critical data associated with tactical equipment by capitalizing on the existing technology and communications architecture for data collection, transmission, and dissemination. Continued to develop and integrate the CSS tools/systems/equipment that will make up the "Marine of 2020". Continued to invest in all types of simulation to allow required OMFTS warfighting capabilities to be tested. Continued to search for, evaluate, and perform seabased logistics support and seabasing analysis. Continued investigation/development of a system that tracks personnel involved in a Non-combatant Evacuation Operations. Continued rapid prototype development, demonstration, and transition of logistics information resources technologies. Continued system concept M&S support for decision support and technology plan development for Joint Expeditionary Forces. Continued to investigate and incorporate automated information technologies for asset tracking, interactive, condition based maintenance support, and sensored logistics information feeds. Continued integrating clothing and equipment that will enhance Marines' survivability. Continued Project Metropolis experimentation efforts. Continued to experiment with electronic markers. Continued to leverage ongoing work in the Day/Night Small Unit Target Acquisition and Small Unit Logistics fields. Continued to evaluate CSS for emerging and developing weapons as they apply to operational concepts of logistics support and sustainment for various non-standard scenarios. Continued investigations into existing and emerging training enhancements and simulation equipment and devices. Continued to search for and to evaluate emerging commercially available technologies that could significantly improve efforts in this area. Completed packaging efforts.

- (U)($1,292) Chemical/Biological (Chem/Bio), Medical, Analysis, and Non-Lethals: Continued medical investigations, including investigations into the chem/bio arena. Continued to define the scope, nature, technical utilities, and TTPs that support domestic and international responses to the human and material casualties of a Weapons of Mass Destruction (WMD) deployment. Continued to support instrumentation capability that provides battlespace instrumentation for experimentation. Continued efforts to improve upon the automated data collection system. Continued to provide overall systems engineering and integration support for ongoing experimentation. Continued to provide overall analysis and reporting of experimentation efforts. Reduced investigations into seeking Non-Lethal technologies that can affect an opponent's infrastructure without necessarily destroying it. Reduced investigations into the use of Non-Lethal technologies to deter, delay, deny, disrupt, and destroy opponents or their material. Completed Project Atlanta efforts with Electro Chemical Activated Decontamination Technology (ECOSOL) study.

2. (U) FY 2002 PLAN:

- (U)($4,000) Project Albert: (Congressional Enhancement) The Project Albert goal is to generate data to support warfighting hypotheses with emphasis on questions relating to urban warfare. Project Albert provides design and development of new tools to capture emergent behavior in synthetic environments that over time will lead to more effective maneuver warriors. Project Albert will continue efforts to support decision-making in a co-evolving world through developing data, concepts, and tools of 21st Century Operations Analysis especially in the areas of non-linear and asymmetric warfare. During FY 2002, Project Albert plans to: 1)Continue the development of realistic agent-based models of combat with an emphasis on building a toolkit with a variety of ways to treat command and control, communication, combat, terrain, and decision making; 2) Design and analyze an influence network (use of Bayesian decision analysis) on a counter terrorist scenario; 3) Further development of the Parallel Execution System so that gridded search, evolutionary, and co-evolutionary studies can be accomplished quickly and easily; 4) Development of a scenario translation capability from the ISAAC model to the SOCRATES model, for use in validating operational concepts across levels of resolution; 5) Continue the research on the dynamics of competition, with the goal of implementing innovative ideas within military modeling and analysis; and 6) Continue to implement innovative approaches in data perception and understanding into the analysis tools that comprise the Albert toolkit.

- (U)($1,700) Fast Refueling System: (Congressional Enhancement) Provides for operational testing and evaluation, modifications, and purchase of the fast refueling system.

- (U)($1,700) Marine Corps Future Logistics: (Congressional Enhancement) Provides for expansion of the Future Naval Capability Expeditionary Logistics Program.

- (U)($2,500) Mobile Counter-Fire System (MCFS): (Congressional Enhancement) MCFS is a sniper detection system. Limited evaluations are being performed on a single platform (High Mobility Multi-purpose Wheeled Vehicle (HMMWV)) prototype system with a baseline software system. In addition, algorithm research is being conducted to address false-alarm issues.

- (U)($6,440) MCWL Operations (Support): Initiate OC04 AWE Experimentation Planning and technology investigations. Initiate Revolution in Military Affairs (RMA)/Project Ellis Program which is the Marine Corps component of the Office of the Secretary of Defense (OSD)/Net Assessment's RMA Wargaming Program. RMA provides an exploratory venue to address critical conceptual, organizational, and technical issues essential to success on the 21st century battlefield. Moreover, this program significantly strengthens Project Ellis as a process of accessing the impact of changes in the strategic landscape on concepts, organization, and technology. Continue Strategic Planning through the location, development, and evaluation of advanced warfighting operational and organizational concepts and related enabling technologies. Synthesize results and lessons learned into proposed TTPs for the Marine Corps. Continue research; planning; M&S, concept, and wargame development; preparation; execution; and analysis and assessment to extend exploration of critical components. This includes investigations into OOTW. Continue providing technical, strategic, and managerial support to the Marine Corps. Continue to provide for Marine Forces (Atlantic and Pacific) Battle Laboratories to conduct experimentation. Conclude development and integration of new Marine Corps TTTPs initiative. Complete MC02 Experimentation Planning and technology investigations.

- (U)($9,297) C4I: Initiate investigations into alternative over the horizon (OTH) communications technologies. Initiate Land Attack Warfare System (LAWS) support during MC02 AWE and IMMACCS testing. Initiate Integrated Global Positioning System (GPS) Radio System (IGRS) effort to aid in data collection efforts. Develop and purchase two high temperature super-cooling filters to extend the range of the current ultra high frequency (UHF) and very high frequency (VHF) radios. Expand Marine Corp Interface Module (Airborne) (MCIM) (A) research experimentation efforts. Continue to develop information processing and to further integrate capabilities into the IMMACCS and the C4 Lab facility. Continue to develop enhanced capability for Shared Net and IMMACCS GUI efforts. Continue to develop/expand capability for the IMMACCS Agent Engine. Continue to conduct experiments and evaluate the performance of advanced command and control investigations and experiments for sea based fire support. Continue to evaluate the effectiveness of commercially available (off-the-shelf) technology for providing wireless connectivity from Marine squads into IMMACCS. Reduce MUBLCOM efforts. Continue/expand voice translation efforts. Continue investigations into alternatives to IMMACCS/C4 Lab. Continue to conduct and investigate red teaming concepts and technologies.

Complete experimental planning and C4ISR development in support of the MC02 AWE. Incorporate lessons learned from Capable Warrior AWE into ongoing technical development efforts and conduct LOEs planned for the build up to MC02 AWE.

- (U)($7,669) Drones, Aviation, Sensors, and Vehicles: Add target tracking capability to Dragon Warrior Forward Looking Infrared (FLIR) payload. Add laser designation capability to Dragon Warrior Electro-optic/Infrared (EO/IR) payload. Initiate Dragon Runner Mobile Ground Sensor (MGS) development/experimentation efforts. Dragon Runner is a ground mobile sensor that will be used by marine infantry battalions. It has the capability to perform autonomously and cooperatively in multi-purpose operational venues in urban combat conditions. Continue small payload development for Dragon Warrior UAV. Continue UGV payload and micro UAV/UGV payload development efforts. Continue development of a class of large population, autonomous robots capable of collecting and reporting on battlefield intelligence, focusing on robotic ground sensor data transfer development. Continue sensor technology investigations/experimentation. Continue investigations/experimentation in aviation technologies that could lead to increasing accuracy and effectiveness of Close Air Support missions and also reduce the possibility of fratricide. Continue Dragon Eye investigations/experimentation. Continue M3M mounted on helicopter platforms experimentation. Continue aviation experimentation in the urban environment and aviation based simulation/instrumentation efforts. Continue to search for new and emerging technologies.

- (U)($3,342) Fires and Targeting: Design breach loading capability and redesign/fabricate fully functional MFSS concept demonstrator. Continue development of a precision targeting device that includes a laser rangefinder. Continue experimentation with/development of small precise munitions. Continue rapid target system exploration/demonstration/development. Continue Combined Arms Coordination Simulation efforts. Continue thermal weapons technology search/developmental efforts. Continue to identify, purchase, and experiment with technologies/concepts to enhance the effectiveness of the warfighter. Continue to investigate emerging fires and targeting technologies.

- (U)($4,462) Seabasing, Logistics, CSS, and Combat in Cities (to include Training and Education): Establish Tactical Warrior experimentation program to explore expanded tactical capabilities in the infantry platoon and company through changes in organization and the exploitation of changes in available training and technology. Initiate M3M machine gun ground experimentation by mounting the system on three vehicle platforms (High Mobility Multipurpose Wheeled Vehicle (HMMWV), 5-ton truck, and 7-ton truck). Continue to develop and integrate the CSS tools/systems/equipment that will make up the “Marine of 2020”. Continue to invest in all types of simulation to allow required OMFTS warfighting capabilities to be tested. Continue to search for, evaluate, and perform seabased logistics support and seabasing analysis. Continue investigation/ development of a system that tracks personnel involved in Non-combatant Evacuation Operations. Continue rapid prototype development, demonstration, and transition of logistics information resources technologies. Continue system concept M&S support for decision support and technology plan development for Joint Expeditionary Forces. Continue to investigate and incorporate automated information technologies for asset tracking, interactive, condition based maintenance support, and sensored logistics information feeds. Continue integrating clothing and equipment that will enhance Marines’ survivability. Continue MOUT experimentation efforts (to include Project Metropolis and Project Rifleman). Continue to experiment with electronic markers. Continue to leverage ongoing work in the Day/Night Small Unit Target Acquisition and Small Unit Logistics fields. Continue to evaluate CSS for emerging and developing weapons as they apply to operational concepts of logistics support and sustainment for various non-standard scenarios. Continue investigations into existing and emerging training enhancements and simulation equipment and devices. Continue to search for and to evaluate emerging commercially available technologies that could significantly improve efforts in this area. Continue Land Warrior efforts. Continue GLC2 efforts. Continue Joint Experimentation Cell investigation/coordination efforts. Continue Urban Ground Reconnaissance efforts. Complete GPADS efforts. Complete NITE Laboratory support efforts.

- (U)($1,435) Chemical/Biological (Chem/Bio), Medical, Analysis, and Non-Lethals: Continue medical investigations, including investigations into the chem/bio arena. Continue to define the scope, nature, technical utilities, and TTPs that support domestic and international responses to the human and material casualties of a WMD deployment. Continue to support instrumentation capability that provides battlespace instrumentation for experimentation. Continue efforts to improve upon the automated data collection system. Continue to provide overall systems engineering and integration support for ongoing experimentation. Continue to provide overall analysis and reporting of experimentation efforts. Continue limited investigations into seeking Non-Lethal technologies that can affect an opponent's infrastructure without necessarily destroying it. Continue limited investigations into the use of Non-Lethal technologies to deter, delay, deny, disrupt, and destroy opponents or their material.

3. (U) FY 2003 PLAN:

- (U)($6,101) MCWL Operations (Support): Initiate OC06 AWE Experimentation Planning and technology investigations. Continue Strategic Planning through the location, development, and evaluation of advanced warfighting operational and organizational concepts and related enabling technologies. Synthesize results and lessons learned into proposed TTPs for the Marine Corps. Continue research; planning; M&S, concept, and wargame development; preparation; execution; and analysis and assessment to extend exploration of critical components. This includes investigations into OOTW. Continue providing technical, strategic, and managerial support to the Marine Corps. Expand OC04 AWE Experimentation Planning and technology investigations. Continue to provide for Marine Forces (Atlantic and Pacific) Battle Laboratories to conduct experimentation. Continue RMA/Project Ellis efforts.

- (U)($8,851) C4I: Initiate experimental planning and C4ISR development to support the OC04 AWE. Continue to develop information processing and to further integrate capabilities into the IMMACCS and the C4 Lab facility. Continue to develop enhanced capability for Shared Net and IMMACCS GUI efforts. Continue to develop capability for the IMMACCS Agent Engine. Continue to conduct experiments and evaluate the performance of advanced command and control investigations and experiments for sea based fire support. Continue to evaluate the effectiveness of commercially available (off-the-shelf) technology for providing wireless connectivity from Marine squads into IMMACCS. Continue/expand OTH communications investigations and voice translation efforts. Continue investigations into alternatives to IMMACCS/C4 Lab. Continue LAWS support during IMMACCS testing. Continue MCIM(A) research/experimentation efforts. Continue IGRS data collection efforts. Continue to conduct and investigate red teaming concepts and technologies.

- (U)($7,301) Drones, Aviation, Sensors, and Vehicles: Continue small payload development for Dragon Warrior UAV. Continue Dragon Warrior target tracking and laser designation payload efforts. Continue UGV payload and micro UAV/UGV payload development efforts. Continue development of a class of large population, autonomous robots capable of collecting and reporting on battlefield intelligence. Continue Dragon Runner MGS efforts. Continue sensor technology investigations/experimentation. Continue investigations/experimentation in aviation technologies that could lead to increasing accuracy and effectiveness of Close Air Support missions and also reduce the possibility of fratricide. Continue Dragon Eye investigations/experimentation. Continue M3M mounted on helicopter platforms experimentation. Continue aviation experimentation in the urban environment and aviation based simulation/instrumentation efforts. Continue to search for new and emerging technologies.

- (U)($3,182) Fires and Targeting: Continue breach loading capability redesign and fabrication efforts of the fully functional MFSS concept demonstrator. Continue development of a precision targeting device that includes a laser rangefinder. Continue experimentation with development of small precise munitions. Continue rapid target system exploration/demonstration/development. Continue Combined Arms Coordination Simulation efforts. Continue thermal weapons technology search/developmental efforts. Continue to identify, purchase, and experiment with technologies/concepts to enhance the effectiveness of the warfighter. Continue to investigate emerging fires and targeting technologies.

- (U)($6,249) Seabasing, Logistics, CSS, and Combat in Cities (to include Training and Education): Continue to develop and integrate the CSS tools/systems/equipment that will make up the “Marine of 2020”. Increase investment in all types of simulation to allow required OMFTS warfighting capabilities to be tested. Continue to search for, evaluate, and perform seabased logistics support and seabasing analysis. Continue investigation/development of a system that tracks personnel involved in a Non-combatant Evacuation Operations. Expand rapid prototype development, demonstration, and transition of logistics information resources technologies. Expand system concept M&S support for decision support and technology plan development for Joint Expeditionary Forces. Continue to investigate and incorporate automated information technologies for asset tracking, interactive, condition based maintenance support, and sensored logistics information feeds. Continue integrating clothing and equipment that will enhance Marines’ survivability. Continue MOUT experimentation efforts (to include Project Metropolis and Project Rifleman). Continue to experiment with electronic markers. Continue to leverage ongoing work in the Day/Night Small Unit Target Acquisition and Small Unit Logistics fields. Continue to evaluate CSS for emerging and developing weapons as they apply to operational concepts of logistics support and sustainment for various non-standard scenarios. Continue investigations into existing and emerging training enhancements and simulation equipment and devices. Continue to search for and to evaluate emerging commercially available technologies that could significantly improve efforts in this area. Continue Land Warrior efforts. Expand Joint Experimentation Cell investigation/coordination efforts. Continue GLC2 efforts. Continue M3M mounted on vehicle platforms experimentation. Continue Tactical Warrior efforts. Continue Urban Ground Reconnaissance efforts.

- (U)($1,366) Chemical/Biological (Chem/Bio), Medical, Analysis, and Non-Lethals: Continue medical investigations, including investigations into the chem/bio arena. Continue to define the scope, nature, technical utilities, and TTPs that support domestic and international responses to the human and material casualties of a WMD deployment. Continue to support instrumentation capability that provides battlespace instrumentation for experimentation. Continue efforts to improve upon the automated data collection system. Continue to provide overall systems engineering and integration support for ongoing experimentation. Continue to provide overall analysis and reporting of experimentation efforts. Continue limited investigations into seeking Non-Lethal technologies that can affect an opponent's infrastructure without necessarily destroying it. Continue limited investigations into the use of Non-Lethal technologies to deter, delay, deny, disrupt, and destroy opponents or their material.

C. (U) PROGRAM CHANGE SUMMARY EXPLANATION: See Program change total summary for PE.

(U) Schedule: MCWL was founded in October 1995 with an experimentation plan that culminated each two year experimentation phase with a major service Advanced Warfighting Experiment (AWE) on odd-numbered years. However, the requirements and opportunities of involvement in Joint Experimentation have led to a change in the Lab’s experimentation program. Beginning with the Capable Warrior experiment (FY 2001) which centered around the Major Systems Demonstration of the Extended Littoral Battlespace (ELB) Advanced Concepts Technology Demonstration (ACTD), the Marine Corps major experiments shifted into support of major Joint Experimentation Events. The United States Marine Corps (USMC) moved its major service experiments in odd years to even years in order to align with the Joint Forces Command (JFCOM) Joint Concept Development and Experimentation (JCDE) Campaign Plan. While conducting its own service experimentation after this realignment, MCWL experiments also support the joint experiments and are being integrated with joint concepts and objectives.

(U) Technical: Joint Service participation will be the largest technical area impacted by the FY 2005 through FY 2007 increase of $12.5M, spread across the Future Years Defense Plan. MCWL, however, will continue to use all available avenues to augment funding (i.e., shared program efforts with other Services and leveraging other Service research, development, testing, evaluation, and experimentation), if necessary, to ensure that Marine Corps joint experimentation future goals and expectations are achieved.

D. (U) OTHER PROGRAM FUNDING SUMMARY: The Navy’s 6.1 program contributes indirectly to this effort.

(U) RELATED RDT&E:

(U) NAVY RELATED RDT&E:
(U) PE 0602131M (Marine Corps Landing Force Technology)

(U) NON NAVY RELATED RDT&E: Not applicable.

E. (U) SCHEDULE PROFILE: Not applicable.

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603640M
PROGRAM ELEMENT TITLE: Marine Corps Advanced Technology Demonstrations

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
R2362	Extending the Littoral Battlespace (ELB)								
	8,293	948	951	0	0	0	0	0	44,283

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The Extending the Littoral Battlespace (ELB) Advanced Concept Technology Demonstration (ACTD) effort responds to the top level military need to rapidly deploy a Naval Expeditionary Task Force with an embarked Marine Air Ground Task Force (MAGTF) as part of a larger Joint Task Force to any region of the world's littorals and conduct military operations from a sea base across the spectrum of conflict to implement national military strategy. Forces employed ashore will be light, agile, distributed and desegregated and capable of optimizing remote fires, to effectively deter aggression, halt attacks and secure critical areas as a precursor to a much larger force. Forces will be empowered by unprecedented situational awareness via a robust information infrastructure that is fully coupled to a decision/planning/execution system on a shared battlespace network (sea/land). The objective of the ACTD is to demonstrate an enhanced integrated command and control/fires and targeting capability to enable rapid employment, maneuver, and fires to support joint dispersed unit operations in an extended littoral battlespace. A Major Systems Demonstration (MSDI) was completed FY 1999 and a second one (MSDII) was completed in FY 2001. The ELB ACTD was approved by Deputy Under Secretary of Defense (Acquisition and Technology) (DUSD (AT)) on 16 January 1997.

B. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 2001 Accomplishments:
   - (U)($8,293) Extending the Littoral Battlespace (ELB) Performed Systems Integration Tests, Full Systems Tests and a Major Systems Demonstration II. Determined, provided and supported transition sets of Full Systems Test (FST) and Major Systems Demonstration II technology. Demonstrated/Post Analysis for evaluating the system concept and assessing its military utility. Planned and conducted MSDII. Demonstrated activity that included systems installation, integration, testing, software verification and validation, ship installation, operator training and system scenario testing. Selected, provided and supported transition sets from Major System Demonstration II for further military utility and operator assessment. Demonstrated the C4ISR system of systems in a realistic combat scenario utilizing operational forces.

2. (U) FY 2002 PLAN:

- (U)($948) Transition technologies, hardware and software to military utilities for users. Demonstrate post demonstration analysis for the evaluation of system concepts and assess its military utilities. ELB determines, provides and supports transitional sets of Full Systems Tests (FST) and MSDII.

3. (U) FY 2003 PLAN:

- (U)($951) ELB continues the transition of demonstrated technologies, hardware, software, and processes to military acquisition communities. Conducting post demonstration testing and analysis for the further evaluation of system concepts and assessment of military utility and suitability. Continue support for service testbeds for integration of demonstrated technologies and establishment of technical infrastructure.

C. (U)PROGRAM CHANGE SUMMARY EXPLANATION: See Program change total summary for PE.

D. (U) OTHER PROGRAM FUNDING SUMMARY:

(U) NAVY RELATED RDT&E:

(U) PE 0603235N (Common Picture Advanced Technology)

(U) NON-NAVY RELATED RDT&E:
(U) PE 0603750D (Advanced Concept Technology Demonstration)

E. (U) SCHEDULE PROFILE: Not applicable.

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603640M
PROGRAM ELEMENT TITLE: Marine Corps Advanced Technology Demonstrations

(U) COST: (Dollars in thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
R2223 Marine Corps ATD	11,680	17,061	17,605	19,099	22,266	23,573	24,417	CONT	CONT

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: As the land warfare component of Naval Expeditionary Forces power projection, the Marine Corps has unique and technologically stressing requirements resulting from its mission; Marine Air-Ground Task Force (MAGTF) organizational structure; and reliance on maneuver, logistic sustainability, and intensive tempo of operations in diverse environments. Critical Marine Corps requirements/imperatives being addressed in this Project are: Mobility; Weapons; Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR); Logistics; and Training and Education. These are ongoing efforts to develop and demonstrate advanced technologies and system concepts in an operational environment. Multiple transitions into the Sub-system/Component Advanced Development Phase are planned, as well as fieldable prototyping to reduce risk in System Concept Development and Demonstration. Joint service efforts are in line with Defense Technology Objectives (DTOs) and Joint Warfighting Objectives (JWOs). Efforts focus on connectivity between MAGTF and Fleet organizations and naval sea-based fire support. Specifically, this Project supports the following capabilities: promptly engaging regional forces in decisive combat on a global basis; responding to all other contingencies and missions in the full spectrum of combat operations (high, mid and low intensity), in Military Operations in Urban Terrain (MOUT), and in operations other than war (OOTW); and warfighting experimentation. By providing the technologies to enable these capabilities, this PE primarily supports the goals and objectives of the Strike, Littoral Warfare and Surveillance Joint Mission Areas. The Future Naval Capabilities (FNC) process is supported and funds are budgeted accordingly.

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603640M PROJECT NUMBER: R2223
PROGRAM ELEMENT TITLE: Marine Corps Advanced Technology Demonstrations PROJECT TITLE: Marine Corps ATD

B. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 2001 ACCOMPLISHMENTS:

- (U)($1,686) Mobility Thrust - Tested Reconnaissance, Surveillance and Targeting Vehicle (RST-V) power electronics and vehicle mobility.

- (U)($4,705) Weapons Thrust - Participated in Objective Crew Served Weapon (OCSW) development with Joint Service Small Arms Program (JSSAP), supporting system reliability enhancement and testing. Transitioned Complimentary Low Altitude Weapons System (CLAWS) to Marine Corps Systems Command Program Manager.

- (U)($1,661) C4ISR: Initiated Command and Control testbed for user prototyping requirements generation on prospective commercial and emerging software. Completed Command and Control testbed (moved from 0602131M). Completed Ultrawide-band radio system integration and prototype hardware delivery. Completed development of prototype gryo-compass for Enhanced Targeting and Location System (transferred to Time-Critical Strike Future Naval Capability).

- (U) ($2,265) Logistics: Development of Fuel Automated Quantity System (FAQS) with interface to Small Unit Logistics (SUL) program. Demonstration of SUL ACTD in Exercise Desert Knight. Continued development of tactical logistics distribution system, Modeling and Simulation program.

- (U)($1,363) Training & Education Thrust - Transitioned Advanced Amphibious Assault Vehicle (AAAV) modeling and simulation products developed as part of the Small Unit Tactics Trainer (SUTT) program to the Capable Manpower (CM) Future Naval Capabilities (FNC) program. Transitioned the AAAV Simulator Prototype to the Direct Reporting Program Manager for AAAV in support of developing a virtual environment training capability for the AAAV gunner, driver, and vehicle commander.

2. (U) FY 2002 PLAN:

- (U)($3,321) Mobility Thrust- Demonstrate light vehicle mobility and survivability. Test and experiment with RST-V in the field.

- (U)($1,964) Weapons Thrust- Fuse combat vehicle targeting/sensors. Leverage Loitering Electronic Warfare Killer (LEWK) joint effort to meet Marine Corps needs. Develop air bursting munition and test weapon reliability of the Objective Crew Served Weapon with Joint Small Arms Program.

- (U) ($1,908) C4ISR: Initiated integration of Mobile Direction Finding capability (moved from 0602131M) for transition to the Team Portable Collection System program (from 0602131M). Completed Mobile Direction Finding Advanced Technology Development (transition).

- (U) ($2,809) Logistics: Transition management of several systems to SUL to Marine Corps Systems Command. Complete development on Onboard Vehicle Refueler Communication (OVRC) and Fuel Automated Quantity System (FAQS). Concepts of Operations work on Expeditionary Fuel System 400.

- (U)($1,059) Training & Education Thrust – Complete prototype development and testing of the Close Combat Marine and Marine Air/Ground Task Force (MAGTF) 21 Tactical Decision Games (TDG). Evaluate technologies available for the development of a Logistics TDG. This TDG will be capable of networking with other TDGs and providing tactically relevant training for the Combat Services Support Element (CSSE) of the MAGTF. Develop and evaluate technologies for the development of a Training Mission Support Center (TMSC). The TMSC will provide a distributed collaborative training environment to seamlessly share information between geographically separate elements in support of all phases of mission planning, analysis, rehearsal, execution and evaluation training. The TMSC will also provide a test bed for further evaluation of technologies to augment human cognition for enhanced decision making ability.

- (U)($1,500) Littoral Combat/Power Projection: Initiate program planning to include the development of Enabling Capabilities, Technology Products, Metrics, Exit Criteria, Technology Risk, and Demonstration planning. Identify and fund technologies that can be demonstrated to specific exit criteria to transition to acquisition.

- (U)($500) Littoral Combat/Power Projection: Conduct Expeditionary Maneuver Warfare (EMW) wargame to determine critical capability gaps that are particularly well suited to be resolved by innovative science and technology solutions in support of the new USMC capstone concept. Several specific expeditionary vignettes encompassing a high-end forcible entry scenario, a high-end forward operations scenario, and a low-end "three block war" scenario will drive the game.

- (U)($4,000) Littoral Combat/Power Projection: Prepare and release Broad Agency Announcements for innovative technology solutions in the capability gap areas that emerged from the insights gained from the EMW wargame. Evaluate and select submitted proposals for funding in the areas of C4ISR, Expeditionary Fires, and Maneuver.

3. (U) FY 2003 PLAN:

- (U)($2,792) Mobility Thrust-Demonstrate advanced vehicle technology test bed. Demonstrate light vehicle mobility and survivability. Transition RST-V to Hybrid Electric Ships and Combat Vehicles Future Naval Capabilities (FNC).

- (U)($1,899) Weapons Thrust-Develop technologies explored in munitions study. Determine potential to improve M-203 system via airbursting fuse concept. Develop OCSW with JSSAP. Fuse combat vehicle targeting/sensor to improve probability of detection and enhance awareness via multi sensor inputs and in a single display.

- (U)($2,592) C4ISR: Reinitiate Command and Control Technology testbed for user prototyping, requirements generation on prospective commercial and developmental software products. Initiate demonstration of Low-Probability of Intercept/Low-Probability of Detection (LPI/LPD) ultra-wide band radios for antenna remoting. Initiate development and demonstration of a Marine-portable, deployable, Tactical Jammer. Initiate development and demonstration of an advanced, wide-spectrum tactical signals intelligence receiver. Complete demonstration of LPI/LPD antenna remoting.

- (U)($2,192) Logistics: Distribution capabilities will be investigated to allow for seamless flow of Combat Service Support to forward based Marine units from a Sea-Based environment. Mission Planning and Modeling and Simulation tools that assist the Logistician to effectively and efficiently support the Warfighter in an Expeditionary Maneuver Warfare environment will be explored. Continued work on Sensors and Autonomic logistics will be conducted to provide the Commander a Common Operating Picture of logistics and readiness in a tactical environment.

- (U)($1,992) Training & Education Thrust - Complete the Logistics Tactical Decision Game (TDG) and transition to the Program Manager for Training Systems (PMTRASYS) for further development and enhancement. Initiate prototyping of technologies developed in the applied research program for the Portable Synthetic Environment Generation system. This system will be capable of automatically producing a three dimensional synthetic database from a video stream of real world terrain and cultural features in a 'common' database format suitable for Close Quarter Battle (CQB) and Military Operations in Urban Terrain (MOUT) training. . Continue to evaluate technologies available for the development of a Training Mission Support Center (TMSC). The TMSC will provide a distributed collaborative training environment to seamlessly share information between geographically separate elements in support of all phases of mission planning, analysis, rehearsal, execution and evaluation training. The TMSC will also provide a test bed for further evaluation of technologies to augment human cognition for enhanced decision making ability.

- (U)($1,638) Littoral Combat/Power Projection: Development of advanced Command and Control technologies for Amphibious Task Force (ATF).

- (U)($2,000) Littoral Combat/Power Projection: Development of advanced Expeditionary Fires technologies to include platform and weapon stabilization techniques to enable firing on the move.

- (U)($1,000) Littoral Combat/Power Projection: Development of advanced technologies for MAGTF Maneuver in the Littorals.

- (U)($1,500) Littoral Combat/Power Projection: Development of prototype Intelligence, Surveillance, and Reconnaissance technologies for the ATF.

C. (U) PROGRAM CHANGE SUMMARY EXPLANATION: See Program change total summary for PE.

D. (U) OTHER PROGRAM FUNDING SUMMARY: Not applicable

(U) NAVY RELATED RDT&E:
- (U) PE 0601152N (In-House Laboratory Independent Research)
- (U) PE 0601153N (Defense Research Sciences)
- (U) PE 0204163N (Fleet Communications -(Tactical))
- (U) PE 0602782N (Mine and Expeditionary Warfare Applied Research)
- (U) PE 0603782N (Mine and Expeditionary Warfare Advanced Technology)
- (U) PE 0603235N (Common Picture Advanced Technology)
- (U) PE 0206623M (Marine Corps Ground/Supporting Arms Systems)
- (U) PE 0602131M (Marine Corps Landing Force Technology)
- (U) PE 0603612M (Marine Corps Mine/Countermeasures Systems)
- (U) PE 0603635M (Marine Corps Ground Combat/Support System)
- (U) PE 0206313M (Marine Corps Communications Systems)
- (U) PE 0603236N (Warfighter Sustainment Advanced Technology)

(U) NON-NAVY RELATED RDT&E:
- (U) PE 0603004A (Weapons and Munitions Advanced Technology)
- (U) PE 0603005A (Combat Vehicle and Automotive Advanced Technology)
- (U) PE 0603606A (Landmine Warfare and Barrier Advanced Technology)
- (U) PE 0603607A (Joint Service Small Arms Program)
- (U) PE 0603619A (Landmine Warfare and Barrier Advanced Development)
- (U) PE 0603772A (Advanced Tactical Computer Science and Sensor Technology)
- (U) PE 0604710A (Night Vision Systems - Engineering Development)
- (U) PE 0604808A (Landmine Warfare and Barrier Engineering Development)
- (U) PE 0602301E (Computing Systems and Communications Technology)
- (U) PE 0602702E (Tactical Technology)

E. (U) SCHEDULE PROFILE: Not applicable.

CONGRESSIONAL PLUS-UPS

This section describes the following Congressional Plus-Ups appropriated in FY 2001 or FY2002 in this program element:

California Central Coast Research Partnership (C3RP) Initiative (Project R2295)
Remote Precision Gun Aiming Platform (Project C2996)

1. FY 2001 Congressional Plus-ups:

- (U) ($1,448) C3RP identified eleven pilot research projects that were selected for funding in FY01. These include projects highly relevant to defense, Marine Corps, and national security: Design Methodologies for Analog/Mixed Signal Very Large Scale Integration (VLSI) Systems Applied to Infrared Focal Plane Arrays; Development of an Autonomous Tactical Reconnaissance Platform; Development of Field Rechargeable Gas Mask Filters; Exploitation of Network Bandwidth and The Ethernet/Internet Protocol Application Layer Standard for Automation Networks; Gas Pocket Models for High Velocity Underwater Projectiles; A Service-Oriented Distributed Approach to Disaster Management Decision -Support Systems; Development of Technologies for Semiconductor Processing: A Partnership with Applied Materials Corporation; Geographic Forecasting: Simulation & Analysis of Fire Patterns; and Correlation of Milk Composition and Fouling with Biofilm Formation and Microbial Spore Production in Heat Exchangers. Initiated the establishment of two research facilities to support future research efforts. These include a computer networking research laboratory and a photovoltaic facility. The project's leaders continue to work with private and government partners to advance the project and secure participating funding.
- (U)($971) Remote Precision Gun Aiming Platform: The Remote Precision Gun is a system by which a machine gun is placed on a Telepresent Rapid Aiming Platform, Model T-2 (TRAP-2) which allows the gun to be aimed, via a remote control, by a gunner in a secured location. Three TRAP T-2s and one TRAP T-250 systems were purchased and funding provided to obtain technical and analytical services in order to assist the Marine Corps Warfighting Laboratory (MCWL) in developing and executing technical and user assessments of the TRAP T-2 and the TRAP T-250 weapons systems. Limited Technical Assessments (LTAs) and experiments involving this system emphasize Force Protection issues.

2. FY 2002 Congressional Plus-ups:

- (U) ($1,289) C3RP will define an area of core excellence and establish an Interdisciplinary Center of Excellence in research relevant to national security and the Marine Corps on the Central Coast of California by bringing together the University, government agencies and units (both federal and state), and the private sector, which can evolve into an exceptional national resource. Efforts will continue to explore this potential and to identify and support relevant research and expertise.

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603706N
PROGRAM ELEMENT TITLE: MEDICAL DEVELOPMENT

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE		FY 2001 ACTUAL	FY 2002 ESTIMATE
R0095	Fleet Health Technology	3,557	*
R0096	Fleet Health Standards	5,792	*
R2333	Rural Health	8,409	6,740
R2334	Bone Marrow	32,920	28,645
R2377	National Biodynamics Lab	906	*
R2491	Naval Blood Research Lab	3,861	0
R2492	Medical Readiness Telemedicine Initiative	8,738	7,632
R2494	Disaster Mgmt & Humanitarian Assistance	4,826	0
R2714	Teleradiology	2,911	991
R2832	Fleet Health Technology	2,895	0
R2833	Optical Imaging of Brain	1,931	0
R2834	Robot Eyes	966	2,478
R2835	Rural Health Deployed	2,220	0
R2836	Vector Vaccine	3,399	991
R9000	Nursing Telehealth Applications	0	2,577
R9001	Mobile Integ Diagnost & Data	0	991
R9002	Minimally Invasion Surgical Technology	0	991
R9003	Biomed Research Imaging Core-CoH Nat Med Ctr		

		0	3,965
R9004	Portable Prod Of Sterile Water For Intravenous		
		0	991
R9005	Community Hospital Telehealth Consortium		
		0	1,487
TOTAL		83,331	58,479

*This PE was restructured in FY 2002. FY2001 efforts are described in PE 0603729N.

Congressional Plus-ups appropriated in this PE are described under the following restructured program elements:

Title	RESTRUCTURED PROGRAM ELEMENT	FY 2001	FY 2002
Biomed Research Imaging Core-CoH Nat Med Ctr	0603729N		3,965
Bone Marrow	0603729N	32,920	28,645
Disaster Mgmt & Humanitarian Assistance	0603729N	4,826	
Community Hospital Telehealth Consortium	0603729N		1,487
Fleet Health Technology	0603729N	2,895	
Medical Readiness Telemedicine Initiative	0603729N	8,738	7,632
Minimally Invasion Surgical Technology	0603729N		991
Mobile Integ Diagnost and Data	0603729N		991
Naval Blood Research Lab	0603729N	3,861	
Nursing Telehealth Applications	0603729N		2,577
Optical Imaging of Brain	0603729N	1,931	
Portable Prod of Sterile Water for Intravenous	0603729N		991
Robot Eyes	0603729N	966	2,478
Rural Health Deployed Military Patient Records	0603729N	2,220	
Rural Health	0603729N	8,409	6,740
Teleradiology	0603729N	2,911	991
Vector Vaccine	0603729N	3,399	991

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET   DATE: February 2002

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603707N
PROGRAM ELEMENT TITLE: MANPOWER, PERSONNEL AND TRAINING ADV TECH DEV

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE		FY 2001 ACTUAL	FY 2002 ESTIMATE
R0542	Air Human Factors Engineering	8,649	*
R1770	Manpower & Personnnel Development	3,601	*
R1772	Education & Training Development	15,520	*
R2496	Advanced Distributed Learning (ADL) Systems	9,654	0
R2715	Distributed Simulation Warfighting Concepts	6,172	0
R2739	RIT Center for Integrated Manufacturing	2,898	1,982
TOTAL		46,494	1,982

*This PE was restructured in FY 2002. FY2001 efforts are described in PEs 0603235N, 0603236N, and 0603729N.

Congressional Plus-ups appropriated in this PE are described under the following restructured program elements:

Title	Restructured Program Element	FY 2001	FY 2002
Advanced Distributed Learning Systems	0603236N	9,654	
RIT Center For Integrated Manufacturing	0603236N	2,898	1,982
Dist. Simulation Warfighting Concepts	0603236N	6,172	

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603712N
PROGRAM ELEMENT TITLE: Environmental Quality & Logistics Advanced Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE
R1910 Logistics Engineering and Advanced Demonstrations (LEAD)	14,595	*
R2206 Environmental Requirements Advanced Technology (ERAT)	4,063	*
R2498 Visualization of Technical Information	1,931	0
R2839 Ocean Power Technology	2,907	0
R2840 Hybrid Lidar-Radar	2,972	0
R2841 Geotrack Positioning Technology	5,791	0
R9006 Sustainable Readiness Center	0	1,388
Total	32,259	1,388

*This PE was restructured in FY 2002. FY 2001 efforts were either completed or terminated.

Congressional Plus-ups appropriated in this PE are described under the following restructured program elements:

Title	PE Number	FY 2001	FY 2002
Geotrack Positioning Technology	0603236N	$5,791	$ 0
Hybrid Lidar-Radar	0603747N	$2,972	$ 0
Ocean Power Technology	0603236N	$2,907	$ 0
Sustainable Readiness Center	0603236N	$ 0	$1,388
Visualization of Technical Information	0603236N	$1,931	$ 0

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603727N
PROGRAM ELEMENT TITLE: Joint Experimentation

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	To COMPLETE	TOTAL PROGRAM
R2497 Joint Experimentation									
	64,615	102,868	97,872	106,500	66,029	67,331	68,664	CONT.	CONT.

(U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: Commander in Chief, U.S. Joint Forces Command (CINCUSJFCOM) is chartered "as the Executive Agent for conducting joint warfighting experimentation within the Department of Defense. This effort will enable CINCUSJFCOM to explore new joint warfighting concepts and capabilities and determine Doctrine, Organization, Training, Materiel, Leadership, Personnel, Facilities, (DOTMLPF) implications for change." US Joint Forces Command's Joint Warfighting Experimentation Charter was signed by the Secretary of Defense on 15 May 1998. Joint Experimentation implements this mission through a process of discovery, innovation, concept development, and experimentation to provide for optimal joint future force capability. Joint Experimentation's role as the shaper of national security/national defense transformation is critical. We are tasked to set the conditions for successful transformation. Our goal is to develop the joint context in which joint and service concept development and experimentation can prosper. The Services determine the specific DOTMLPF requirements for their core competencies supporting the joint context.

(U) The future is the US Joint Forces Command's area of responsibility. Within that area of responsibility, we examine ways to enhance the current force, to actualize the Joint Vision 2020, and to dominate the revolution in military affairs. Joint Experimentation's purpose is to lay the foundation for national security transformation. Development of a coherent joint force starts with aggressive concept development and robust joint experimentation. US Joint Forces Command establishes a common joint context for the Department of Defense. This common joint context has not historically existed, but it has already proven to be a powerful tool that fosters coherence, improved stewardship and early interoperability. Concept development, both Joint and Service, is done through intellectual courage, focus, and solid work. It is a process of discovery, innovation, and experimentation.

(U) Recommended changes resulting from this experimentation activity are forwarded to the Chairman, Joint Chiefs of Staff and the Joint Requirements Oversight Committee (JROC) for implementation. Individual Military Services and United States Special Operations Command (USSOCOM) retain primary responsibility to develop concepts and conduct experimentation within their core competencies, to include their land, air and space, sea, expeditionary and special operations roles. USJFCOM serves as the joint force integrator. The Assistant Secretary of Defense for Strategy and

Threat Reduction (ASD (S&TR)) monitors USJFCOM's joint concept experimentation activities on behalf of the Secretary of Defense. ASD (S&TR), working with the Defense Resources Board (DRB), acting in its Revolution in Military Affairs (RMA) oversight role, conducts reviews of CINCUSJFCOM experimentation activities.

(U) US Joint Forces Command serves in two major roles in advancing joint warfighting capabilities. These are documented in the following:

- DODI 5000.2-R, June 2001, Mandatory Procedures for Major Defense Acquisition Programs, C7.3.1. “United States Joint Forces Command shall be available to comment on interoperability and integration issues that the JROC [sic. Joint Requirements Oversight Council] forwards to the DAB [sic. Defense Acquisition Board].”
- CJCSI 3170.01B, 15 April 2001, Requirements Generation System, B2.d.7.b. “USCINCJFCOM will serve as the Chairman’s advocate for joint warfighting interoperability. USJFCOM [sic. US Joint Forces Command] will provide the warfighter perspective during the development of joint operational concepts to ensure that joint forces have interoperable systems.”

(U) The Chairman of the Joint Chief of Staff (CJCS) Joint Experimentation Campaign Plan 01 Guidance directed exploration of revolutionary concepts and advanced technologies that have potential to significantly alter the conduct of military operations. These concepts and advanced technologies include autonomous operations, nano-technologies, bio-centric operations, non-kinetic engagement technologies, and space-based capabilities. Additionally, US Joint Forces Command has CJCS direction to work closely with the science and technology community in developing warfighting capabilities.

(U) The Joint Experimentation Campaign Plans focus on high priority tasks assigned to US Joint Forces Command through the Defense Planning Guidance (DPG) and the Chairman of the Joint Chiefs of Staff (CJCS) Instructions on Joint Concept Development and Experimentation. The Defense Planning Guidance and the Chairman of the Joint Chief of Staff Instructions direct US Joint Forces Command to continue development and refinement of and experimentation with Rapid Decisive Operations (RDO) as the integrating concept supported by seven functional concepts that provide critical capabilities for Rapid Decisive Operations. These functional concepts are Common Relevant Operational Picture (CROP), Adaptive Joint Command and Control (AJC2), Joint Interactive Planning (JIP), Focused Logistics: Enabling Early Decisive Operations (FLEEDO), Information Operations (IO), Assured Access (AA), and Strategic Deployment (SD). Two new proposals entering pre-concept development are Joint Intelligence, Surveillance and Reconnaissance (JISR) and Effects-Based Operations (EBO). Development of these new concepts is based on lessons learned from completed FY00 joint experimentation activities.

(U) In FY 2001, US Joint Forces Command conducted a series of risk mitigation experiments and Limited Objective Experiments in preparation for Millennium Challenge 2002 and the Olympic Challenge series (to be staged in the even years). This series of field experiments will address the challenges of Rapid Decisive Operations through FY07, then will address a follow-on integrating concept in FY15 and beyond. Millennium Challenge 2002 (MC 02) will explore a coherent joint force capable of conducting a rapid, decisive joint strike operation in the 2004-2007 timeframe. Olympic Challenge 2004 (OC 04) will explore Rapid Decisive Operations (RDO) in the 2010-2015 timeframe. The Millennium Challenge/Olympic Challenge series of joint experiments provide the joint context for exploring how well these future concepts work together to transform joint military capabilities at the operational level of war. These experiments will include elements representative of each military service and U.S. Special Operations Command's future force concepts, e.g., Air Force Expeditionary Aerospace Force, Army medium-weight brigades, and Navy Forward from the Sea vision. US Joint Forces Command coordinates continuously with all the CINC's, the Joint Staff, and Services in the concept development and experimentation on the Millennium Challenge/Olympic Challenge series and the execution of concepts.

(U) In FY 2001, US Joint Forces Command started to conduct a series of annual Unified Vision experiments to provide context for refinement of the Rapid Decisive Operations concept and its supporting functional concepts. Experiments and activities to support this concept are structured to provide near, mid and far term operational context and results. Unified Vision 2001 (UV01) served as the preliminary concept, risk mitigation, and experimentation refinement initiative supporting Millennium Challenge 2002. Unified Vision 2001 was designed to begin exploring the "how" of Rapid Decisive Operations. Specific objectives were to examine the Joint Force Headquarters, including external relationships with other national agencies and organizations; to examine the operational-level, effects-based operations planning and execution methodologies; to examine the process of integrating a wider set of national capabilities than reside in the Department of Defense alone; and to begin to examine the information requirements and characteristics of a decision support system that enhances the joint force commander's decision-making ability.

(U) US Joint Forces Command also conducted a series of Limited Objective Experiments (LOE), including Non-Kinetic Technologies (NKT); Open Source Information Management (OSIM); and Presentation.

(U) Millennium Challenge 2002 is the major experimental focus of FY02 activities at US Joint Forces Command. Efforts are continuing on a second track separate from Millennium Challenge 2002 to accelerate development of other concepts such as Forcible Entry Operations (FEO), Effects Based Operations (EBO), Assured Access (AA), Joint Intelligence Surveillance and Reconnaissance (JISR), and Joint Fire Support (JFS), among others.

(U) Due to the number of efforts in the PE, the programs described are representative of the work included in the PE.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the ADVANCED TECHNOLOGY Budget Activity because it encompasses design, development, simulation, and experimental testing or prototype hardware to validate technological feasibility and concept of operations and reduce technological risk prior to initiation of a new acquisition program or transition to an ongoing acquisition program.

(U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 2001 ACCOMPLISHMENTS:

- (U) ($15,582) Rapid Decisive Operations. A concept to achieve rapid victory by attacking the coherence of an enemy's ability to fight. It is the synchronous application of the full range of our national capabilities in timely and directed effects-based operations. It employs our asymmetric advantages in the knowledge, precision, and mobility of the joint force against the enemy's critical functions to create maximum shock. The concept seeks to address this critical question: How do we, in a matter of days, project sufficient military power across global distances and present an operational 'show stopper' to a capable regional power that may have numerically superior combined arms force, home field advantage with asymmetric means to deny access, information operations to attack our national/coalition will, military and civilian casualty tolerance and adaptive and innovative learning with no time constraints. A series of sequential wargames, seminars, virtual and constructive experiments, and field experiments will be used to develop and assess this concept. The Unified Vision 2001 experiment conducted in April-May 2001 was a concept refinement experiment designed to begin exploring the "how" of the Rapid Decisive Operations concept in preparation of Millennium Challenge 2002 experiment. The Millennium Challenge 2002 experiment, which will be held in July-August 2002, will be a major joint integrating experiment designed to assess the "how" of the Rapid Decisive Operations concept. Both the National Interagency Coordination Process and the Joint Command and Control (C2) Element initiatives, including battlespace awareness through our Common Relevant Operational Picture (CROP), are being used following the 11 September 2001 terrorist attack. CENTCOM is actively using CROP and the C2 element, which they learned as a result of participation in the Rapid Decisive Operations Unified Vision 2001 experiment.

- (U) ($1,197) Attack Operations Against Critical Mobile Targets. This was a functional concept supportive of Rapid Decisive Operations (RDO). The AOACMT, (Attack Operations Against Critical Mobile Targets) concept proposed a multifaceted approach to overcoming the asymmetric peril posed by mobile threats such as theater missiles. It hypothesized the identification and continuous, accurate tracking of critical mobile and time sensitive targets, and subsequent engagement with precise, retargetable and responsive weapons and offensive information operations. Experimentation results on Attack Operations through FY00 indicated that near term improvements in the ability to address time sensitive targets are possible, but that they do not necessarily constitute a major symmetric advantage in a Rapid Decisive Operations context. Continued effort in this area will consist of monitoring specific service efforts with a view toward understanding its relevance to providing assured access for Rapid Decisive Operations. Based on post exercise

analysis of the October 2000 major AOACMT experiment JFCOM recommended to the Joint Staff that this concept be integrated into the Assured Access concept. An analysis of the experiment findings resulted in shifting the funding for AOACMT to Assured Access in FY01.

- (U) ($6,384) Information Superiority: Includes the enhancement of four functional warfighting concepts: Common Relevant Operational Picture (CROP), Joint Interactive Planning (JIP), Adaptive Joint Command and Control (AJC2), and Information Operations (IO). Together, these concepts work to provide a Joint Force Commander with a superior picture of both national and coalition forces, and seek to deny or disrupt information that is critical to the enemy's concept of operations and mission.
  - Common Relevant Operational Picture (CROP) is a “virtual warehouse” that links to all the information required by the warfighters. From this, decision makers will tailor information displays that are relevant to their needs. The tailored displays generated from the common virtual warehouse will provide enhanced shared battlespace awareness.
  - Joint Interactive Planning (JIP) meets the need to operate inside the adversary’s decision cycle which requires that planning and execution transition from what is currently a serial process to a parallel process. Enhancement of Adaptive Joint Command and Control (AJC2) deals with ways that the Joint Force Command and Control Headquarters should be organized, to be adaptable to the mission being supported, to best support new ways of doing business such as Rapid Decisive Operations, and to take best advantage of the advances in information technologies.
  - Information Operations (IO) are actions taken that attack an adversary’s understanding and perceptions of the environment that affect its ability to make timely, effective decisions and, ultimately, its will to continue. IO uses the information medium to apply various capabilities to produce or create effects that influence decision-making, behavior, and will. The ultimate targets of IO are adversary decision makers, their decision-making processes, and their decision support systems.

- (U) ($120) Focused Logistics Enabling Early Decisive Operations/Strategic Deployment (FLEEDO/SD). Preliminary planning stage for the integration of advanced technologies with logistics management to effectively support early force deployment and continued force employment and provision of significantly improved strategic deployed forces capable of projecting joint forces by sea, land and air, along with sustainment for these forces, across strategic distances in order to support Rapid Decisive Operations. Focuses on refining the logistics organization, functional relationships, and planning, coordinating, and executing distributed missions between the Commander in

Chief's Joint Theater Logistics Management Center and the Joint Task Force. In FY01 Strategic Deployment was combined with Focused Logistics Enabling Early Decisive Operations to provide a broader spectrum of logistics efforts.

- (U) ($35,531) Millennium Challenge. Millennium Challenge 2002 is a major joint integrating experiment that is the culminating point for assessing how we can do a rapid, decisive operation in this decade and determining the extent to which the joint force is able to implement the principles of Joint Vision 2020. It is designed to assess the "how" of the Rapid Decisive Operations concept. The experiment will look at a high-end, small-scale contingency that has the potential to escalate to a major theater of war and is based on a real-world military threat for which we have robust and realistic databases to support an operational net assessment. It will permit integration of the overarching Rapid Decisive Operations and supporting concepts with future warfighting concepts being developed by each of the services.

- (U) ($120) Advanced Concept Technology Demonstrations (ACTDs). Programs listed below are OSD sponsored ACTDs which are under the direct sponsorship of US Joint Forces Command and which are being coordinated and integrated into joint warfighting experimentation concepts. US Joint Forces Command will become participants in several FY 2002 ACTDs, which are not listed in this report. These programs are awaiting completion of review and prioritization by the Joint Requirements Oversight Council (JROC). Funding for ACTDs has always been covered under other PE's except for the civilian salary. Effective mid-FY01, the ACTD mission was moved from Joint Experimentation to US Joint Forces Command J9, Joint Interoperability and Integration:
    - Multi-Link Antenna System (MLAS)
    - Content Based Information Security (CBIS)
    - Joint Theater Logistics (JTL)
    - Force Medical Protection (FMP)
    - Theater Air and Missile Defense Interoperability (TAMDI)
    - Integrated Collection Management (ICM)
    - Coalition Combat Identification (CCID)
    - Joint Area Clearance (JAC)
    - Personnel Recovery and Extraction Aided by Smart Sensors (PRESS)

•

• (U) ($1,500) Limited Objective Experiments. Short term experiments supporting specific, tightly focused future warfighting concepts. Limited Objective Experiments provide a low cost, highly reliable environment to scientifically control and research initiatives prior to inserting them into a larger experiment. The Limited Objective Experiments performed in FY2001 include:

- Non-Kinetic Technologies LOE developed a wider range of effects options to be considered by Joint Force Headquarters during the Millennium Challenge 2002 experiment.
- Forward Operating Base Pattern Recognition LOE identified logistics sites of critical targets based upon recognizing patterns of sensor data.
- Open Source Information Management LOE defined and exercised the open source element of the Common Relevant Operational Picture (CROP) functional concept in support of the Rapid Decisive Operations Operational Net Assessment.
- Information Presentation LOE determined if the situation awareness of a decision-maker could be improved by presenting the information in innovative new ways.
- Intelligent Agent LOE developed and used an Artificial Intelligence engine to identify and track information.
- Preliminary planning for the Operational Net Assessment LOE
- Preliminary planning for the Focused Logistics LOE
- Preliminary planning for the Multi-National LOE

• (U) ($1,000) Concept Development. Future experimentation efforts are dependent upon an aggressive, continuous effort to develop concepts relating to transformation. Transformation requires a robust and aggressive level of effort of concept development that aligns with the Joint Experimentation Campaign Plan and focuses on high priority tasks assigned. Refining and maturing joint concepts in preparations for live field experiments is a detailed process, and requiring a series of concept development workshops and seminars, analytical wargames, and limited objective experiments supported by virtual and constructive simulation. Joint Experimentation is currently focused nearly exclusively on the Rapid Decisive Operations concept, and only five of its supporting concepts. On the spectrum of military operations, we are only focused on small-scale contingency operations. Joint Experimentation is targeting work on at least 24 emerging concepts including the next integrating concept after Rapid Decisive Operations over the 2003-2007 timeframe, and critical concepts such as: Assured Access, Multi-national operations, Interagency Operations, Focused Logistics, Strategic Deployment, and Effects Based Operations.

- (U) ($500) Innovation and Transformation (Futures). Activities looking at emerging technologies in the 2020-2030 timeframe that may lead to far-term changes in the joint force. The emerging technologies studied were:
  - Bio-mimetic, nano-technology and compact power
  - Autonomous/automated decision making and joint command and control, enhancing human performance, learning and training, and space-based capabilities in support of joint operations

- (U) ($250) Integration with Other CINC, Military Services and DoD Agencies. Communication efforts to fully coordinate planned concept development and experimentation. Adequately capture and assess current joint warfighting needs and directions for experimentation.

- (U) ($500) Multi-national and Coalition Concept Development. Multi-national concept of operations, engagement, education and collaboration with our multi-national partners by establishing a partnership with Foreign Liaison Officers of NATO member states, Australia, Japan, South Korea, Argentina, Singapore, and the Gulf Cooperation Council states. The coalition environment is consistent with and required for our next decade CONOPS. Multi-national experimentation efforts are embedded in our other experimentation efforts.

- (U) ($1,931) FY 2001 CONGRESSIONAL PLUS-UP. Joint Experimentation. Completed the planning and preparation for the Millennium Challenge, a coordinated joint field experimentation effort under U.S. Joint Forces Command. This is a major joint experiment involving all the military services battle laboratories.

2. (U) FY 2002 PLAN:

- (U) ($20,499) Rapid Decisive Operations. Continue exploration and refinement of the Rapid Decisive Operations Concept through the execution of various Limited Objective Experiments (Operational Net Assessment, Focused Logistics, Multi-National, and Effects Tasking Order-to-Action), and the Millennium Challenge 2002 (MC02) experiment in July-August 2002. The Limited Objective Experiments and the Millennium Challenge 2002 experiment will assess the “how” of the concept. The experiments include:
  - Effects Tasking Orders (ETO)-to-Action, how they are issued and prepared in a collaborative environment with the Common Relevant Operational Picture
  - Operational Net Assessment (ONA) addresses how we accurately do Operational Net Assessment-a continuously updated system-of-systems analysis of the adversary’s total war-making capabilities. It’s purpose is to identify key links and nodes within the adversary’s systems, propose methods that will influence, neutralize or destroy them and achieve a desired effect or outcome.
  - Peer-to-Peer, explores information sharing between computers and wireless equipment for military application.

- (U) ($6,500) Information Superiority. Continue exploration and enhancement of the four functional warfighting concepts: Common Relevant Operational Picture (CROP), Joint Interactive Planning (JIP), Adaptive Joint Command and Control (AJC2), and Information Operations (IO), through the planning and execution of Limited Objective Experiments.

- (U) ($4,000) Focused Logistics Enabling Early Decisive Operations/Strategic Deployment (FLEEDO/SD). Integration of advanced technologies with logistics management to effectively support early force deployment continued force employment and will provide significantly improved strategic deployment of forces capable of projecting joint forces by sea, land and air. This will be accomplished through a series of Focused Logistics Limited Objective Experiments which will concentrate on specific aspects relating to force deployment as it refined the logistics organization, functional relationships, and planning, coordinating and executing distributed missions between the Commander in Chief’s Joint Theater Logistics Management Center (JTLMC), and the Joint Task Force.

- (U) ($3,500) Assured Access. Continue exploration of the Assured Access Concept through the execution of the Millennium Challenge 2002 experiment and Limited Objective Experiments. The concept will explore how a Joint Force Commander can gain the requisite level of physical, spectral and cyber access to an adversary’s domain.

- (U) ($52,397) Millennium Challenge. Millennium Challenge 2002 experiment, to be executed in July-August 2002, is a major joint integrating experiment that is the culminating point for assessing how we do a rapid, decisive operation in this decade and determine the extent to which the joint force is able to implement the principles of Joint Vision 2020. The experiment will encompass both live and virtual forces, including elements from all military services and special operations. Given the capabilities of the joint force and a major regional threat in the 2007 period, the Millennium Challenge 2002 experiment will determine the extent to which we can set the operational conditions for Rapid Decisive Operation; establish a knowledge network; establish Joint Command and Control functions and Joint Intelligence, Surveillance and Reconnaissance capabilities; establish access and then sustain a distributed, non-contiguous operation without relying on fixed bases adjacent to the objective area; establish full-dimensional/time-definite superiority for selected forces and actions with the battlespace; and conduct simultaneous, joint tactical actions throughout the battlespace that are based on a shared understanding of both the tactical and operational situation.

- (U) ($3,072) Limited Objective Experiments (LOE):

- Peer-to-Peer LOE will explore the contributions of peer-to-peer collaboration in support of Rapid Decisive Operations by examining the ease of setup, mobility, redundancy/survivability, functionality, and security of peer-to peer collaboration systems.
- Operational Net Assessment LOE focuses on the Operational Net Assessment product and process, but includes an assessment of the CONOPS for Information Operations, Inter-agency Community, and Effects Based Planning.

- Focused Logistics LOE focuses on refining the logistics organization, functional relationships, and planning, coordinating and executing distributed missions between the Commander in Chief's Joint Theater Logistics Management Center (JTLMC), and the Joint Task Force.
- Multi-National LOE focuses on collaborative planning with multi-national partners who are planning Rapid Decisive Operations when the planning time is short. It will compare the plan developed using a more traditional process with a plan using an integrated planning process.
- Effects Tasking Order (ETO)-to-Action LOE focuses on effects based planning, execution and assessment, but will also include a review of the Standing Joint Command and Control Element (SJC2E) CONOPS as it relates to collaboration with functional components.

• (U) ($9,000) Concept Development. Future experimentation efforts continue to be dependent upon an aggressive, continuous effort to develop concepts relating to transformation. This requires a robust and aggressive level of effort of concept development that aligns with the Joint Experimentation Campaign Plan and focuses on high priority tasks assigned. Refining and maturing joint concepts in preparation for the Millennium Challenge 2002 and Olympic Challenge 2004 live field experiments is a detailed process, and requiring a series of concept development workshops and seminars, analytical wargames, and limited objective experiments supported by virtual and constructive simulation. Joint Experimentation is currently focused nearly exclusively on the Rapid Decisive Operations concept, and only five of its supporting concepts. Joint Experimentation is targeting work on at least 24 emerging concepts including the next integrating concept after Rapid Decisive Operations over the 2003-2007 timeframe, and critical concepts such as: Assured Access, Multi-national operations, Interagency operations, focused logistics, Joint Intelligence, Surveillance and Reconnaissance, and effects based operations.

• (U) ($1,600) Innovation and Transformation (Futures). Activities continuing to look at emerging technologies in the 2020-2030 timeframe that may lead to far-term changes in the joint force. This is done through a series of seminars and wargames, and the leveraging of the Service wargames. The emerging technologies to be studied are:
  - Homeland Defense
  - Spaced-Based support for Joint Operations
  - Alternate Fuel Vehicles
  - Preventing strategic and operational surprise

- Autonomous and automated decision making
- Enhancing human performance and learning

• (U) ($500) Integration with Other CINC, Military Services and DoD Agencies. Continue communication efforts to fully coordinate planned concept development and experimentation through a series of meetings, workshops and seminars. Adequately capture and assess current joint warfighting needs and directions for experimentation.

• (U) ($1,800) Multi-national and Coalition Concept Development. Continue exploration of the multi-national concept of operations, engagement, education and collaboration with our multi-national partners through a series of Limited Objective Experiments that will explore information sharing and collaboration during Rapid Decisive Operations. The multi-national experimentation efforts are embedded in our other experimentation efforts.

3. (U) FY 2003 PLAN:

• (U) ($31,475) Rapid Decisive Operations. Continue refinement of the Rapid Decisive Operations Concept through the execution of various Experiments (Olympic Vision 2003 and Olympic Challenge 2003), and pre-planning of the Olympic Challenge experiment in 2004. Olympic Vision 2003 experiment in preparation for Millennium/Olympic Challenge experiments in 2004 and 2006,Non-Kinetic Technologies Limited Objective Experiments integrated into exercise Unified Endeavor 01-3. The Olympic Challenge 2004 experiment will examine the capabilities of the joint force in the 2010-2020 time frame against a projected capable regional threat, in a small-scale contingency, to determine how the joint force will execute Rapid Decisive Operations in the next decade.

• (U) ($3,576) Information Superiority. Continue exploration and enhancement of the four functional warfighting concepts (Common Relevant Operational Picture (CROP), Joint Interactive Planning (JIP), Adaptive Joint Command and Control (AJC2), and Information Operations (IO)), as we Explore the Rapid Decisive Operations Concept in the next decade.

• (U) ($1,490) Focused Logistics Enabling Early Decisive Operations/Strategic Deployment (FLEEDO/SD). Continue integration of advanced technologies with logistics management to effectively support early force deployment and continued force employment through a series of Focused Logistics Limited Objective Experiments which will concentrate on specific aspects relating to force deployment as it refined the logistics organization, functional relationships, and planning, coordinating and executing distributed missions between the Commander in Chief's Joint Theater Logistics Management Center (JTLMC), and the Joint Task Force.

• (U) ($2,450) Assured Access. Refinement of the Assured Access Concept through the execution of Limited Objective Experiments and the preliminary planning and coordination for the Olympic Challenge 2004 experiment. The concept will explore how a Joint Force Commander can gain the requisite level of physical, spectral and cyber access to an adversary's domain.

- (U) ($41,027) Olympic Challenge. Will explore and refine the findings of the Millennium Challenge 2002 experiment, conducted in July-August 2002, as the basis of the Olympic Challenge 2004 experiment and the Rapid Decisive Operations-Next Decade concept. The Olympic Challenge 2004 will examine how a rapid decisive operation could be executed in the next decade during an operation that is at the high-end, small-scale contingency area on

  the range of operations. The Rapid Decisive Operations (RDO) in the Next Decade concept will integrate knowledge, command and control, and effects-based operations to achieve the desired political/military effort.

- (U) ($5,989) Limited Objective Experiments:
  - Non-Kinetic Technologies (Low Collateral Damage Weapons) LOE
  - Olympic Vision 2003 LOE will set the stage as a risk mitigator for the Olympic Challenge 2004 experiment.
  - Focused Logistics LOE will continue to focus on specific aspects relating to force deployment as it refined the logistics organization, functional relationships, and planning, coordinating and executing distributed missions between the Commander in Chief's Joint Theater Logistics Management Center (JTLMC), and the Joint Task Force.
  - Multi-National LOE will continue the series of experiments with multi-national partners to define and refine coalition participation in the Olympic Challenge 2004 experiment. The LOE will explore information sharing and collaboration during Rapid Decisive Operations in the next decade with coalition partners.

- (U) ($6,054) Concept Development. Experimentation efforts after the conclusion of Millennium Challenge 2002 experiment will continue to be dependent upon an aggressive, continuous effort to develop concepts relating to transformation. The Rapid Decisive Operations (RDO) in the Next Decade concept, will integrate knowledge, command and control, and effects-based operations to achieve the desired political/military effort. This will continue to require a robust and aggressive level of effort of concept development that aligns with the Joint Experimentation Campaign Plan and focuses on high priority tasks assigned.

- (U) ($2,384) Innovation and Transformation (Futures). Activities continuing to look at emerging technologies in the 2020-2030 timeframe that may lead to far-term changes in the joint force. This is done through a continued series of seminars and workshops, and the leveraging of the Service wargames.

- (U) ($745) Integration with Other CINC, Military Services and DoD Agencies. Continue communication efforts to fully coordinate planned concept development and experimentation through a series of meetings, workshops and seminars. Adequately capture and assess current joint warfighting needs and directions for experimentation.

- (U) ($2,682) Multi-national and Coalition Concept Development. Continue exploration of the multi-national concept of operations, engagement, education and collaboration with our multi-national partners through a series of Limited Objective Experiments that will explore information sharing and collaboration during Rapid Decisive Operations in the next decade. The multi-national experimentation efforts are embedded in our other experimentation efforts.

(U) PROGRAM CHANGE SUMMARY:

	FY 2001	FY 2002	FY 2002
FY 2002 President's Budget	51,033	118,802	
Adjustments from FY 2002 President's Budget			
SBIR Reduction	-1,418		
FY 01 Supplemental	+15,000		
Program Growth Reduction		-15,000	
Section 8123 Management Reform Initiative Reduction		-917	
FFRDC Reduction		-17	
FY 2003 President's Submission	64,615	102,868	97,872

(U) Schedule: Not Applicable.

(U) Technical: Not Applicable.

(U) OTHER PROGRAM FUNDING SUMMARY: The Navy's 6.1 program contributes to this effort.

(U) NAVY RELATED RDT&E:
- (U) 0601152N In-House Laboratory Independent Research
- (U) 0601153N Defense Research Sciences
- (U) 0602114N Power Projection Applied Research
- (U) 0602123N Force Protection Applied Research
- (U) 0602131M Marine Corps Landing Force Technology
- (U) 0602235N Common Picture Applied Research
- (U) 0602236N Warfighter Sustainment Applied Research
- (U) 0602271N RF Systems Applied Research

- (U) 0602435N Ocean Warfighting Environment Applied Research
- (U) 0602747N Undersea Warfare Applied Research
- (U) 0602782N Mine & Expeditionary Warfare Applied Research
- (U) 0603114N Power Projection Advanced Technology
- (U) 0603123N Force Protection Advanced Technology
- (U) 0603235N Common Picture Advanced Technology
- (U) 0603236N Warfighter Sustainment Advanced Technology
- (U) 0603271N RF Systems Advanced Technology
- (U) 0603640M Marine Corps Advanced Technology Demonstrations
- (U) 0603729N Warfighter Protection Advanced Technology
- (U) 0603747N Undersea Warfare Advanced Technology
- (U) 0603758N Naval Warfighting Experiments and Demo
- (U) 0603782N Mine and Expeditionary Warfare Advanced Technology
- (U) 0603750D Advanced Concept Technology Demonstration
- (U) 0603727D Joint Warfighting

(U) SCHEDULE PROFILE: Not applicable.

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603729N
PROGRAM ELEMENT TITLE: Warfighter Protection Advanced Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
R2494 Disaster Management and Humanitarian Assistance		2,181						0	2,181
R2715 Distributed Simulation Warfighting Concepts		5,100						0	5,100
R2914 Warfighter Protection Advanced Technology	**	17,477	19,040	20,238	18,954	20,611	21,874	CONTINUE	CONTINUE
R9030 Organ Transfer Technology		1,982						0	1,982
R9031 Damage Control Operational Concepts		1,685						0	1,685
TOTAL	**	28,425	19,040	20,238	18,954	20,611	21,874	CONTINUE	CONTINUE

**The Science and Technology Program Elements (PEs) were restructured in FY 2002. The work described in 2001 was funded in PEs 0603706N and 0603707N.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This program supports the development and demonstration of advanced technologies for improved warfighter protection medical equipment, techniques, technologies and systems. These technologies enhance Navy and Marine Corps capabilities in Casualty Care and Management, Casualty Prevention, and maintenance of a Healthy and Fit Force. The goal of Casualty Care and Management is to maximize the continuum of care with lifesaving interventions as far forward as possible, in an increasingly lethal battlespace, with reduced infrastructure and logistics. Casualty Prevention includes enhancing warfighter situation awareness and countering threats from disease, battle and non-battle injuries. Healthy and Fit Force efforts preserve health and enhance fitness of ready forces against physical and psychological threats through the continuum of peace and war.

(U) Due to the number of efforts in this PE, the programs described are representative of the work included in this PE.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the ADVANCED TECHNOLOGY Budget Activity because it encompasses design development, simulation, or experimental testing of guidelines and prototype hardware to validate technological feasibility and concept of operations and reduce technological risk prior to operational use or transition to an acquisition program.

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603729N
PROGRAM ELEMENT TITLE: Warfighter Protection Advanced Technology

B. (U) PROGRAM CHANGE SUMMARY:

	FY 2001	FY 2002	FY 2003
FY 2002 President's Submission:		17,678	
Adjustments from FY 2002 PRESBUDG:			
Congressional Plus Ups		11,000	
Section 8123 Management Reform Initiative Reduction		-253	
FY 2003 President's Submission	**	28,425	19,040

** The Science and Technology PEs were restructured in FY 2002. FY 2001 efforts were funded in PEs 0603706N and 0603707N.

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603729N
PROGRAM ELEMENT TITLE: Warfighter Protection Advanced Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
R2914 Warfighter Protection Advanced Technology	**	17,477	19,040	20,238	18,954	20,611	21,874	CONTINUE	CONTINUE

** The Science and Technology PEs were restructured in FY 2002. FY 2001 efforts were funded in PEs 0603706N and 0603707N.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFCATION: This program supports the development and demonstration of advanced technologies for improved warfighter protection medical equipment, techniques, technologies and systems. These technologies enhance Navy and Marine Corps capabilities in Casualty Care and Management, Casualty Prevention, and maintenance of a Healthy and Fit Force. The goal of Casualty Care and Management is to maximize the continuum of care with lifesaving interventions as far forward as possible, in an increasingly lethal battlespace, with reduced infrastructure and logistics. Casualty Prevention includes enhancing warfighter situation awareness and countering threats from disease, battle and non-battle injuries. Healthy and Fit Force efforts preserve health and enhance fitness of ready forces against physical and psychological threats through the continuum of peace and war.

B. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 2001 ACCOMPLISHMENTS:

- (U) ($4,792) <u>Casualty Care and Management:</u> FY01 accomplishments were funded in PE 0603706N and PE 0603707N.

Initiated FY01
- (U) Initiated the development of a hemostatic dressing with microbicidal agent.
- (U) Began to develop a pelvic clamp for hemostasis.

Continued FY01
- (U) Continued to develop novel resuscitation fluids, specifically ketone additive.
- (U) Continued to develop low volume resuscitation fluids, specifically the comparison of all Food and Drug Administration (FDA)-approved hypertonic crystalloids in hemorrhage.
- (U) Continue to develop low volume resuscitation fluids, specifically the evaluation of new FDA-approved low volume colloid fluid.

-

- (U) Continued to develop intranasal ketamine for pain control.
- (U) Continued to develop ultrasound intra-operative cautery.
- (U) Continued to develop the casualty management coordination system.
- (U) Continued to develop novel oxygen carrying blood substitutes, pegylated liposome-encapsulated synthetic hemoglobin, and freeze-dried red blood cells.
- (U) Continued to develop a portable injectable water shipboard system.
- (U) Continued to develop novel resuscitation fluids such as gas diffusion.
- (U) Continued to develop a hollow fiber frozen red cell glycerolization/deglycerolization system enhancement.

Completed FY01
- (U) Completed freeze dried platelet research and transferred over to Army funding.
- (U) Completed the FDA approved algal polymer hemostatic field dressing.

• (U) ($6,480) Casualty Prevention: FY01 accomplishments were funded in PE 0603706N.

Initiated FY01
- (U) Initiated evaluation of body armor-torso interaction biodynamics.
- (U) Began evaluation of laser technology and laser injury impact on operational performance.
- (U) Initiated Assessment Gz-tolerance in repeated high/Gz conditions.
- (U) Initiated studies of methods for enhanced maintenance of spatial orientation.
- (U) Initiated the development of a smart uniform with embedded physiological sensors.

Continued FY01
- (U) Continued the development of a laser event recorder.

Completed FY01
- (U) Completed the assessment of pharmacological interventions for decompression sickness/oxygen toxicity.
- (U) Completed guidelines for low frequency acoustic effects on human divers (transition).
- (U) Completed the development of criteria to evaluate new technology sensor based devices.
- (U) Validated new methods for neurotoxicant testing.
- (U) Completed investigations on the impact of thermal stress on operational performance.
- (U) Validated radio frequency induced current model in shipboard environment.

• (U) ($433) Healthy and Fit Force: FY01 accomplishments were funded in PE 0603706N

Initiated FY01
- (U) Initiated the assessment and prevention of noise-induced hearing loss using antioxidants.

Continued FY01
- (U) Continued to develop tuned materials for hearing protection.
- (U) Continued efforts in occupational fitness for injury reduction.

Completed FY01
- (U) Completed investigations of the application of acoustic technology for hearing protection.
- (U) Completed the assessment of vibration characteristics and resonance frequencies in waterborne low frequency sound.

1. (U) FY 2002 PLAN:

• (U) ($8,435) Casualty Care and Management:

Initiate FY02
- (U) Develop high intensity focussed ultrasound technology for hemorrhage location and hemostasis.
- (U) Develop hand-held portable ultrasound diagnostic imager evaluation in trauma.
- (U) Develop novel analgesics to reduce pain.

Continue FY02
- (U) Continue to develop novel resuscitation fluids: ketone additive.
- (U) Continue the development of low volume resuscitation fluids, specifically the comparison of all FDA-approved hypertonic crystalloids in hemorrhage.
- (U) Continue to develop low volume resuscitation fluids, specifically the evaluation of new FDA-approved low volume colloid fluid.
- (U) Continue the development of intranasal ketamine for pain control.
- (U) Continue with the development of the casualty management coordination system.
- (U) Continue to develop novel oxygen carrying blood substitutes; pegylated liposome-encapsulated synthetic hemoglobin; freeze-dried red cells.
- (U) Continue to develop a hemostatic dressing with microbicidal agent.
- (U) Continue the development of a pelvic clamp for hemostatsis.
- (U) Continue to develop low-volume resuscitation fluids: gas diffusion enhancer.

Complete FY02
- (U) Demonstrated an ultrasound intra-operative cautery device.
- (U) Completed the development of an injectable water shipboard system.
- (U) Complete the development of hollow-fiber frozen red cell glycerolization/deglycerolization system.

• (U) ($7,828) Casualty Prevention:

Initiate FY02
- (U) Begin development of agile laser eye protection.
- (U) Begin development of Helicopter Aircrew Integrated Life Support Systems.
- (U) Initiate studies for development of an advanced multi-purpose diving system.

Continue FY02
- (U) Continue to evaluate laser technology and laser injury impact on operational performance.
- (U) Continue to assess Gz-tolerance in repeated high/Gz conditions.
- (U) Continue to enhance maintenance of spatial orientation
- (U) Continue to develop smart uniform with embedded physiological sensors.

Complete FY02
- (U) Complete the laser event recorder for a demonstration.

• (U) ($1,214) Healthy and Fit Force:

Initiate FY02
- (U) Begin injury prevention/fitness optimization.

Continue FY02
- (U) Continue the treatment and prevention of noise-induced hearing loss using antioxidants.
- (U) Continue to develop occupational fitness for injury reduction.

Complete FY02
- (U) Complete demonstration of tuned materials for hearing protection.

1. (U) FY 2003 PLAN:

- (U) ($7,579) Casualty Care and Management: This effort intends to maximize care as far forward as possible with reduced infrastructure and logistics.

Continue FY03
- (U) Continue to develop novel resuscitation fluids, ketone additive.
- (U) Continue to develop low volume resuscitation comparison of all FDA-approved hypertonic crystalloids in hemorrhage.
- (U) Continue to evaluate low volume resuscitation study of new FDA-approved volume colloid fluid.
- (U) Continue the development of usage of intranasal ketamine for pain control.
- (U) Continue the development of a casualty management coordination system.
- (U) Continue the development of novel oxygen carrying blood substitutes; pegylated lipsome encapsulated synthetic hemoglobin; freeze-dried red cells.
- (U) Continue to develop hemostatic dressing with microbicidal agent.
- (U) Continue to develop a pelvic clamp for hemostasis.
- (U) Continue to develop a low-volume resuscitation gas diffusion enhancer.
- (U) Continue to develop a high intensity focused ultrasound technology for hemostasis.
- (U) Continue to develop a hand held portable ultrasound diagnostic imager for evaluation of trauma.
- (U) Continue to develop novel analgesics to reduce pain.

- (U)($10,167) Casualty Prevention: This effort intends to enhance warfighter situation awareness and counter threats from disease, battle and non-battle injuries.

Continue FY03
- (U) Continue to evaluate laser technology and laser injury impact on operational performance.
- (U) Continue to assess Gz-tolernace in repeated high/Gz conditions.
- (U) Continue to enhance the maintenance of spatial oriention.
- (U) Continue to develop smart uniform with embedded physiological sensors.
- (U) Continue to develop agile laser eye protection.
- (U) Continue to develop the Helicopter Aircrew Integrated Life Support Systems.
- (U) Continue to develop an advanced multi-purpose diving system.

- (U)($1,294) Healthy and Fit Force: This effort intends to preserve the health and enhance the fitness of ready forces.

Continue FY03
- (U) Continue the assessment and prevention of noise-induced hearing loss using antioxidants.
- (U) Continue studies of occupational fitness for injury reduction.
- (U) Continue to develop strategies for injury prevention and fitness optimization.

C. (U) PROGRAM CHANGE SUMMARY EXPLANATION:
(U) Funding: Not Applicable.
(U) Schedule: Not Applicable.

D. (U) OTHER PROGRAM FUNDING SUMMARY:

(U) RELATED RDT&E:

(U) NAVY RELATED RDT&E:
(U) PE 0602235N Common Picture Applied Research
(U) PE 0602236N Warfighter Sustainment Applied Research
(U) PE 0603236N Warfighter Sustainment Advanced Technology
(U) PE 0604771N Medical Development

(U) NON-NAVY RELATED RDT&E:
(U) PE 0602716A Human Factors Engineering Technology
(U) PE 0602785A Manpower, Personnel and Training Technology
(U) PE 0602787A Medical Technology
(U) PE 0603002A Medical Advanced Technology
(U) PE 0602202F Human Effectiveness Applied Research
(U) PE 0603231F Crew Systems and Personnel Protection Technology

E. (U) SCHEDULE PROFILE: Not applicable.

CONGRESSIONAL PLUS-UPS

This section describes the following congressional Plus-Ups appropriated in FY2001 and/or FY2002 whose efforts fall within the scope of this restructured program, or which were appropriated in this PE.

Biomedical Research Imaging Core – COH National Medical Center
Bone Marrow Program
Community Hospital Telehealth Consortium
Damage Control Operational Concepts – Distributed Damage
Disaster Management and Humanitarian Assistance
Distributed Simulation Warfighting Concepts
Fleet Health Technology
Medical Readiness Telemedicine Initiative
Medical Readiness Telemedicine Initiative Follow-On
Minimally Invasive Surgical Technology Institute
Mobile Integrated Diagnosis and Data Analysis System (MIDDAS)
Naval Blood Research Laboratory (NBL)
Nursing Telehealth Applications
Optical Imaging of the Brain
Optical Sensing System: Robot Eyes for Advanced Military Medicine
Organ Transfer Technology
Portable Production of Sterile Water for Intravenous
Robot Eyes
Rural Health
Rural Health Deployed Military Patient Records
Teleradiology Program
Vectored Vaccine Research

1. (U) FY 2001 CONGRESSIONAL PLUS-UPS:

- (U) ($32,900)Bone Marrow Program: Supported the National Marrow Program/Registry, funding research associated with transplantation. (Appropriated in PE 0603706N.)
- (U) ($4,826) Disaster Management and Humanitarian Assistance: Provided support to U.S. Southern Command (USSOUTHCOM) by researching issues related to natural and man-made disasters in the Latin American and Caribbean area of responsibility, including the prevention or mitigation of causative or contributing factors, and the humanitarian response to those disasters. (Appropriated in PE 0603706N.)
- (U) ($2,895) Fleet Health Technology: Supported Fleet Health Technology. (Appropriated in PE 0603706N.)
- (U) ($8,738) Medical Readiness Telemedicine Initiative: Funds supported Navy Participation in the Joint Medical Operations (Telemedicine) Advanced Concepts Demonstration (ACTD). This ACTD is aimed at changing business practice in the delivery of medical services during warfare. (Appropriated in PE 0603706N.)
- (U) ($3,861) Naval Blood Research Laboratory (NBL): Research at the Naval Blood Research Laboratory was centered around the test and evaluation of the safety and efficacy of frozen blood products. (Appropriated in PE 0603706N.)
- (U) ($1,931) Optical Imaging of the Brain: Studied the basic theory of photon migration through tissues for analysis of prefrontal cortex activation in cognitive activity using picosecond pulsed and high frequency modulation of near infrared (NIR) light spectroscopy. (Appropriated in PE 0603706N.)
- (U) ($996) Robot Eyes: Integrated an existing optical sensing system, Robot Eyes, (that performs automatic acquisition, processing, and perception and when necessary, reproduction of visual three-dimensional objects) with various devices, to include prosthetic devices that will have the capability to perform delicate tasks requiring precision manipulative skills. (Appropriated in PE 0603706N.)
- (U) ($8,409) Rural Health: This program supported remote medical education, training and telemedicine in rural America. (Appropriated in PE 0603706N.)
- (U) ($2,200) Rural Health Deployed Military Patient Records: Funds were provided to design, implement, and validate a healthcare information system with application in rural civilian and Navy deployed forces environments that increases the quality and reduces the cost of healthcare. (Appropriated in PE 0603706N.)
- (U) ($2,911) Teleradiology Program: A collaborative research effort between the Uniformed Services University of the Health Sciences, the National Naval Medical Center, and the University of South Florida in computer aided diagnostics and digital x-ray imaging to develop advanced applications in digital mammography and telemammography. (Appropriated in PE 0603706N.)
- (U) ($3,399) Vectored Vaccine Research: Funds addressed delivery methods for DNA vaccines, per vaccine program between industry and the Naval Medical Research Center. (Appropriated in PE 0603706N.)

1. (U) FY 2002 CONGRESSIONAL PLUS-UPS:

- (U) ($1,685) Damage Control Operational Concepts-Distributed Damage: Supports Damage Control Operations.
- (U) ($2,181) Disaster Management and Humanitarian Assistance: Provides support to U.S. Southern Command (USSOUTHCOM) by researching issues related to natural and man-made disasters in the Latin American and Caribbean area of responsibility, including the prevention or mitigation of causative or contributing factors, and the humanitarian response to those disasters.
- (U) ($5,100) Distributed Simulation Warfighting Concepts: Examine the warfighting and weapon system design concepts and their relationship to future aircraft carrier designs.
- (U) ($1,982) Organ Transfer Technology: Pre-clinical and clinical investigations directed at demonstrating the induction of tolerance to transplanted foreign tissues in the recipient through use of certain immunological reagents.
- (U) Biomedical Research Imaging Core – COH National Medical Center: Funds will support the Biomedical Research Imaging Core. (Appropriated in PE 0603706N, $3,965.)
- (U) Bone Marrow Program: Supports the National Marrow Program/Registry, funding research associated with transplantation. (Appropriated in PE 0603706N, $28,645.)
- (U) Community Hospital Telehealth Consortium: Support for the Community Hospital Telehealth Consortium. (Appropriated in PE 0603706N, $1,487.)
- (U) Medical Readiness Telemedicine Initiative Follow-On: Funds support Navy Participation in the Joint Medical Operations (Telemedicine) Advanced Concepts Demonstration (ACTD). This ACTD is aimed at changing business practice in the delivery of medical services during warfare. (Appropriated in PE 0603706N, $7,632.)
- (U) Minimally Invasive Surgical Technology Institute: Support for the Minimally Invasive Surgical Technology Institute. (Appropriated in PE 0603706N, $991.)
- (U) Mobile Integrated Diagnosis and Data Analysis System (MIDDAS): Support for the Mobile Integrated Diagnosis and Data Analysis System. (Appropriated in PE 0603706N, $991.)
- (U) Nursing Telehealth Applications: An international effort by a consortium of military medical technicians, educators, researchers, and domestic rural health care providers to design and deliver a nurse training curriculum to remote international locations with special emphasis on emergency medical training and humanitarian relief. (Appropriated in PE 0603706N, $2,577.)
- (U) Optical Sensing System; Robot Eyes for Advanced Military Medicine: Integrate an existing optical sensing system, Robot Eyes, (that performs automatic acquisition, processing, and perception and, when necessary, reproduction of visual three-dimensional objects) with various devices, to include prosthetic devices that will have the capability to perform delicate tasks requiring precision manipulative skills. (Appropriated in PE 0603706N, $2,478.)
- (U) Portable Production of Sterile Water for Intravenous: The improvement of an existing prototype of a light-weight, man-portable, disposable device for producing water suitable for injection from potable water in the field. (Appropriated in PE 0603706N, $991.)

- (U) Rural Health: This program supports remote medical education, training and telemedicine in rural America. (Appropriated in PE 0603706N, $6,740.)
- (U) Teleradiology: A collaborative research effort between the Uniformed Services University of the Health Sciences, the National Naval Medical Center, and the University of South Florida in computer aided diagnostics and digital x-ray imaging to develop advanced applications in digital mammography and telemammography. (Appropriated in PE 0603706N. $991)
- (U) Vectored Vaccine Research: Funds would address delivery methods for DNA vaccines, per vaccine program between industry and the Naval Medical Research Center. (Appropriated in PE 0603706N, $991.)

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603747N
PROGRAM ELEMENT TITLE: UNDERSEA WARFARE ADVANCED TECHNOLOGY

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
X1933 Air Anti-submarine Warfare	10,148	0	0	0	0	0	0	0	179,556
R2142 Undersea Warfare Concepts	28,965	0	0	0	0	0	0	0	175,534
R2267 USW Weapons Advanced Technology	12,532	0	0	0	0	0	0	0	44,477
R2844 Magnetrestrictive Transduction	2,417	2,081	0	0	0	0	0	0	4,498
R2845 Prototype Multi-Function Radar	2,899	0	0	0	0	0	0	0	2,899
R2846 Low Frequency Broadband Acoustic Airgun Source	2,899	0	0	0	0	0	0	0	2,899
R2916/Undersea Warfare Advanced Technology	**	55,805	40,125	40,966	39,258	45,956	50,094	CONT.	CONT.
R9033/Multipulse Airgun System	0	1,289	0	0	0	0	0	0	1,289
TOTAL	59,860	59,175	40,125	40,966	39,258	45,956	50,094	CONT.	CONT.

** In FY01, efforts under project R2916 were executed under projects X1933, R2142 and R2267.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: All Navy advanced technology development in undersea target detection, classification, localization, tracking and neutralization is funded through this Program Element (PE). In countering the proliferation of quiet diesel submarines to third world countries and Russia's continued heavy investment in submarine technology, work within this PE provides an enabling capability for power projection and force sustainability. This approach protects the country's capital investment in surveillance, submarine, surface ship and air Anti-Submarine Warfare (ASW) assets by exploring those high risk/high payoff technologies that promise to provide capabilities of exceptionally high military value in three to five years. Emphasis is on development of fieldable prototypes, components and systems necessary to demonstrate and validate concepts and techniques previously developed in

Basic and Applies Research, or developed and suggested by industry, academia, or military research laboratories/agencies. These technology options include advanced research in the following areas:

- Improving reliable undersea target detection and tracking to enable on-command application of precision offensive military force. Programs include undersea sensors and arrays to provide robust shallow water (SW) surveillance and reconnaissance, and to detect undersea threats to the surface battleforce.
- Dominating the undersea battlespace to enable timely execution of joint/combined operations and to ensure joint force sustainability. Programs include advanced sensors and arrays for both improved ASW surveillance and enhanced battleforce self-defense, ASW data fusion for better tactical control, and low frequency active sonar and rapidly deployable surveillance systems for covert/non-covert indication and warning.
- Improving reliable undersea target detection and tracking, thus enabling joint battleforce sustainability. Programs include the entire spectrum of technology development undertaken in support of the Littoral ASW (LASW) Future Naval Capability (FNC).
- Improving undersea weapons effectiveness while reducing overall costs through improvements to current systems as well as the development of new weapons concepts. The goal of Undersea Weaponry is to produce cost effective, quick reaction intelligent weapons incorporating broadband processing with battlegroup connectivity, intelligent countermeasures, hard kill torpedo defense, improved littoral operation, and weapon flexibility. Several S&T challenges must be addressed including cluttered operating environments, multipath acoustic propagation, low/no doppler targets, detonation physics, high density power sources, and fusing/safety/arming mechanics. The technology developed under this project will be transitioned to the acquisition community for incorporation into existing platforms. For a complete picture of these efforts, see also PE 0602747N. These efforts support the LASW and Platform Protection FNCs.

(U) The Navy S&T program includes projects that focus on or have attributes that enhance the affordability of warfighting systems.

(U) While the program addresses technical issues associated with a broad range of high interest operational areas, the emphasis is on SW environments

(U) Due to the number of efforts in the PE, the programs described are representative of the work included in the PE.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the ADVANCED TECHNOLOGY Budget Activity because it encompasses design development, simulation, or experimental testing of prototype hardware to validate technological feasibility and concept of operations and reduce technological risk prior to initiation of a new acquisition program or transition to an ongoing acquisition program.

B. (U) PROGRAM CHANGE SUMMARY:

	FY 2001	FY 2002	FY 2003
FY 2002 President's Budget	66,182	56,303	
Adjustments from FY 2002 President's Budget:			
Congressional Plus-up		+3,400	
Section 8123 Management Reform Initiative		-528	
Execution Adjustment	-4,103		
SBIR/STTR ADJ	-2,219		
FY 2003 President's Submission	59,860	59,175	40,125

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603747N
PROGRAM ELEMENT TITLE: UNDERSEA WARFARE ADVANCED TECHNOLOGY

PROJECT NUMBER & TITLE	FY 2001 ESTIMATE	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
R2916/Undersea Warfare Advanced Technology	**	56,303	40,663	40,739	39,542	46,366	50,622	CONT.	CONT.

In FY01, efforts under project R2916 were executed under projects X1933, R2142 and R2267.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION:

(U) JUSTIFICATION FOR BUDGET ACTIVITY: All Navy advanced technology development in undersea target detection, classification, localization, tracking and neutralization is funded through this project. In countering the proliferation of quiet diesel submarines to third world countries and Russia’s continued heavy investment in submarine technology, work within this project provides an enabling capability for power projection and force sustainability. This approach protects the country’s capital investment in surveillance, submarine, surface ship and air Anti-Submarine Warfare (ASW) assets by exploring those high risk/high payoff technologies that promise to provide capabilities of exceptionally high military value in three to five years. Emphasis is on development of fieldable prototypes, components and systems necessary to demonstrate and validate concepts and techniques previously developed in 6.1 and 6.2, or developed and suggested by industry, academia, or military research laboratories/agencies. These technology options include advanced research in the following areas:

- Improving reliable undersea target detection and tracking to enable on-command application of precision offensive military force. Programs include undersea sensors and arrays to provide robust shallow water (SW) surveillance and reconnaissance, and to detect undersea threats to the surface battleforce.
- Dominating the undersea battlespace to enable timely execution of joint/combined operations and to ensure joint force sustainability. Programs include advanced sensors and arrays for both improved ASW surveillance and enhanced battleforce self-defense, ASW data fusion for better tactical control, and low frequency active sonar and rapidly deployable surveillance systems for covert/non-covert indication and warning.

- Improving reliable undersea target detection and tracking, thus enabling joint battleforce sustainability. Programs include the entire spectrum of technology development undertaken in support of the Littoral ASW (LASW) Future Naval Capability (FNC).
- Improving undersea weapons effectiveness while reducing overall costs through improvements to current systems as well as the development of new weapons concepts. The goal of Undersea Weaponry is to produce cost effective, quick reaction intelligent weapons incorporating broadband processing with battlegroup connectivity, intelligent countermeasures, hard kill torpedo defense, improved littoral operation, and weapon flexibility. Several S&T challenges must be addressed including cluttered operating environments, multipath acoustic propagation, low/no doppler targets, detonation physics, high-density power sources, and fusing/safety/arming mechanics. The technology developed under this project will be transitioned to the acquisition community for incorporation into existing platforms. For a complete picture of these efforts, see also PE 0602747N. These efforts support the LASW (ASW), Autonomous Operations, and Platform Protection FNC.

(U) While the program addresses technical issues associated with a broad range of high interest operational areas, the emphasis is on SW environments.

(U) The Navy S&T program includes projects that focus on or have attributes that enhance the affordability of warfighting systems.

B. PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 2001 ACCOMPLISHMENTS:
   (U)($3,492) Wide Area Surveillance
      (U) Continued:
         (U) Design/construction/testing of the Deployable Autonomous Distributed System (DADS) in preparation for FY03 barrier demonstration.

      (U) Completed:
         (U) Development and demonstration of a compact prototype Lead Zirconate Titanate (PZT) slotted cylinder transducer mini-array to address Littoral Low Frequency Active (LFA) requirements with decreased ship impact.
         (U) Demonstration of improved slotted cylinder shell technology that will help reduce the cost of these key transducers.

(U) Development of “A” size slotted cylinder source elements/array design to support NAVAIR PMA 264 requirements for the Air Deployed Low Frequency Projector (ADLFP) program.
(U) Delivery of a prototype lightweight power amplifier for acoustic sources that will allow operation from smaller vessels.
(U) Advanced development and testing of deployable LFA multistatic technologies.

(U)($26,225) Battlegroup Anti-submarine Warfare (ASW) Defense
(U) Initiated
(U) Design and installation of an acoustic array testbed to support future passive sonar system designs.
(U) Diesel Electric Submarine Speed-Related Tone feature detection for automatic detection and classification of threat diesel electric submarines.
(U) Sonar automation study to establish next generation Sonar Automation requirements.
(U) Auto-change detection, dwell time compensation for surveillance applications and multi-sensor auto-classification processing features for inclusion in the Interactively Trainable Passive Acoustic Classifier (IPAC).
(U) Design and development of high frequency (HF), high power, broadband projector arrays for conformal submarine, surface ship, unmanned underwater vehicle (UUV), and weapon applications with a 2+ octave frequency band of operation.
(U) At-sea demonstrations of the EA-53C sonar system using fleet test platforms.

(U) Continued:
(U) Characterization of undersea threat signals and environmental clutter to be used to design improved signal-processing algorithms for submarine and surveillance passive sonar systems.
(U) Cable Strum Mitigation technique to improve the ability to detect very low frequency acoustic signals associated with threat submarines.
(U) Single-Ping Hyperbolic Frequency Modulation (Markov Random Field (MRF)) Cluster Version 2.0 pre-detection technique.
(U) Improved Very Low Frequency (VLF) Type 1 autodetector to exploit certain acoustic vulnerabilities of modern threat nuclear submarines.
(U) Spatial Doppler Reverberation Suppression technique to improve the performance of active sonar systems in shallow water environments.
(U) SXXX Version 2.0 autodetector that exploits certain acoustic vulnerabilities of modern nuclear submarines.
(U) Striation autodetector modified for IPAC.

(U) Integration and testing of Lightweight Broadband Variable Depth Sonar LBVDS subsystems in preparation for the final fleet operational system demonstration in FY02.
(U) At-sea engineering shakedown and structured operational test for LBVDS.
(U) Development of EA-53C sonar signal processing and system control software.

(U) Completed:
(U) Transition of Ridge Distance Measurement (RDM) active classification and Single-Ping Range Rate detection techniques to the Advanced Processing Build (APB 01).
(U) Transition of dwell-time compensation feature in IPAC for surveillance applications to APB 02.
(U) Automatic Radar Periscope Detection and Discrimination laboratory demonstration of reduced false alarm rate using data from FY99 airborne test; conduct airborne evaluation during western Pacific deployment; complete and publish final documentation.

- (U)($9,396) Cooperative ASW
  (U) Continued:
  (U) Littoral Warfare Advanced Development (LWAD) scientific support, fleet and research vessel coordination, test reconstruction, logistical and environmental compliance support for three Littoral ASW (LASW) Future Naval Capability (FNC) at-sea experiments. One of which was conducted around the continental United States (CONUS) and two were conducted overseas in conjunction with the Seventh Fleet, teaming with Surface Warfare Development Group (SWDG) for one and operating with Destroyer Squadron Fifteen for both.

  (U) Completed:
  (U) Integrated ASW (IASW) sea-test planning
  (U) At-sea demonstration of IASW data-fusion capabilities
  (U) IASW technology transition planning to the Advanced Undersea Warfare Concept (AUSWC) program

- (U) ($12,532) Neutralization
  (U) Initiated:
  (U) Development of modular warhead concept for Canister Counterweapon Anti-Torpedo (CCAT) all-up-round (AUR)

  (U) Continued:
  (U) Frequency agility/optimum frequency selection using adaptive cancellation and low resolution imaging against countermeasures.

(U) Development and demonstration of broadband signal processing and intelligent torpedo control for dramatically improved single- and multi-ping detection of broadband signal processing and intelligent torpedo control advancements (including waveforms, algorithms, etc.) that will dramatically improve single- and multi-ping detection, classification, and localization transition to MK-48 CBASS Program (PE 0205632N). for the MK 48 CBASS Program.
(U) Development of torpedo countermeasures for close-in waterborne/underwater threats and high-speed weapons, and torpedo Detection, Classification, and Localization (DCL) algorithms and anti-torpedo torpedo technologies for transition to NAVSEA (PMS415) Tripwire Torpedo Defense System (AN/WSQ-11).

(U) Completed:
(U) Integration of affordable countermeasure components in common MK3/MK4 configuration; performed at-sea testing.
(U) Low rate semi-fuel cell and lithium Wick-Stirling power sources for undersea vehicle propulsion. Low rate propulsion transferred to Autonomous Operations FNC.

2. (U) FY 2002 PLAN:

- (U)($19,142) Wide Area Surveillance

(U) Initiate:
(U) Development of automated multi-static sonar classification algorithms.
(U) Compact Deployable Multistatic Active Receiver (Super-ADAR).
(U) Super-ADAR in-buoy processing laboratory demonstrations.
(U) Development of Compact Deployable Multi-static (CDMS) sources for use by the air as well as other communities.
(U) At-sea tests of long-endurance off-board source prototypes that will complement platform mounted sources while avoiding the beaconing effect of on-board transmissions.
(U) Requirements and technology study for CDMS.

(U) Continue:
(U) Advanced development and test of multi-static source technologies.
(U) Five-node test at sea to verify sensor stability, array element localization capability, acoustic/non-acoustic track fusion and automatic feature extraction (DADS).
(U) Construction/testing of DADS in preparation for FY03 barrier demonstration.

- (U)($20,551) Battlegroup Anti-submarine Warfare (ASW) Defense

(U) Initiate:

(U) Sonar automation technology development plan to be used as a long-term master plan for the 6-year Sonar Automation Program.
(U) Development, demonstration and transition of signal processing algorithms designed to detect and classify acoustic signatures of threat submarines.
(U) Design and analysis of conformal arrays (including sparse and closely packed variations) using theoretical tools employing both analytical and numerical methods.

(U) Continue:

(U) Characterization of undersea threat signals and clutter to be used to design new signal processing algorithms for submarine and surveillance passive sonar systems.
(U) Design and installation of an acoustic array testbed to support future passive sonar system designs.
(U) Development and interim testing of on-board, in-flight real-time processor and associated detection algorithms. Additionally will continue development of a "strawman" Engineering, Development and Manufacturing (EMD) assessment (Claymore Marine).

(U) Analyze and document the results of the FY 2001 LBVDS engineering shakedown and operational sea tests.
(U) Development of EA-53C sonar signal processing and system control software.
(U) Development and fabrication of prototype, high power, high frequency transducers and subsequently small partial arrays for the conformal array program. The transducer designs will enable a 2+ octave frequency band of operation.
(U) Demonstrations of multiple EA-53C sonar systems at-sea using fleet test platforms

U) Complete:

(U) Transition of Cable Strum Mitigation technique to improve the ability to detect very low frequency acoustic signals associated with threat submarines.
(U) Transition of the Single-Ping Hyperbolic Frequency Modulation Cluster Version 1.0 or the Hyperbolic Frequency Modulation (Markov Random Field) pre-detector to APB, depending on performance results.
(U) Transition of improved VLF Type 1 autodetector, which exploits certain acoustic vulnerabilities of modern threat nuclear submarines to APB 02.
(U) Transition of Spatial Doppler Reverberation Suppression technique which improves the performance of active sonar systems in shallow water environments to APB 03.

(U) Transition of SXXX Version 2.0 autodetector, which exploits certain acoustic vulnerabilities of modern nuclear submarines, to APB 03.
(U) Transition of Diesel Electric Submarine Speed-Related Tone feature detection for automatic detection and classification of threat diesel electric submarines to APB 03.
(U) Transition of auto-change detection and multi-sensor auto-classification processing features of IPAC to APB 03.
(U) Transition striation autodetector signal processing algorithm to APB 03.
(U) Transition Single-ping Cluster signal processing algorithm to APB 03.
(U) Transition of Improved Feature Space Classification technique to APB 02.
(U) Sonar automation technology development plan.
(U) Development, demonstration and transition of signal processing algorithms designed to detect and classify acoustic signatures of threat submarines.
(U) Analysis of system characterization test data and complete tactical testing (Claymore Marine). The results of the System Characterization Test will be analyzed and the results incorporated into preparations for the Tactical Test at the end of FY02; this test will involve a cooperative target, and data will processed post-flight vice real-time.
(U) Development and demonstration of LBVDS.

- (U)($6,600) Cooperative ASW
  (U) Continue:
  (U) LWAD scientific support, fleet and research vessel coordination, test reconstruction, logistical and environmental compliance support for three LASW FNC at-sea experiments. One experiment is to be conducted around the continental United States (CONUS) and two overseas. The overseas experiments will be collaborative with SWDG for one, and the other collaborative with The Technical Cooperative Program (TTCP)

- (U) ($9,512) Neutralization
  (U) Initiate:
  (U) Development and demonstration of technologies that will enable a Heavyweight torpedo and a shooting platform to be effectively employed as a fully linked on-board and off-board sensor system.
  (U) Adaptation, application, and validation of DYSMAS explosion effects hydro-code to full-ship scale.
  (U) Development and demonstration of a broadband array for the MK 54 Lightweight Torpedo.

  (U) Continue:

(U) Development and demonstration of broadband signal processing and intelligent torpedo control for dramatically improved single- and multi-ping detection of broadband signal processing and intelligent torpedo control advancements (including waveforms, algorithms, etc.) that will dramatically improve single- and multi-ping detection, classification and localization transition to MK-48 CBASS Program (PE 0205632N).
(U) Development of modular warhead concept for CCAT all up round (AUR).
(U) Development of torpedo countermeasures for close-in waterborne/underwater threats and high-speed weapons, and torpedo DCL algorithms and anti-torpedo torpedo technologies for transition to NAVSEA (PMS415) Tripwire Torpedo Defense System (AN/WSQ-11).
(U) Frequency agility/optimum frequency selection using adaptive cancellation and low resolution imaging against countermeasures.

(U) Complete:
(U) Development and demonstration of improvements in torpedo effectiveness of a Torpedo Intelligent Controller and transition to MK 48 CBASS Program (PE 0205632N).

3. (U) FY 2003 PLAN:

- (U)($14,044) Wide Area Surveillance

(U) Continue:
(U) Development of Compact Deployable Multi-static Sources.
(U) Advanced development and test of multi-static source technologies.
(U) Development of multi-static active classification algorithms.
(U) Development of Compact Deployable Multistatic Active Receiver (Super-ADAR).
(U) Laboratory demonstrations of Compact Deployable Multi-static Receiver (Super-ADAR) in-buoy processing, including field management concepts.
(U) DADS field demonstration at sea with automated detection and contact reporting of a submarine crossing a sensor barrier.
(U) Preparation for FY05 demonstration of DADS with maneuvering submarine in the sensor field.

(U) Complete:
(U) Requirements technology study for CDMS.
(U) The initial at-sea operational demonstration of off-board multi-static source

- (U)($11,591) Battlegroup Anti-submarine Warfare (ASW) Defense

(U) Initiate:

(U) Fabrication of partial HF conformal transducer array for concept demonstration using transducer technology identified in the HF prototype conformal transducer development task. The design shall be tailored for specific operational requirements and power levels.

(U) Continue:

(U) Design and installation of an acoustic array testbed to support future passive sonar system designs
(U) Development, demonstration and transition of signal processing algorithms designed to detect and classify acoustic signatures of threat submarines.
(U) Characterization of undersea threat signals and clutter to be used to design new signal processing algorithms for submarine and surveillance passive sonar systems.
(U) At-sea demonstration of LBVDS in an operational scenario.
(U) Development of EA-53C sonar signal processing and system control software.
(U) Multiple demonstrations of EA-53C sonar systems at-sea, using fleet test platforms.
(U) Evaluation of HF prototype transducers and small arrays and identification of the most promising technology for full development. We also will continue to confirm design goals of broadband high power operation in a conformal array configuration.
(U) Design and analysis of conformal arrays through the development of theoretical models that are computationally efficient.

(U) Complete:

(U) Development and demonstration of EA-53C sonar systems.
(U) Sonar automation technology development plan to be used as a long-term master plan for the 6-year Sonar Automation Program.
(U) Development and testing of project CLAYMORE MARINE; an airborne non-acoustic ASW technology on an SH-60 helicopter (technology may also be employed on fixed-wing aircraft). Completion of project CLAYMORE MARINE will document sufficient technical information to support a decision whether or not to proceed to an Engineering Development Model (EDM).
(U) Claymore Marine (CM) EMD assessment and document results. Provide recommendation for a potential acquisition decision.
(U) Analysis of CM tactical test data from the FY02 Tactical Test. Complete incorporation of results into planning for the Demonstration Test later in FY03.

(U) Development of the in-flight real-time processor and the advanced detection algorithms. Resulting processor will be flown during the Demonstration Test later in FY03. The Demonstration Test will include limited free-play against a non-cooperative target, with detections called in-flight.

- (U)($6,800) Cooperative ASW
  - (U) Continue:
    - (U) LWAD scientific support, fleet and research vessel coordination, test reconstruction, and logistical environmental compliance support for two LASW FNC CONUS at-sea experiments and one overseas demonstration.

- (U) ($7,690) Neutralization
  - (U) Continue:
    - (U) Demonstration of technologies that will enable a Heavyweight torpedo and a shooting platform to be effectively employed as a fully linked on-board and off-board sensor system.
    - (U) Development of torpedo countermeasures for close-in waterborne/underwater threats and high-speed weapons, and torpedo DCL algorithms and anti-torpedo torpedo technologies for transition to NAVSEA (PMS415) Tripwire Torpedo Defense System (AN/WSQ-11).
    - (U) Frequency agility/optimum frequency selection using adaptive cancellation and low resolution imaging against countermeasures.
    - (U) Adaptation, application, and validation of DYSMAS explosion effects code to full-ship scale.
  - (U) Complete:
    - (U) Development and Demonstration of broadband signal processing technologies and transition to the MK 48 CBASS Program (PE 0205632N).
    - (U) Development of modular warhead concept for CCAT all-up-round

C. (U) PROGRAM CHANGE SUMMARY EXPLANATION: See program change summary for PE.
(U) Schedule: Not applicable
(U) Technical: Not Applicable

D. (U) OTHER PROGRAM FUNDING SUMMARY: The Navy’s 6.1 program contributes to this effort.

(U) RELATED RDT&E:
(U) NAVY RELATED RDT&E:

(U) PE 0204311N (Integrated Undersea Surveillance System)
(U) PE 0601153N (Defense Research Sciences)
(U) PE 0602235N (Common Picture Applied Research)
(U) PE 0602747N (Undersea Warfare Surveillance Applied Research)
(U) PE 0602782N (Mine and Expeditionary Warfare Applied Research)
(U) PE 0602435N (Ocean Warfighting Environment Applied Research)
(U) PE 0603235N (Common Picture Advanced Technology)
(U) PE 0603254N (ASW Systems Development)
(U) PE 0603506N (Surface Ship Torpedo Defense)
(U) PE 0603553N (Surface ASW)
(U) PE 0604221N (P-3 Modernization Program)
(U) PE 0604261N (Acoustic Search Sensors (ENG))
(U) PE 0604784N (Distributed Surveillance Systems)
(U) PE 0604503N (SSN-688 and Trident Modernization)

(U) NON-NAVY RELATED RDT&E:
(U) PE 0602173C (Support Technologies Applied Research)
(U) PE 0602702E (Tactical Technology)
(U) PE 0603739E (Advanced Electronics Technologies)
(U) PE 0603763E (Marine Technology)

E. (U) SCHEDULE PROFILE: Not Applicable

CONGRESSIONAL PLUS-UPS

This section describes the following Congressional Plus-Ups appropriated in FY 2001 and FY2002 whose efforts fall within scope of this program element, or were appropriated in this PE:

(U) Advanced Technology Demo (Prototype Multifunction Hull Mounted Sonar), Project R2845
(U) Hybrid Lidar Radar Project R2840
(U) Low Frequency Broadband Acoustic Airgun Source, Project R2846
(U) Magnetrestrictive Transduction, Project R2844
(U) Multipulse Airgun System, Project R9033

1. FY 2001 Congressional Plus-ups:
- (U) ($2,899) Advanced Technology Demo (Prototype Multifunction Hull Mounted Sonar). The focus of this effort was to perform an advanced technology demonstration of smaller, hull-mounted sonar and to evaluate the potential for enhancing both ASW and mine avoidance for new surface combatant ships.
- (U) Hybrid Lidar Radar. The focus of this effort is to build hybrid lidar/radar research instruments for brain imaging and for underwater propagation; collect data with these instruments and analyze their performance; develop and test narrowband optical sources, and collect/analyze optical properties of littoral waters to support utility estimates of potential hybrid lidar/radar systems During FY 01 the microwave research facility was augmented with microwave network analyzers, spectrum analyzers, short-pulse mode-locked laser and ultra-narrow line frequency-locked lasers. (Appropriated in 0603712N, $2,972).
- (U) ($2,899) Low Frequency Broadband Acoustic Airgun Source. The focus of this effort was to develop a compact multi-pulse air gun system as an acoustic source deployable from small platforms, to create a system design and to conduct mechanical, electrical and acoustic testing.
- (U) ($2,417) Magnetrestrictive Transduction. The focus of this effort was to develop high energy density magnetostrictive material (TERFENOL-D) and demonstrate its applicability to naval acoustic transduction systems.

2. FY 2002 Congressional Plus-ups:
- (U) ($2,081) Magnetrestrictive Transduction. The focus of this effort will be to finalize the development of TERFENOL-D, a magnetostrictive material, for use with naval acoustic transduction systems.

- (U) ($1,289) Multipulse Airgun System. The focus of this low frequency, broadband acoustic airgun source will be to continue concept development, demonstration and evaluation of the system for the detection of submarines in littoral environments.

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603758N
PROGRAM ELEMENT TITLE: Naval Warfighting Experiments and Demonstrations

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	To COMPLETE	TOTAL PROGRAM
R2918 Naval Warfighting Experiments and Demonstrations Experimentation	**	42,827	43,460	44,275	43,307	47,255	49,500	CONT.	CONT.

** The Science and Technology Program Elements (PEs) were restructured in FY 2002. The work described in FY 2001 was funded in PE(s) 0603792N and 0603238N.

(U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: The mission of this program is to mature select technologies to facilitate advanced operational experimentation. The co-evolution of concepts and technologies requires that potentially revolutionary developments be investigated in Naval service operational experimentation: Fleet Battle Experiments (FBE), Advanced Warfighting Experiments (AWE) and Limited Objective Experiments (LOEs). Concept driven operational experimentation is constrained because the technology employed is either from currently deployed/available systems, or those about to complete the acquisition process. This program, in collaboration with the concept development activities for the Navy and Marine Corps, identifies high leverage and potentially revolutionary technology/concept pairings and focuses developmental efforts on preparation of Operational Experimentation Articles (OEA). The OEAs (fieldable technology prototypes) tailored for operational experimentation will provide the ability to operate/experiment with technologies and concepts that would otherwise be too advanced or high risk to be employed in the operational environment. Initial efforts will mature technologies in unmanned vehicles, High Speed Vessels, “Expeditionary Grid” elements, small low cost sensors, rapid target geo-location, Combat Identification, advanced countermeasures and knowledge management systems, tailored for littoral environments and expeditionary operations. These technologies are key enablers for evolving Network Centric access concepts for Naval first on scene operations in conflict and operations-other-than-war. Through maturation of key enabling technologies, the program will provide surrogate capabilities, which would be otherwise unavailable, and allow leading edge operational experimentation. The iterative technology/concept collaboration will enable innovation and dramatically shorten the time to understand and capitalize on the ramifications of new technologies.

(U) This program also completes the following Advanced Technology Demonstrations (ATD): Reactive Material Advanced Warhead, Multi-Element Buoyant Cable Antenna, Multi-Platform Broadband Processing, and Forward Air Support Marine (FASM). ATD programs are selected for a match between technological potential and Navy requirements, which are derived from operational issues of concern to the fleet. Risk-reducing ATDs cover integrating and assessing technology in a realistic operational environment and are focused on laying the technical foundations for acquiring improvements to future joint warfighting capabilities. Each demonstration is designed to assess the extent to which the technology is feasible, affordable, and compatible with operational concepts and projected force structure.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the ADVANCED TECHNOLOGY Development Budget Activity because it encompasses design, development, simulation, and experimental testing or prototype hardware. It is also necessary to validate technological feasibility and concept of operations and reduce technological risk prior to initiation of a new acquisition program or transition to an ongoing acquisition program.

B. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

- 1.(U) FY 2001 ACCOMPLISHMENTS:
- (U) ($5,390) Reactive Material Advanced Warhead ATD. Multiple full-scale cylindrical explosive launches of reactive fragmentation material were conducted showing significant structural damage to target structures. Sub-scale explosive launch testing of reactive material fragments against specific targets was completed for lethality studies. Preliminary scale-up production plans, materials property sensitivity studies and processing specifications were developed and documented for the Reactive Materials Enhanced Warhead. Preliminary Design Review of the Full Scale Demonstration Test completed. (FY01 accomplishments were funded in PE 0603792N)

- (U) ($6,801) Multi-Element Buoyant Cable Antenna ATD. Completed antenna module, tow cable, and inboard electronics design. Completed fabrication of tow cable. Completed fabrication and testing of critical antenna module components. (FY01 accomplishments were funded in PE 0603792N)

- (U) ($5,518) Multi-Platform Broadband Processing ATD: Completed development of broadband hybrid waveform/simultaneous signal processing for employment in an autonomous undersea weapon. Completed development of a Submarine Demonstration Sonar System required for the FY02 in-water demonstration. (FY01 accomplishments were funded in PE 0603792N)

- (U) ($5,017) Forward Air Support Marine ATD. Full-scale flight vehicle was demonstrated in radio controlled flight. Ground Control Computer software and wind tunnel test model were completed. Video downlink from onboard sensor suite was demonstrated. (FY01 accomplishments were funded in PE 0603238N)

(U) FY 2001 Congressional Plus-ups:

- (U) ($7,238) USMC Advanced Technology Transition (ATT) Initiative. Under this initiative, science, and technology efforts were focused and accelerated, toward developing a man-portable, Nuclear Quadrupole Resonance (NQR)-based, Advanced Mine Detector (AMD) for detecting metallic and nonmetallic buried landmines. The AMD requirement was recently given A-Priority status by the Marine Corps Ground Combat Element Advocate. Detection techniques were enhanced to discriminate buried mines from clutter (metal objects, rocks, voids), under field conditions. The ability to detect Tetryl explosives was dramatically improved, along with techniques for detecting other, multi-compound explosives. Metal and void detection parameters, and radio-frequency remediation effects were also identified, indicating bright prospects for fabricating the lightweight AMD components necessary for an operational system. (Funded in PE 0603792N)

2. (U) FY 2002 PLANS:

- (U) Naval Warfighting Experimentation Articles. This project includes initiatives for technology maturation to support technology concept pairing and for development and preparation of Operational Experimentation Articles (OEA). The project develops and provides OEAs for operational experimentation and limited objective experimentation. The project will modify these articles in an iterative manner in response to insights gained during experimentation in order to facilitate co-evolution of concepts and technology. The following efforts will be initiated in FY 2002:
  - (U)($5,700) Naval Warfare Experimentation- High Speed Vessel Experimentation and Demonstrations. The Navy Warfare Development Command (NWDC); U.S. Army Combined Arms Support Command; Office of Naval Research (ONR); the Marine Corps Plans, Policies, and Operations Department; Navy Special Warfare Command and the U.S. Coast Guard Deep Water Project Program, have agreed to cooperate in a joint experimentation effort to explore and develop this kind of technology. The 12-24 month experimentation phase will be coordinated by NWDC, in close partnership with other elements of the U.S. Navy, the U.S. Marine Corps, U.S. Army and U.S. Coast Guard. These commands and others will develop the experimentation plan that incorporates all the research objectives from each of the services to include joint experimentation in Millennium Challenge 02, the major Joint experimentation venue led by Joint Forces Command. The services will also work together to consolidate the analytical talent to both build the experiments and analyze results. Members of the experimentation team expect to conclude this joint experimentation effort with an understanding of where these technologies can best be applied across our respective mission spectrums. At that point, each partner will be able to much more accurately define and articulate the capabilities they need to include in the future ships that will optimize the advantages of these technologies.

  - (U)($7,783) Naval Warfare Experimentation- Expeditionary Sensor Grid (ESG) Enabling Experimentation. The Expeditionary Sensor Grid (ESG) Enabling Experimentation program (EEE) is the underlying foundation To allow concept based operational, limited objective, and virtual experimentation to be conducted supporting the aligned concepts of Network-Centric Operations, FORCEnet and the Expeditionary Sensor Grid. A common methodology and connectivity will be established to facilitate a capability for Distributed Laboratory Experimentation allowing scoping analysis using each laboratory's contributions in their areas of excellence. The objective of the EEE is to deliver software to operational experiments that allows for easy connection of heterogeneous elements that comprise an ESG, that allow for dynamic configuration and reconfiguration of an ESG, and that delivers the power of the next generation Internet (Semantic Web) to provide the necessary information for dynamic command and control. The hypothesis is that ESG will improve the ease and availability of data and information to the warfighter, make available data that is not available today, improve the ability to fuse data and information from disparate sources, and decrease the decision makers' workload by providing actionable information. The deliverable will provide the ability to conduct operational experiments to co-evolve network-centric warfare concepts, technologies, and TTP (tactics, techniques and procedures).

-(U)($8,400) Naval Warfare Experimentation Articles- Expeditionary Sensor Grid (ESG) Elements. The ESG Elements initiative matures technology and produces Operational Experimentation Articles (OEA) which enable investigation of the feasibility and contribution of distributed sensors and affectors in littoral operations. The United States has some of the most sophisticated sensor systems in the world that have the ability to provide standoff sensing of adversary targets of interest. While these systems provide valuable data, potential adversaries have developed capabilities to cover, conceal, and deny information from these systems. The ESG concept envisions thousands of additional sensors that can be distributed across the battlespace of interest and placed in close proximity to the targets of interest. Network-Centric Operations envisions bringing the data and information from all sensor sources into one common picture that can be tailored to meet the specific requirements of each warfighter. Currently the existing and planned sensor systems have been developed in a stove-piped manner and are not integrated or even interoperable making it extremely difficult to provide timely decision quality information to each decision-maker. The proposed, traditional solution of standardization among systems is one that cannot achieve the Network-Centric Operations vision in the dynamic information environment of the future. The ESG concept envisions another solution with a true "plug and play" of, not only, new sensors and systems, but also legacy sensors, databases, and processes.
(U) ESG will include new expeditionary sensors, processing, and the supporting networks that when combined with the emerging information infrastructure of our programmed forces (Joint, Coalition, and National) will provide the tactical and operational warfighters with the necessary situational awareness to maintain battlespace dominance while rapidly dismantling any potential adversary's anti-access capabilities. The new sensors provide for exploitation of phenomenology (possibly new or currently unexploited) associated with targets of interest and are distributed across the domains of space, air, sea, land, and information. ESG sensors can be widely distributed, carried by unmanned vehicles, or on traditional manned platforms. ESG provides the means to move data to decision quality information to be used by the appropriate tactical and

operational warfighter. ESG provides or supports sensing, data archiving, processing, fusion, course of action assessment, and information presentation. ESG provides "plug and play" interoperability between heterogeneous elements, the capability to dynamically reconfigure the grid as systems enter and leave, and information assurance. ESG is envisioned as more than just a collector of information; it also can be used for information operations to inject false targets and information into an enemy's surveillance and targeting systems. The ESG elements are content generators that provide relevant data, which aggregates to actionable information in the context of Network Centric Operations. These types of simple sensors and affectors have not been fully investigated in the context of platform centric acquisition programs. Innovative and advanced technologies will be examined to reduce cost and risk, while expanding mission capabilities by enabling new operational concepts. ESG Elements being developed include: Distributed ELINT, Unmanned Autonomous Vehicle (UAV)-Borne Distributed Counter Battery Sensors, SWARM Distributed Micro-Affectors, Unattended Sea-Based Cruise Missile Sensors, Distributed Unattended Ground Sensor Field, and Distributed Undersea Warfare Pyramid Electromagnetic Sensors.

- (U)($5,200) Reactive Material Advanced Warhead ATD. Complete the ATD. Complete cylindrical full-scale explosive launch test series for Reactive Fragmentation Material and inclusion of results in lethality estimation programs. Conduct full-scale live explosive static testing of the Reactive Materials Enhanced Warhead against a number of targets, both real and simulated. Completion of Reactive Warhead Critical Design review and submission of design package to transition agent, including systems design interface considerations. Completion of Lethality Analysis and Toolset for Anti-Air Warfare (AAW) target set. Transition to Engineering Manufacturing Development (EMD) Production program.

- (U)($4,500) Multi-Function Buoyant Cable Antenna ATD. Complete the ATD. This includes completion of system fabrication and component testing, conducting surface based system tests using cable depressor and conducting a submarine demonstration.

  - (U) ($4,600) Multi-Platform Broad Band Processing Advanced Technology Demonstration (ATD). Complete the ATD. Demonstrate the performance of coherent broadband signal processing for submarine, surface ship and undersea weapon applications.

  - (U) ($6,644) Forward Air Support Marine. Complete the ATD. This entails completion of full-scale wind tunnel testing of the cruise vehicle, autonomous flights of the cruise vehicle and gun launch of full-scale test vehicle.

3. (U) FY 2003 PLAN:

- (U) Naval Warfighting Experimentation Articles. This project continues and expands initiatives for technology maturation to support technology concept pairing and for development and preparation of Operational Experimentation

Articles (OEA). The project develops and provides OEAs for operational experimentation and limited objective experimentation. The project will modify these articles in an iterative manner in response to insights gained during experimentation in order to facilitate co-evolution of concepts and technology. The following efforts will be ongoing in FY 2003:

-(U)($8,000) High Speed Vessel Experimentation and Demonstrations. The Navy Warfare Development Command (NWDC); U.S. Army Combined Arms Support Command; Office of Naval Research (ONR); the Marine Corps Plans, Policies, and Operations Department; Navy Special Warfare Command and the U.S. Coast Guard Deep Water Project Program, will continue to cooperate in a joint experimentation effort to explore and develop this kind of technology. The second phase of the 24 month experimentation phase will be coordinated by NWDC, in close partnership with other elements of the U.S. Navy, the U.S. Marine Corps, U.S. Army and U.S. Coast Guard. These commands and others will execute and dynamically modify the experimentation plan that incorporates all the research objectives from each of the services to include joint experimentation. The services will continue to work together to consolidate the analytical talent to both build the experiments and analyze results. Members of the experimentation team expect to conclude this joint experimentation effort with an understanding of where these technologies can best be applied across our respective mission spectrums. At that point, each partner will be able to much more accurately define and articulate the capabilities they need to include in the future ships that will optimize the advantages of these technologies.

-(U)($7,000) Naval Warfare Experimentation- Expeditionary Sensor Grid Enabling Experimentation. The Expeditionary Sensor Grid (ESG) Enabling Experimentation program (EEE) is the underlying foundation to allow concept based operational, limited objective, and virtual experimentation to be conducted supporting the aligned concepts of Network-Centric Operations, FORCEnet and the Expeditionary Sensor Grid. Work will continue toward establishment of a common methodology and connectivity to facilitate a capability for Distributed Laboratory Experimentation allowing scoping analysis using each laboratory's contributions in their areas of excellence. Additional Laboratories will be added and sensors and simulations increased. Each shall participate in the development of an Expeditionary Sensor Grid (ESG) operational capability through enabling experimentation with elements of the grid

arrayed in an end-to-end fashion. Develop an end-to-end capability enabled by the DARPA developed Control of Agent Based Systems (CoABS) grid and agent based computing technologies. Sensor types to be included are ELINT, radar, sonobuoys, tactical ship towed arrays, the ONR sponsored Distributed Acoustic Detection System (DADS) arrays, and environmental sensors. Sensor processing and fusion will incorporate existing algorithms, but new caching and retrieval schema will be used to provide expanded data and information. Computer agents, fuselets, and the Air Force Rome Laboratory developed "Publish and Subscribe" will be used to assist in data and information retrieval. Capabilities will be matured in distributed laboratory experiments and be further tested during Fleet Battle Experiments. The deliverable will provide the ability to conduct operational experiments to co-evolve network-centric warfare concepts, technologies, and TTP (tactics, techniques and procedures).

-(U) ($26,960) Naval Warfare Experimentation Articles- Expeditionary Sensor Grid (ESG) Elements. The ESG Elements initiative continues to mature technologies and produce Operational Experimentation Articles (OEA) which enable investigation of the feasibility and contribution of distributed sensors and affectors in littoral operations. ESG will add new expeditionary sensors, processing, and the supporting networks that when combined with the emerging information infrastructure of our programmed forces (Joint, Coalition, and National) will provide the tactical and operational warfighters with the necessary situational awareness to maintain battlespace dominance while rapidly dismantling any potential adversary's anti-access capabilities. The new sensors provide for exploitation of phenomenology (possibly new or currently unexploited) associated with targets of interest and are distributed across the domains of space, air, sea, land, and information. Innovative and advanced technologies will be examined to reduce cost and risk, while expanding mission capabilities by enabling new operational concepts. ESG Elements being developed will include: Miniaturized Undersea Warfare Sensors, Dissimilar Distributed ELINT, UAV-Borne Distributed Electro-Optical/Infrared Sensors, SWARM Distributed Micro-Affectors, Unattended Sea-Based Cruise Missile Sensors, Distributed Unattended Ground Sensor Field, and Distributed Undersea Warfare Pyramid Electromagnetic Sensors.

- (U)($1,500) Science and Technology Analysis and Assessments. Independent S&T reviews will be conducted to assure that experimentation is executed and operational analyses conducted which address relevant issues and allow the iterative improvement of concepts and technologies (in the form of OEAs). Analyses and assessments will be directed toward ensuring that S&T resources are focused in a context of relevance centered on unique naval needs, transformational concepts and opportunities.

C. (U) PROGRAM CHANGE SUMMARY:

	FY 2001	FY 2002	FY 2003
FY 2002 President's Budget	**	43,277	
Adjustments from FY 2002 President's Budget			
FFRDC Reduction		-68	
8123 Management Reform Initiative Reduction		-382	
FY 2003 President's Submission	**	42,827	43,460

**The Science and Technology PESs were restructured in FY 2002. FY 2001 efforts were funded in PEs 0603792N and 0603238N.

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603758N
PROGRAM ELEMENT TITLE: Naval Warfighting Experiments and Demonstrations

(U) PROGRAM CHANGE SUMMARY EXPLANATION:

(U) Schedule: Not Applicable.

(U) Technical: Not Applicable.

D. (U) OTHER PROGRAM FUNDING SUMMARY: The Navy's 6.1 program contributes to this effort.

(U) NAVY RELATED RDT&E:
- (U) PE 0601152N (In-house Lab Independent Research)
- (U) PE 0601153N (Defense Research Sciences)
- (U) PE 0602114N (Power Projection Applied Research)
- (U) PE 0602123N (Force Protection Applied Research)
- (U) PE 0602131M (Marine Corps Landing Forces Technology)
- (U) PE 0602235N (Common Picture Applied Research)
- (U) PE 0602236N (Warfighter Sustainment Applied Research)
- (U) PE 0602271N (RF Systems Applied Research)
- (U) PE 0602435N (Ocean Warfighting Environment Applied Research)
- (U) PE 0602747N (Undersea Warfare Applied Research)
- (U) PE 0602782N (Mine and Expeditionary Warfare Applied Research)
- (U) PE 0603114N (Power Projection Advanced Technology)
- (U) PE 0603123N (Force Protection Advanced Technology)
- (U) PE 0603235N (Common Picture Advanced Technology)
- (U) PE 0603236N (Warfighter Sustainment Advanced Technology)
- (U) PE 0603271N (RF Systems Advanced Technology)
- (U) PE 0603640M (Marine Corps Advanced Technology Demonstrations)
- (U) PE 0603729N (Warfighter Protection Advanced Technology)
- (U) PE 0603747N (Undersea Warfare Advanced Technology)
- (U) PE 0603727N (Navy Technical Information Presentation System)
- (U) PE 0603782N (Mine & Expeditionary Warfare Advanced Technology)

(U) NON NAVY RELATED RDT& E.
- (U) PE 0603750D (Advanced Concept Technology Demonstration)

E. (U) SCHEDULE PROFILE: Not applicable.

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603782N
PROGRAM ELEMENT TITLE: Mine and Expeditionary Warfare Advanced Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
R2917 Mine and Expeditionary Warfare Advanced Technology	43,559*	47,852	43,725	44,324	43,105	43,888	42,558	CONT.	CONT
R2720 Ocean Modeling Research for Mine & Submarine Warfare	2,797	1,487							
TOTAL	46,538	49,339	43,725	44,324	43,105	43,888	42,558	CONT.	CONT

* In FY01, effort under R2917 was executed under R2226.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project develops and demonstrates prototype Mine Warfare (MIW) system components that support a range of capabilities enabling Naval Expeditionary Forces to influence operations ashore. Third-world nations have the capability to procure, stockpile and rapidly deploy all types of naval mines, including new generation mines having sophisticated performance characteristics, throughout the littoral battlespace.

(U) Due to the number of efforts in this PE, the programs described are representative of the work included in the PE.

(U) JUSTIFICATION FOR BUDGET ACTIVITY: This program is budgeted within the Advanced Technology Budget Activity, because it encompasses design, development, simulation or experimental testing or prototype hardware to validate technological feasibility and concept of operations and reduce technological risk prior to initiation of a new acquisition program or transition to an ongoing acquisition program.

B. (U) PROGRAM CHANGE SUMMARY:

	FY 2001	FY 2002	FY 2003
FY 2002 President’s Submission:	48,172	48,279	0
Adjustments from FY 2002 PRESBUDG:			
SBIR Adjustment	-2,079		
Execution Adjustment	+ 445		
Congressional Plus-ups		+1,500	
Section 8123 Management Reform Initiative Reduction		-440	
FY 2003 President’s Submission:	46,538	49,339	43,725

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603782N
PROGRAM ELEMENT TITLE: Mine and Expeditionary Warfare Advanced Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE	FY 2003 ESTIMATE	FY 2004 ESTIMATE	FY 2005 ESTIMATE	FY 2006 ESTIMATE	FY 2007 ESTIMATE	TO COMPLETE	TOTAL PROGRAM
R2917 Mine and Expeditionary Warfare Advanced Technology	43,559*	47,852	43,725	44,324	43,105	43,888	42,558	CONT.	CONT.

* In FY01, this effort was funded under R2226.

A. (U) MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project develops and demonstrates prototype Mine Warfare (MIW) system components that support a range of capabilities enabling Naval Expeditionary Forces to influence operations ashore. Third-world nations have the capability to procure, stockpile and rapidly deploy all types of naval mines, including new generation mines having sophisticated performance characteristics, throughout the littoral battlespace. “Desert Storm” demonstrated the U.S. Navy’s needs to counter the projected third world mine threat. Advanced technologies are required to rapidly detect and neutralize all mine types, from deep water through the beach. This project supports the advanced development and integration of sensors, processing, warheads and delivery vehicles to demonstrate improved MIW capabilities. The Thrust Areas in this project are:(1) Surveillance and Reconnaissance; and (2) Breaching and Neutralization. These Thrust Areas support the Organic Mine Countermeasures (MCM) Future Naval Capability.

(U) The Surveillance and Reconnaissance Thrust Area focuses on developing and demonstrating technologies to detect, classify, and identify mines and obstacles throughout the Littoral Penetration Area. Efforts within this thrust include: remote sensing techniques to survey threat mining activities and mine/obstacle field locations; advanced acoustic/non-acoustic sensors and processing technologies for rapid minefield reconnaissance and determination of the location of individual mines and obstacles. A major current focus is the development of technologies that provide rapid, surveillance and reconnaissance, specifically in the very shallow water, surf zone, beach zones, craft landing zones, and beach exit zones (VSW,SZ,BZ,CLZ,BEZ), that enable Ship to Objective Maneuver.

(U) The Breaching and Neutralization Thrust Area focuses on developing and demonstrating technologies for stand-off breaching of mines and obstacles in the SZ/BZ/CLZ/BEZ and precision neutralization of individual mines. Efforts within this thrust include: influence sweeping technologies for influence minefield clearance, explosive and non-explosive technologies for mine/obstacle field breaching, and advanced technologies to rapidly neutralize shallow water (SW) sea mines. A major current focus is the development of technologies that provide rapid detection and standoff breaching of mines and obstacles, specifically in the VSW/SZ/BZ/CLZ/BEZ) that enable Ship to Objective Maneuver.

(U) This research directly supports the Department of Defense Joint Warfighting Science and Technology Plan and the Defense Technology Area Plans.

(U) The Navy Science and Technology program includes projects that focus on or have attributes that enhance the affordability of warfighting systems.

B. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 2001 ACCOMPLISHMENTS:

(U) ($24,559) SURVEILLANCE/RECONNAISSANCE

- (U) ADVANCED SURVEILLANCE/RECONNAISSANCE: Continued algorithm development efforts on critical environmental parameters, including offshore bathymetry, optical clarity, and other essential elements of information for amphibious operations. Continued assessment of performance of algorithms against ground truth data. Demonstrated near shore surveillance during Kernal Blitz 2001 (a 3rd Fleet Training Exercise). Continued transition of results to the Naval Oceanographic Office.

- (U) MODELING AND SIMULATION: Continued simulation/visualization concept-based assessment of technologies for naval surface fire support and Future Naval Capabilities in organic MCM. Initiated technology guideline study for mine countermeasures in support of ship to objective maneuver. Continued participation in Fleet Battle Laboratory experiments and expeditionary warfare wargaming.

- (U) EXPEDITIONARY WARFARE COMMUNICATIONS NETWORKING: Completed evaluation/assessment of high capacity communications links between ships and objectives ashore during Fleet Battle Experiment Hotel. Completed documentation of all deployment assessments.

- (U) SURFACE SURVEILLANCE, TARGET ACQUISITION, FIRE CONTROL, AND ORDNANCE: Completed development of composite metal fleschettes and delivery system. Began integration of guidance, control and warhead technologies into 5-inch projectile.

- (U) MINE IDENTIFICATION: Completed analysis of helicopter towed Streak Tube Imaging Lidar (STIL) mine identification technology demonstration. Completed development of automated mine identification algorithms and completed performance assessment utilizing data obtained during ship/helicopter towed technology demonstration. Transitioned STIL mine identification technology to AQS-20X acquisition program (PE 0604373N (Airborne Mine Countermeasures)).

- (U) LITTORAL SEA MINE: Integrated target detection/tracking long baseline sensors, detection/tracking algorithms, underwater communications, and test bed weapons system (hybrid lightweight torpedo). Demonstrated target detection, tracking and fire control and completed documentation of littoral sea mine technology demonstration.

- (U) VERY SHALLOW WATER/EXPLOSIVE ORDNANCE DISPOSAL (VSW/EOD) RECONNAISSANCE: Demonstrated capability to communicate VSW target information to a control authority by surface piercing Radio Frequency technology. Demonstrated asset redirection and command redirection by a remote control. Demonstrated integrated search, marking, bathymetry mapping, threat objects and gaps and report back in test-bed minefields in VSW environments. Demonstrated capability to enable diver teams to efficiently and accurately reacquire previously targeted areas and individual targets. Demonstrated VSW reconnaissance during Kernal Blitz 2001 (a 3rd Fleet Training Exercise).

- (U) ORGANIC MINEHUNTING AND NEUTRALIZATION OF MINES: Developed and demonstrated (during Kernal Blitz 2001) adaptive, shallow water reconnaissance and minehunting sampling strategies which are optimized based on information provided by environmental survey data and through in-situ environmental measurements. Completed development of conductively cooled, low temperature superconducting magnetic solenoid for organic mine sweeping.

- (U) VECTORED THRUST DUCTED PROPELLER (VTDP) COMPOUND HELICOPTER: Completed design of the flight control, power, and propulsion systems and H-60 airframe structural modifications. Conducted Preliminary Design Review (PDR). (Funded in PE 0603792N in FY01, $5,100K).

(U) ($19,000) BREACHING AND NEUTRALIZATION

- (U) SZ NEUTRALIZATION OF MINES AND OBSTACLES: Completed development of GPS only guidance component. Assessed through simulation, the accuracy of warhead deployment utilizing GPS only inverse guidance technology. Continued development of reactive darts for neutralization of beach and surf zone mines. Initiated development of chemical darts for neutralization of beach and surf zone mines. Initiated development of dispensing technologies for distributing reactive and chemical darts. Assessed neutralization capability for small targets, which are predominant in the SZ.

- (U) BZ NEUTRALIZATION OF OBSTACLES: Initiated development of air delivered, explosively formed impactor for neutralization of beach obstacles. Began integration of guidance and warhead technologies for demonstration.

- (U) ADVANCED AIRBORNE MINE DETECTION: Initiated development of advanced electro-optic technologies for detection of near surface mines from a maritime unmanned airborne vehicle (UAV). Initiated development of multi-spectral laser for detection and targeting of minefields from a maritime UAV. Initiated development of three-dimensional camera for detection and targeting of minefields.

2. (U) FY 2002 PLAN:
(U)($26,852) SURVEILLANCE/RECONNAISSANCE:

- (U) ADVANCED SURVEILLANCE/RECONNAISSANCE: Continue algorithm refinement efforts on critical environmental parameters, including offshore bathymetry, surface currents, and other essential elements of information for amphibious operations. Update surveillance exploitation guide. Complete transition of critical battlespace products to the Naval Oceanographic Office.

- (U) MODELING AND SIMULATION: Continue simulation/visualization concept-based assessment of technologies for Future Naval Capabilities in organic MCM. Complete technology guideline study for mine countermeasures in support of ship to objective maneuver. Initiate system integration of technologies/concepts for mine countermeasures in support of ship to objective maneuver. Continue participation in Fleet Battle Laboratory experiments and expeditionary warfare wargaming.

- (U) VSW/EOD RECONNAISSANCE: Continue development of UUV based optimized search strategies for VSW reconnaissance. Continue demonstration of asset redirection and command redirection by a remote control. Continue demonstration of integrated search, marking, bathymetry-mapping threat objects and gaps and reports back in test-bed minefields in VSW environments. Continue demonstration of capability to enable diver teams to efficiently and accurately reacquire previously targeted areas and individual targets. Demonstrate VSW reconnaissance from a high-speed vessel during Fleet Battle Experiment Juliet.

- (U) ADVANCED AIRBORNE MINE DETECTION: Continue development of advanced electro-optic technologies for detection of near surface mines from a maritime unmanned airborne vehicle (UAV). Initiate development of automated mine/minefield detection and classification algorithms for active/passive electro-optic sensors. Continue development of multi-spectral laser for detection and targeting of minefields from a maritime UAV. Continue development of three-dimensional camera for detection and targeting of minefields.

- (U) DATA FUSION: Initiate multi-platform, multi-sensor fusion of mine countermeasure sensor data. Initiate development and demonstration of a Common Tactical Picture to support expeditionary maneuver planning in a mined environment. Initiate development and demonstration of planning tools for expeditionary maneuver in a mined environment.

- (U) FLEET DEMONSTRATIONS: Initiate planning for demonstration of mine countermeasures AUV technologies during Fleet Battle Experiment Juliet (FBE (J)). Conduct Gulf of Mexico Limited Objective Experiment in preparation for FBE (J). Demonstrate deployment and operation of mine countermeasures AUV technologies from a high-speed vessel during FBE (J). Initiate planning for Kernal Blitz 2003 demonstration of mine countermeasure technologies in support of ship to objective maneuver.

- (U) VECTORED THRUST DUCTED PROPELLER (VTDP) COMPOUND HELICOPTER: Complete modifications to H-60 helicopter for flight testing of the VTDP. Complete pilot-in-the-loop verification of the VTDP flight control system. Continue flight test planning.

(U) ($21,000) BREACHING AND NEUTRALIZATION

- (U) SZ NEUTRALIZATION OF MINES AND OBSTACLES: Continue development of reactive darts for neutralization of beach and surf zone mines. Continued development of chemical darts for neutralization of beach and surf zone mines. Continue development of dispensing technologies for distributing reactive and chemical darts. Complete demonstration of chemical dart lethality against representative beach zone mines. Initiate demonstration of dart lethality against representative surf zone mines. Initiated integration of high velocity, reactive dart warhead payload and delivery platform for system levels demonstration.

- (U) BZ NEUTRALIZATION OF OBSTACLES: Continue development of air delivered, continuous rod warhead for neutralization of beach obstacles.

- (U) ORGANIC MINEHUNTING AND NEUTRALIZATION OF MINES: Initiate development of an unmanned surface vehicle (USV) for mine sweeping. Initiate development of magnetic and acoustic sweep generators for integration onto USV.

3. (U) FY 2003 PLAN:

(U)($19,325) SURVEILLANCE/RECONNAISSANCE

- (U) ADVANCED SURVEILLANCE/RECONNAISSANCE: Continue algorithm refinement efforts on critical environmental parameters, including offshore bathymetry, surface currents, and other essential elements of information for amphibious operations. Optimize processing and data reduction tools for wide area detection of beach mined areas and obstacle belts. Demonstrate wide area detection of beach mined areas during Kernal Blitz 2003.

- (U) ADVANCED AIRBORNE MINE DETECTION: Continue development of advanced Electro-optic technologies for detection of near surface mines from a maritime unmanned airborne vehicle (UAV). Continue development of automated mine/minefield detection and classification algorithms for active/passive Electro-optic sensors. Complete development of multi-spectral laser for detection and targeting of minefields from a maritime UAV. Complete development of three-dimensional camera for detection and targeting of minefields. Initiate integration of multi—spectral laser and three-dimensional camera on a UAV testbed.

- (U) DATA FUSION: Continue multi-platform, multi-sensor fusion of mine countermeasure sensor data. Continue development and demonstration of a Common Tactical Picture to support expeditionary maneuver planning in a mined environment. Continue development and demonstration of planning tools for expeditionary maneuver in a mined environment.

- (U) MODELING AND SIMULATION: Continue simulation/visualization concept-based assessment of technologies for Future Naval Capabilities in organic MCM. Continue system integration of technologies/concepts for mine countermeasures in support of ship to objective maneuver. Continue participation in Fleet Battle Laboratory experiments and expeditionary warfare wargaming.

- (U) VSW/EOD RECONNAISSANCE: Continue development of UUV based optimized search strategies for VSW reconnaissance. Continue demonstration of integrated search, marking, bathymetry mapping, threat objects and gaps and report back in test-bed minefields in VSW environments. Continue demonstration of capability to enable diver teams to efficiently and accurately reacquire previously targeted areas and individual targets. Demonstrate multi platform, coordinated VSW reconnaissance during Kernal Blitz 2003.

- (U) FLEET DEMONSTRATIONS: Complete documentation of FBE (J) exercise results. Continue planning for Kernal Blitz 2003 demonstration of mine countermeasure technologies in support of ship to objective maneuver. Demonstrate mine countermeasure technologies in support of ship to objective maneuver during Kernal Blitz 2003.

- (U) VECTORED THRUST DUCTED PROPELLER (VTDP) COMPOUND HELICOPTER: Continue preparations for flight-testing.

(U) ($24,400) BREACHING AND NEUTRALIZATION

- (U) SZ NEUTRALIZATION OF MINES AND OBSTACLES: Continue development of chemical darts for neutralization of beach and surf zone mines. Continue development of dispensing technologies for distributing reactive and chemical darts. Complete demonstration of chemical dart lethality against representative surf zone mines. Begin integration of chemical dart warhead payload and delivery platforms for system level demonstration. Demonstrate standoff breaching of mines in the surf and beach zones during Kernal Blitz 2003.

- (U) BZ NEUTRALIZATION OF OBSTACLES: Continue development of air delivered, continuous rod warhead for neutralization of beach obstacles.

- (U) ORGANIC MINEHUNTING AND NEUTRALIZATION OF MINES: Continue development of an unmanned surface vehicle (USV) for mine sweeping. Continue development of magnetic and acoustic sweep generators for integration onto USV. Demonstrate USV for mine sweeping during Kernal Blitz 2003 (a 3rd Fleet Training Exercise).

C. (U) PROGRAM CHANGE SUMMARY EXPLANATION: See change summary for total PE.

(U) Schedule: Not applicable
(U) Technical: Not applicable

D. (U) OTHER PROGRAM FUNDING SUMMARY:

(U) NAVY RELATED RDT&E: The Navy's 6.1 program contributes to this effort.
(U) PE 0601153N (Defense Research Sciences)
(U) PE 0602131M (Marine Corps Landing Force Technology)
(U) PE 0602747N (Undersea Warfare Applied Research)
(U) PE 0602782N (Mine and Expeditionary Warfare Applied Research)
(U) PE 0602435N (Ocean Warfighting Environment Applied Research)
(U) PE 0603502N (Surface and Shallow Water Mine Countermeasure)
(U) PE 0603513N (Shipboard System Component Development)
(U) PE 0603640M (Marine Corpse Advanced Technology Demo (ATD))
(U) PE 0604373N (Airborne Mine Countermeasures)
(U) PE 0604784N (Distributed Surveillance System)

(U) NON NAVY RELATED RDT&E:
(U) PE 0602712A (Countermine Systems)
(U) PE 0603606A (Landmine Warfare and Barrier Advanced Technology)

E. (U) SCHEDULE PROFILE: not applicable

(U) CONGRESSIONAL PLUS-UPS

(U) This section describes the following Congressional Plus-Ups appropriated in FY 2001 or FY2002:

Ocean Modeling Research for Mine and Submarine Warfare

1.FY 2001 Congressional Plus-ups:

- (U) ($2,979), Ocean Modeling Research for Mine and Submarine Warfare: The focus of this effort was to continue installation and maintenance of an ocean observational and data management system for the Gulf of Maine and to demonstrate, during Fleet Battle Experiments, the generation and exploitation of a common environment for enhancing mine and expeditionary warfare.

FY 2002 Congressional Plus-ups:

- (U) ($1,487), Ocean Modeling Research for Mine and Submarine Warfare: The objective of this effort is to continue maintenance of an ocean observational and data management system for the Gulf of Maine and to demonstrate the exploitation of a common environment for enhancing expeditionary operations in a mined environment.

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 3 PROGRAM ELEMENT: 0603792N
PROGRAM ELEMENT TITLE: Advanced Technology Transition

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE
R1889 Advanced Technology Demonstration	77,712	*
R2721 Vectored Thrust Ducted Propeller	3,090	0
R2724 Advanced Hull Form In-Shore Demonstrator	7,726	0
R2847 USMC ATT Initiative	7,238	0
R2848 Hybrid Small Waterplane Area Catamaran (HYSWAC)	4,852	0
TOTAL	100,618	

*This Program Element (PE) was restructured in FY 2002. FY 2001 efforts are described in PEs 0603114N, 0603236N, 0603758N, and 0603782N.

FY 2001 Congressional Plus-ups appropriated in this PE are described under the following restructured PEs.

TITLE	PE Number	FY 2001
Advanced Hull Form In-Shore Demonstrator	0602123N	$7,726
HYAWAC	0603123N	$4,852
USMC ATT Initiative	0603758N	$7,238
Vectored Thrust Ducted Propeller	0603114N	$3,090

FY 2003 RDT&E,N BUDGET ITEM JUSTIFICATION SHEET DATE: February 2002

BUDGET ACTIVITY: 3

PROGRAM ELEMENT: 0603794N
PROGRAM ELEMENT TITLE: C3 Advanced Technology

(U) COST: (Dollars in Thousands)

PROJECT NUMBER & TITLE	FY 2001 ACTUAL	FY 2002 ESTIMATE
R2239 Advanced Targeting	15,486	*
R2601 Dominant Battlespace Command	5,795	0
R2602 National Technology Alliance	9,659	0
X2091 SEW Advance Technology	17,459	*
TOTAL	48,399	*

*This PE was restructured in FY 2002. FY 2001 efforts are described in PE 0603271N.

Congressional Plus-ups appropriated in this PE are described under the following restructured program element:

Title	PROGRAM ELEMENT	FY 2001
Dominant Battlespace Command Initiative	0603235N	$5,795
National Technology Alliance	0603235N	$9,659