BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N
PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES

COST: (Dollars in Thousands)

Project Number & Title	FY 2005 Actual	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
DEFENSE RESEARCH SCIENCES	370,229	371,048	366,649	377,950	389,595	397,686	406,632

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This program element (PE) 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. Additionally, it exploits scientific breakthroughs and provides options for new Future Naval Capabilities (FNCs) and Innovative Naval Prototypes (INPs). It responds to S&T directions of the DON Naval Power 21 (NP21) Transformational Roadmap, and Chief of Naval Operations (CNO) N70 Mission Capability Package (MCP) requirements for long term Navy and Marine Corps improvements. Defense Research Sciences 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 (JCS) 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 (D&I) with Exploitation and Delivery". DON basic research is the core of D&I. It includes scientific study and experimentation directed toward increasing knowledge and understanding in national security related aspects of physical, engineering, environmental and life sciences. Basic research efforts are developed, managed, and related to more advanced aspects of research in some hundred-plus technology and capability-related 'thrusts', which are consolidated in fifteen research areas. These in turn support the major motivational research focus areas of the Navy and Marine Corps; 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, weapons systems for naval forces, and superior human performance/training/care of Sailors and Marines.

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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. Key aspects also include 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 FY99), Underwater Weaponry (started FY02), and Naval Engineering (started in FY03). The basic research portfolio can be represented in three segments of emphasis identified as naval unique, participation, and harvest. Naval unique defines a category where the S&T is important to naval operations and largely undertaken only by the DON. It includes the NNR areas. Participation refers to S&T elements vital to naval operations, and naval investment can leverage funding sources other than DON such as airborne radars, communications and networks, materials sciences, and advanced energetic materials. Harvest defines cross cutting areas of science and engineering with potential to generate unanticipated naval capabilities or savings, and which DON should nurture such as nanoscience (potential new material properties) and the behavioral sciences.

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

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B. PROGRAM CHANGE SUMMARY:

	FY 2005	FY 2006	FY 2007
FY 2006 President's Budget Submission	380,441	356,885	366,680
Congressional Action	0	19,600	0
Congressional Undistributed Reductions/Rescissions	-292	-5,437	0
Execution Adjustments	-3,598	0	0
Federal Technology Transfer	-35	0	0
FY 2005 SBIR	-6,287	0	0
Program 38 Support	0	0	-205
Rate Adjustments	0	0	174
FY 2007 President's Budget Submission	370,229	371,048	366,649

PROGRAM CHANGE SUMMARY EXPLANATION:
Technical: Not applicable.

Schedule: Not applicable.

C. OTHER PROGRAM FUNDING SUMMARY:
Not applicable.

D. ACQUISITION STRATEGY:
Not applicable.

E. PERFORMANCE METRICS:
Defense Basic Research seeks to improve the quality of defense research conducted predominantly through universities and government laboratories such as the Naval Research Laboratory. It also supports the education of engineers and scientists in disciplines critical to national defense needs through the development of new knowledge in an academic environment. Initial research focus is generally conducted in an unfettered environment because of the nature of basic research, but as more is learned and applications emerge, individual research projects take on a more applied focus. Individual project metrics then become

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more tailored to the needs of specific applied research and advanced development programs. Example metrics include a biporous wick structure for thermal management of power electric modules capable of removing 900 watts per square centimeter which was recently been developed by an academia/industry team. The National Research Council of the National Academies of Science and Engineering’s congressionally directed ``Assessment of Department of Defense Basic Research'' concluded that the DoD is managing its basic research program effectively.

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COST: (Dollars in Thousands)

Project Number & Title	FY 2005 Actual	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
DEFENSE RESEARCH SCIENCES	362,122	346,448	366,649	377,950	389,595	397,686	406,632

A. MISSION DESCRIPTION AND BUDGET ITEM JUSTIFICATION: This project 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. Additionally, it exploits scientific breakthroughs and provides options for new Future Naval Capabilities (FNCs) and Innovative Naval Prototypes (INPs). It responds to S&T directions of the DON Naval Power 21 (NP21) Transformational Roadmap, and Chief of Naval Operations (CNO) N70 Mission Capability Package (MCP) requirements for long term Navy and Marine Corps improvements. Defense Research Sciences 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 (JCS) 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 D&I with Exploitation and Delivery". DON basic research is the core of D&I. It includes scientific study and experimentation directed toward increasing knowledge and understanding in national-security related aspects of physical, engineering, environmental and life sciences. Basic research efforts are developed, managed, and related to more advanced aspects of research in some hundred-plus technology and capability-related 'thrusts', which are consolidated in fifteen 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, weapons systems for naval forces, 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

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research: Naval Battlespace Awareness, Electric Power Sources for the Navy and Marine Corps, Naval Materials by Design, and Multifunctional Electronics for Intelligent Naval Sensors. Key aspects also include 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 FY99), Underwater Weaponry (started FY02), and Naval Engineering (started in FY03). The basic research portfolio can be represented in three segments of emphasis identified as naval unique, participation, and harvest. Naval unique defines a category where the S&T is important to naval operations and largely undertaken only by the DON. It includes the NNR areas. Participation refers to S&T elements vital to naval operations, and naval investment can leverage funding sources other than DON such as airborne radars, communications and networks, materials sciences, and advanced energetic materials. Harvest defines cross cutting areas of science and engineering with potential to generate unanticipated naval capabilities or savings, and which DON should nurture such as nanoscience (potential new material properties) and the behavioral sciences.

B. ACCOMPLISHMENTS/PLANNED PROGRAM:

	FY 2005	FY 2006	FY 2007
AIR, GROUND AND SEA VEHICLES	22,624	22,025	24,988

Efforts include: Surface/subsurface reduced signatures; free-surface, subsurface, and propulsor hydromechanics; hull life assurance; advanced ship concepts; distributed intelligence for automated survivability; advanced electrical power systems; air vehicles; air platforms propulsion and power; air platforms survivability and signature control; special aviation projects; Unmanned Air Vehicle/Unmanned Combat Air Vehicle (UAV/UCAV); environmental quality; and logistics. Accomplishments and plans described below are examples for each effort category. Starting in FY 05, resources were realigned from this activity to fund Counter IED efforts in support of the Global War on Terrorism.

FY 2005 Accomplishments:

Air Vehicles
• Continued investigations into controlled initiation and recovery from aggressive non-linear aero-maneuvers conducted by unmanned air vehicles.
• Completed exploration of communications and control concepts for autonomous collaboration between unmanned helicopters.

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Ship Concepts and Hydrodynamics
• Continued the computational and experimental study of Coanda (fluid flow along surfaces) Flows.
• Continued development of reliable sea-keeping prediction methods for advanced surface ship hull forms in heavy seas.
• Continued nonlinear seakeeping code for structural loading of multi-hulls.
• Continued modeling of two-way, unsteady, non-spherical bubble/vortical flow interaction and resulting acoustics.
• Continued modeling and optimization techniques for Naval design of multi-hulls, optimal functional arrangements for both ship and submarine design, and optimization for semi-displacement craft.
• Continued hydrodynamic analysis of fast multi-hull ships.
• Continued Reynolds Averaged Navier-Stokes (RANS) predictions of surface ship motion for high speeds.
• Continued validating a breaking wave prediction method against experimental data.
• Continued development of unsteady field pressure measurement technique using Particle Image Velocimetry (PIV).
• Continued vortex/vortex interaction experiments to understand the tip gap cavitation inception physics.
• Continued expanding nationwide distribution of small underwater remotely operated vehicles for hands-on instruction of Naval Engineering principles at high schools.
• Continued implementation of a nationwide program to educate high school guidance counselors on Naval engineering career opportunities.
• Completed detailed measurements of total wave field and resulting ship motions using new instrumentation.
• Completed wind tunnel experiments to characterize unsteady tip-gap flow in turbomachinery.
• Completed development of LES method for unsteady propulsor tip-gap flow predictions.
• Completed Database efforts for multi-hull and monohull small craft with transfer of two dimensional (2D) body plans into 3D computer aided design (CAD) models.
• Completed application of validated optimization procedure for ducted propellers and podded propellers to design analysis tools.
• Completed transition of Unified Test Environment/Technical Identification, Evaluation System (UTE/TIES) design methodology for application on Submarine Synthesis Tool.
• Initiated investigation of the use of Large-Eddy Simulation (LES) for acoustic prediction.
• Initiated comprehensive Laser-Doppler Velocimetry (LDV) development for unsteady propulsor gap flow characterization.
• Initiated development of modeling of highly unsteady separated flow around ducted propulsor using Large-Eddy Simulation (LES).

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• Initiated and completed quantification and modeling of bubble sources around surface ships for prediction methods.
• Initiated modeling and experiments for roughness-wall boundary layer noise.
• Initiated holographic PIV system development for unsteady three dimensional (3D) turbo machinery flow.

Ship Signatures, Structures, and Materials
• Continued development of computational mechanics to provide predictive capabilities of acoustics, linear and nonlinear dynamic response and failure mechanisms of structures.
• Continued further examination of computational mechanics in order to address prediction of acoustic signatures in complex structures, modeling of structural failures and optimization, sensitivity analysis, and error control.
• Continued the structural performance of hybrid ship hulls and hybrid joints subject to sea loads and weapons effects for application to high speed, low signature vessels.
• Continued studies of the structural acoustics of anisotropic propulsion ducts.
• Continued modeling of alternating current sources and propagation.
• Continued evaluating the mechanical behavior of elastomeric coatings and their effects on fracture and failure under extreme dynamic loading.
• Completed study of ductile fracture in naval steels from materials issues through ship sections including ongoing modeling efforts.
• Completed an analytical extension of radiation from elastic duct structures using a rational function approximation.
• Completed initial development of an energy finite element capability for modeling hull flow noise.
• Completed evaluating electromagnetic signature basic physics to further understand low observable and infrared (IR) technology performance against evolving threats.
• Initiated PIV/LDV studies of multiphase bubble flows and interaction with elastic plates in a small quiet water tunnel.
• Initiated pod/hull acoustic interaction measurements at small scale using 3D acoustic holography.
• Initiated power flow inversion methods for complex surface ship structures.
• Initiated LDV of scaling effects studies of unsteady elastic duct and propulsor interaction in a wind tunnel.
• Initiated concept for photonic band gap waveguide.

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Ship and Air Platform Machinery and Systems
• Continued efforts to understand and control the generation and propagation of far-field jet noise.
• Continued evaluation of stability and control of electrical power systems.
• Continued development of advanced magnetocaloric materials for magnetic refrigeration.
• Continued seabasing effort for an Advanced Logistics Delivery System including new technologies for gliders and ship launching methods.
• Completed studies of thermoelectric material requirements for shipboard cooling applications.
• Completed efforts to design and test stability and control mechanisms for power distribution in nonlinear circuits.
• Completed scientific approaches to alternate heat transfer and cooling methodologies.
• Completed examination of turbomachinery flow using holographic PIV.
• Completed validating LES predictions of turbomachinery flow against experimental data.
• Completed integrating distributed heterogeneous control simulation capability into the overall control system simulation infrastructure.
• Completed testing and evaluating control system algorithms and strategies in a virtual environment including affordability issues.
• Completed half and full-scale engine testing of most promising on-board noise reduction technologies (e.g. air/water injection).

FY 2006 Plans:

Air Vehicles
• Continue all efforts of FY 2005 less those noted as completed above.
• Initiate university research in rotorcraft technology areas such as multi-tilt rotor aeromechanics (i.e., flying quality maneuverability/expansion/development/structural modes, autonomous rotorcraft operations in shipboard environment, etc.), active rotor control for enhanced ship board operations, autonomous rotorcraft operations in shipboard environment, and innovative rotor design concepts for naval applications.

Ship Concepts and Hydrodynamics
• Continue all efforts of FY 2005 less those noted as completed above.
• Complete the computational and experimental study of Coanda flows.
• Complete comprehensive LDV development for unsteady propulsor gap flow characterization.
• Complete modeling of two-way, unsteady, non-spherical bubble/vertical flow interaction and resulting acoustics.

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES
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• Complete validating a breaking wave prediction method against experimental data.
• Complete efforts in nonlinear seakeeping code for structural loading of multi-hulls.
• Complete vortex/vortex interaction experiments to understand the tip gap cavitation inception physics.
• Complete development of unsteady field pressure measurement technique using PIV.
• Initiate the investigation of the effect of roughness on turbulent boundary layers.
• Initiate modeling of two-phase flow using LES method.
• Initiate and complete validation of panel-code prediction of nonlinear waves and capsize using model scale data.
• Initiate and complete validation of prediction methods for bubble sources around surface ships.
• Initiate and complete validation of RANS predictions of surface ship motion in pitch and heave.
• Initiate further examination of computational mechanics to address prediction of acoustic signatures in complex structures, modeling of structural failures and optimization, sensitivity analysis and error control.

Ship Signatures, Structures, and Materials
• Continue all efforts of FY 2005 less those noted as completed above.
• Complete efforts in modeling of ductile fracture in Naval steels.
• Initiate application of an energy finite element capability for modeling flow noise to waterjets and pods
• Initiate new concepts to enable Sea Basing

Ship and Air Platform Machinery and Systems
• Continue all efforts of FY 2005 less those noted as completed above.
• Complete efforts in seabasing for an Advanced Logistics Delivery System.
• Initiate development of control capabilities and distributed intelligence strategies for shipboard systems.
• Initiate integration of distributed heterogeneous control simulation capability into the overall control system simulation infrastructure.
• Initiate test and evaluation of control system algorithms and strategies in a virtual environment including affordability issues.

FY 2007 Plans:

Air Vehicles
• Continue all efforts of FY 2006 less those noted as completed above.

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES
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• Focus university research in rotorcraft technology areas such as tilt rotor aeromechanics, rotor flow field/ship air wake coupling during shipboard operations, flight simulation of advanced ducted fan air vehicles, active rotor control for enhanced ship board operations, autonomous rotorcraft operations in shipboard environment, and innovative rotor design concepts for naval applications.

Ship Concepts and Hydrodynamics
• Continue all efforts of FY 2006 less those noted as completed above.
• Complete modeling and experiments for roughness-wall boundary layer noise.
• Complete nonlinear seakeeping code for structural loading of multi-hulls.
• Complete RANS predictions of surface ship motion for high speeds.
• Complete development of modeling of highly unsteady separated flow around ducted propulsor using LES.
• Complete holographic PIV system development for unsteady 3D turbo machinery flow.
• Initiate and complete validation of six degrees of freedom (6DOF) RANS for surface ship motions (without capsize).
• Initiate and complete validation of prediction of ship wave breaking and bubbly flow at full scale.
• Initiate study to determine most promising foul-release approaches based on silicones to meet Navy durability requirements for further development and testing.
• Initiate half and full-scale engine testing of most promising on-board noise reduction technologies (e.g. air/water injection).

Ship Signatures, Structures, and Materials
• Continue all efforts of FY 2006 less those noted as completed above.

Ship and Air Platform Machinery and Systems
• Continue all efforts of FY 2006 less those noted as completed above.

	FY 2005	FY 2006	FY 2007
ATMOSPHERE AND SPACE SCIENCES	38,859	22,291	18,709

Efforts include: Marine Meteorology and Prediction; High Frequency Active Auroral Research Program (HAARP) and Space Sciences. Accomplishments and plans described below are examples for each effort category. Starting in FY 05, resources were realigned from this activity to fund Counter IED efforts in support of the Global War on Terrorism.

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Decrease in funding from FY 2005 to FY 2006 is due to HAARP program completion.

FY 2005 Accomplishments:

Marine Meteorology and Prediction
• Continued analysis of results from major field projects on air-sea interaction and transition improvements into applied research to improve the treatment of fluxes in coupled atmosphere-ocean prediction systems.
• Continued the development of next-generation ocean-atmosphere coupled models.
• Continued effort to investigate and better understand the bulk exchanges, aerosol-cloud interaction, and physical processes that take place at the atmospheric boundary layer interface. (Includes NRL investment/performance in this effort.)
• Continued theoretical and observational effort to improve understanding of the fundamental dynamics of mountain waves, including generation, propagation, nonlinear interaction, and wave breaking. (Includes NRL investment/performance in this effort.)
• Continued effort to gain a fundamental understanding of the flow-dependent limits of predictability by combining research in data assimilation and atmospheric instability. (Includes NRL investment/performance in this effort.)
• Completed a major field experiment to investigate air-sea interface processes and better understand the exchanges of heat, moisture and momentum between the ocean and atmosphere; results have led to applied research to improve the treatment of these fluxes in coupled atmosphere-ocean prediction systems.
• Completed field experiments in aerosol-cloud-radiation interaction (with emphasis on sea spray and desert dust aerosols) that improved the understanding of the absorption and scattering of visible and infrared radiation in the atmosphere.
• Initiated investigation into the near-earth environmental effects on electromagnetic propagation. (NRL)

High Frequency Active Auroral Research Program (HAARP)
• Completed improvements in the performance of the HAARP Facility with the installation of transmitters.

Space Sciences
• Continued calibration/validation of meteorological satellite wind (WindSat) polarimetric passive microwave data, and developed the version 1 of the WindSat wind vector retrieval algorithm. WindSat wind vectors have been released to the science community for evaluation. (NRL)
• Continued effort to exploit the polarametric aspect of WindSat for non-ocean surface wind vector Meteorological and Oceanographic Command (METOC) retrievals. Effort this year focused on soil moisture and sea

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ice. (NRL)
• Continued the development of 3D magneto-hydrodynamic code for simulations of solar filament eruptions leading to flare and coronal mass ejection (CME) activity. (NRL)
• Continued studies of the major October-November 2003 solar activity events and the associated effects on the near-Earth space environment. (NRL)
• Continued effort to improve understanding of tropospheric and stratospheric bulk exchanges through observations and modeling. Effort this year focused on finding individual thunderstorm cells spawned by forest fires (pyro-cumulonimbus clouds) which have injected material into the stratosphere. (NRL)
• Completed development of a new model on the evolving shock geometry and seed particle population in solar flare/coronal mass ejection events to explain the variability in high-energy solar particle events at the Earth. (NRL)
• Completed expansion of modeling of the near-Earth space environment with the development a self-consistent coupled model of the solar wind/magnetosphere/ionosphere system. (NRL)
• Completed evaluating/developing techniques for remediation of nuclear-enhanced radiation belts using amplification induced whistler waves or turbulent plasma created by ionizable chemical release. (NRL)
• Initiated assessment of advanced techniques and algorithms for remote sensing of ocean and atmospheric properties including winds, waves, currents, and surface topography.

FY 2006 Plans:

Marine Meteorology and Prediction
• Continue all efforts of FY 2005 less those noted as completed above.
• Complete validation of environmental data and models used by S&T community to ensure reliability and realistic depiction of actual ocean and atmospheric conditions.
• Initiate investigation of sub-grid-scale processes that influence marine boundary layer turbulence, aerosol production and removal, and marine stratocumulus cloud and drizzle formation and dissipation with the goal of improving the predictability of these phenomena in high-resolution mesoscale prediction systems.
• Initiate investigation of Western Pacific tropical cyclone dynamics in order to improve the predictability of storm genesis, structure and intensity changes, radii of maximum winds and effects on sea surface waves.
• Initiate investigation of the effects of radioactively important aerosols on cloud dynamics and thermal structure of the lower atmosphere for the purpose of improving the treatment of these processes in numerical weather prediction models.
• Initiate effort to assimilate WindSat wind vector, Ozone Mapping and Profiler Suite (OMPS) ozone profiles, and Global Positioning System (GPS) temperature and water vapor profile retrievals into NOGAPS (Navy

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Operational Prediction System). (NRL)
• Initiate effort to derive sea foam coverage from WindSat and to use this information in microphysical aerosol models to derive marine optical properties. (NRL)

Space Sciences
• Continue all efforts of FY 2005 less those noted as completed above.
• Initiate assessment of advanced improvements to specification and prediction of the space environment to improve space system performance and their on-call availability. (Includes NRL investment/performance in this effort.)
• Initiate assessment of advanced techniques and algorithms for remote sensing of ocean and atmospheric properties including winds, waves, currents, and surface topography.
• Initiate assessment of advanced improvements to specification and prediction of the space environment to improve space system performance and their on-call availability. (Includes NRL investment/performance in this effort.)
• Initiate development and evaluation of techniques for remote sensing of upper atmosphere phenomena including neutral density, winds and bulk exchange cycles. (NRL)

FY 2007 Plans:

Marine Meteorology and Prediction
• Continue all efforts of FY 2006 less those noted as completed above.
• Initiate assessment of the status of aerosol observation, prediction, and understanding for use in slant-range visibility and electro-optical performance prediction models.

Space Sciences
• Continue all efforts of FY 2006 less those noted as completed above.
• Initiate program to develop advanced improvements to specification and prediction of the space environment to improve space system performance and their on-call availability.
• Initiate monitoring of other-agency efforts for Naval Harvest of advanced techniques and algorithms for remote sensing of ocean and atmospheric properties including winds, waves, currents, and surface topography.
• Initiate a focused program to develop a predictive, operational capability for the onset and evolution of equatorial spread-F that limits space-based communications and navigation capabilities. (NRL)

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• Initiate a program to use large high frequency/very high frequency (HF/VHF) arrays to investigate fine scale ionospheric phenomena with associated improvements in ionospheric modeling and the performance of current and future DoD capabilities impacted by ionospheric disturbances. (NRL)

	FY 2005	FY 2006	FY 2007
COUNTER IMPROVISED EXPLOSIVE DEVICE (IED) SCIENCES	14,214	22,108	20,614

The ONR Basic Research Counter IED program seeks to develop innovative scientific concepts that will form the foundation for future technologies that may be developed and implemented to efficiently and effectively address the IED threat. The effort will emphasize fundamental scientific concepts that can be applied to the detection, neutralization, destruction and mitigation of the effects of these devices and to advance prediction of the occurrence or potential occurrence of IED events. The program also seeks to establish and nurture a multi-disciplinary counter-IED Science and Technology community of Government, academic and industry researchers to accelerate the transition of new science and technology into fielded systems.

Funds were realigned from other activities to fund these efforts described below.

FY 2005 Accomplishments:

• Completed development of new tissue simulants and modeling capabilities that simulate bio-tissue for GelMan surrogate human thorax models used to measure blast wave effects and evaluate personnel protection systems from blast weapons including conventional, enhanced blast devices and IEDs. (NRL)
• Continued computational fluid dynamics (CFD) CT-Analyst technology that provides a sensitive operational-quality capability to backtrack airborne detections of the chemical signatures and taggants of explosives instantly to their source. (NRL)
• Continued reactive flow dynamics study of multiphase reactive flow modeling and simulation that can be applied to investigate mitigation strategies to counter the IED threat. (NRL)
• Continued laboratory-on-a-chip studies of molecular dynamics and recognition including complex, integrated separations performed on a rapid timescale for DoD target analyses such as toxic industrial chemicals and chemical warfare agents which may be used in IEDs. (NRL)
• Continued flame suppression mechanism investigation of additives to fine water mist to provide the scientific basis to guide search for suitable fine water mist based fire suppression strategies for DOD platforms, and to mitigate explosive blast effects. (NRL)
• Continued solid hybrid nanoporous materials investigation to develop robust biosensors, reactive filters,

and high capacity sorbents to detect/defeat improvised weapons. (NRL)
• Continued investigating neutron-sensitive glass materials for remote radiation sensing to develop novel approaches for detection of radiological threats: special nuclear materials, dirty bombs, IEDs. (NRL)
• Initiated effort in the area of Prediction to develop theoretical and technical approaches that permit prediction and analysis of IED emplacement as well as the assembly of IEDs. This included recognition of emplacement patterns, human activity recognition from video and other sensing systems, human intelligence and social network analysis of terrorist networks, modeling and simulation of the full spectrum of IED activities, analysis of communications, and knowledge management systems to combine diverse data sources.
• Initiated effort in the area of Detection to develop concepts that would permit stand-off detection and localization of the explosive, the case materials, the environment in which the device is located, and other components of the IED.
• Initiated effort in the area of Neutralization to develop scientific concepts that may be applied to remotely render an IED ineffective without necessarily having to detect or destroy it.
• Initiated effort in the area of Destruction to develop scientific concepts that may be applied to quickly and remotely destroy IEDs without necessarily having to detect them.
• Initiated effort in the area of Mitigation to develop scientific concepts that may be applied to protect people and/or equipment from the destructive effects of an IED that may be detonated.
• Initiated the study of radar for active detection of suicide bombers. (NRL)
• Initiated exploration into advanced microarchitectures for bioprocessing and sensing to develop and characterize cellular microarrays expressing G-protein coupled receptors (GPCRs) and other proteins as targets for environmental detection. (NRL)
• Initiated the study of molecular motions & physical properties under stress to develop better elastomers for applications of flexible materials (blast resistant coatings, sonar domes, appliqués). (NRL)
• Initiated studies of the fundamental issues in processing of quartz-crystal microbalance arrays directed to making micro-arrays of quartz crystals, each working at different frequencies. (NRL)

FY 2006 Plans:

• Continue all efforts of FY 2005 less those noted as completed above.
• Initiate investigation and development of nonlinear methods to more effectively describe and analyze hyperspectral and multi-sensor data to improve characterization using nonlinear (manifold) methods. (NRL)
• Initiate activities to devise and demonstrate chemical templates for assembling/ positioning nanoclusters and nanowire leads with nanometer precision to better understand the chemical & biochemical assembly of nanocluster-based electronics/sensors. Investigate ultra-fine electroless deposition for forming electrical

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leads. Explore early applications to single-electron devices and high-sensitivity sensors. (NRL)
• Initiate study of metal nanoparticles for insensitive munitions (IM) with high energy density and low sensitivity to hazardous conditions, operational environment and countermeasures. (NRL)
• Initiate development of rapid identification of biological aerosols, a novel method that allows specific biological aerosols to be identified within a background of others and that can fulfill the criteria of continuous sampling, real time performance, use of a small amount of consumables, and portability. (NRL)
• Initiate a systems biology approach for the interrogation of marine microorganisms to describe and predict the functioning of an entire marine bacterial system in response to certain stimuli which will provide the ability to comprehensively model and manipulate microbiological systems for the development of next generation sensors for biological, chemical and explosive agent detection. (NRL)
• Initiate synthetic nanopores for single molecule identification to demonstrate a novel synthetic-nanopore-based strategy for real-time, label-free, single molecule detection of chemical and biological threats. (NRL)

FY 2007 Plans:

• Continue all efforts of FY 2006 less those noted as completed above.

	FY 2005	FY 2006	FY 2007
HUMAN SYSTEMS	7,062	7,960	8,181

Efforts include: human factors and organizational design; manpower, personnel, and training; integrated avionics, displays, and advanced cockpit; and pattern recognition.

FY 2005 Accomplishments:

• Continued study of social networks for counterterrorism.
• Continued research on how people represent and understand uncertainty.
• Continued studies of the interaction of auditory and visual displays.
• Continued expansion of cognitive architectural modeling capability to increase coverage, including spatial reasoning, multi-tasking, impact of physiological and stress variables, etc.
• Continued research on human cognition and performance to create more realistic simulations for training.
• Continued program to combine cognitive architectures with computational neuroscience to better predict human performance.
• Continued development of novel multidisciplinary approaches to human-activity inference from video imagery

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to enable force protection and counterterrorism.
• Continued program on implantable electronics for performance enhancement.
• Continued studies of hierarchical, cellular, and hybrid organization structures for command and control.
• Continued schema theory applications to multi-echelon command decision making.
• Continued investment in natural language interaction capability for artificially intelligent training systems.
• Completed study of retinal information processing and modeling environments.
• Initiated study of neuro-control of Unmanned Underwater Vehicles (UUVs) and active vision and cognitive navigation skills in mobile robots.
• Initiated investigations to support new missions for Expeditionary Strike Groups in three areas: 1) analysis and diagnosis of Command and Control Organizational structures; 2) effects-based operations and development of reach-back capability for course of actions analysis; and 3) decision support systems for management of Battle Rhythm.
• Initiated social-science based computational toolsets for terror network analysis at PACOM'S Joint Intelligence Center and on the USS TARAWA (LHA-1) to support Expeditionary Strike Group One in the Global War on Terrorism.

FY 2006 Plans:

• Continue all efforts of FY 2005 except those noted as completed above.
• Complete research on how people represent and understand uncertainty.
• Complete studies of attention management in multi-tasking.

FY 2007 Plans:

• Continue all efforts of FY 2006 except those noted as completed above.
• Complete studies of the interaction of auditory and visual displays.
• Complete development of novel multidisciplinary approaches to human-activity inference from video imagery to enable force protection and counterterrorism.
• Complete expansions to cognitive models to include spatial reasoning.
• Initiate computational and agent-base modeling and experimentation to explore options for Effects-Based Operations.

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• Initiate models of operational decision making for component commanders of an Expeditionary Strike Group with special emphasis on elaboration and planning knowledge.

	FY 2005	FY 2006	FY 2007
INFORMATION SCIENCES	22,318	22,279	22,670

Efforts include: Computational theory and tools for design, communication, and control of intelligent autonomous systems; decision theory, algorithms, and tools; heterogeneous information integration, management, and presentation; information assurance, secure and reliable information infrastructure for Command and Control; mathematical optimization for optimal resource allocation and usage; modeling and computation of complex physical phenomena; modeling and computation for electromagnetic and acoustic wave propagation and scattering; seamless, robust connectivity and networking; and expeditionary operations Command, Control, Communications, Computers Intelligence Surveillance and Reconnaissance (C4ISR). Starting in FY 05, resources were realigned from this activity to fund Counter IED efforts in support of the Global War on Terrorism.

FY 2005 Accomplishments:

• Continued development of mathematical optimization framework and heuristic algorithms that serve as theoretical and computational basis for network design, optimal sensor allocation, and logistics.
• Continued development of improved tactical and battlespace decision aids through creation of synthetic natural environments.
• Continued to refine techniques for extracting maximum knowledge from multi-modal imagery, text, and electromagnetic signal data.
• Continued 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.
• Continued efforts for enabling teams of autonomous systems to work together and work on representations for evolution of cooperative behaviors, including efforts in multi-modal interactions with autonomous systems.
• Continued developing framework for dealing with effect of variable latencies in communication within teams of humans and autonomous systems.
• Continued efforts on development of mathematical foundations for image enhancement, feature extraction, feature-based/texture-based compression, denoising, and segmentation; data representation and metrics, content-based indexing and retrieval; reconstruction, interpolation, and registration; and scene analysis and image understanding.

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- Continued efforts on quantum computing and cryptography.
- Continued efforts on general automated theorem prover technologies and biometric technologies for authentication.
- Continued efforts in multi-modal dialog.
- Continued efforts in physics-based modeling of natural phenomena.
- Continued efforts in mathematical techniques for inverse problems, including reliable approximate solutions in 3D; adequate representation of the physics of the media and the scatterer; and improved resolution of structural and material properties.
- Continued efforts in extended augmented/virtual reality with haptics, sound, and olfactory components.
- Continued development of technology for maximizing information delivery in tactical networks via encoding information under speech. (NRL)
- Continued development of technology for improving behavior of coordinated teams of autonomous systems. (NRL)
- Continued the development of technology to improve tactical wireless ad hoc networks via development of cross-layer design approaches. (NRL)
- Completed efforts on modeling chaotic phenomena in network operations.
- Completed efforts for integrating domain knowledge into learning methods.
- Completed efforts for semantic-based information gathering.
- Completed refinement of theory and algorithms for autonomous systems to recognize a particular scene from different perspectives.
- Completed refinement of turbo-codes and iterative processing techniques to enable high data rates for wireless communication applications.
- Completed development of adaptive routing protocols to select the links for routing information packets that maximize communication network throughput with minimum energy consumption.
- Completed investigation of Extremely Low Frequency modulation and efficiency improvements and magnetospheric propagation.
- Completed development of computational framework for integrating information of disparate sources - Program Decision Memorandum for University Research - Surveillance & Knowledge Systems.
- Completed development of a systematic approach that will serve as a theoretical and computation basis for automated image understanding and automatic object recognition.
- Completed refinement of techniques for ensuring privacy of information transferred across public networks.
- Completed collaborative mission planning tools to facilitate knowledge sharing and management, regulation of information flow, and work-process monitoring.
- Completed development of technology for the automated construction of high assurance software. (NRL)

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FY 2006 Plans:

- Continue all efforts of FY 2005 less those noted as completed above.
- Complete efforts in extended augmented/virtual reality with haptics, sound, and olfactory components.
- Complete development of technology for increasing efficiency of tactical wireless networks based on fundamental invariants for random-access protocols. (NRL)
- Initiate development of technology to re-engineer legacy code. (NRL)
- Initiate development of technology to improve analysis of distributed systems. (NRL)

FY 2007 Plans:

- Continue all efforts of FY 2006 less those noted as completed above.
- Complete the development of technology to improve tactical wireless ad hoc networks via development of cross-layer design approaches. (NRL)
- Initiate development of technology for improved network management of wireless networks. (NRL)

	FY 2005	FY 2006	FY 2007
MATERIALS/PROCESSES	66,104	64,175	75,871

Efforts include: Structural materials; functional materials; maintenance reduction; Energy Generation, Conversion, and Storage; and Environmental Sciences. Accomplishments and plans described below are examples for each effort category. Starting in FY 05, resources were realigned from this activity to fund Counter IED efforts in support of the Global War on Terrorism.

FY 2005 Accomplishments:

Structural Materials
- Continued development of physics-based models of thermal and materials flow during friction stir welding of steels, including the development of residual stresses that will lead to distortion.
- Continued development of first-principles based methodologies for predicting the thermodynamics and kinetics controlling microstructural evolution for the design of advanced weldable, naval steels.
- Continued design, synthesis, and optimization welding consumables and process methodologies for joining superaustenitic stainless steels.

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- Continued development of understanding and constitutive models of dynamic behavior of naval steels.
- Continued development of physics-based constitutive models of fatigue evolution in naval alloys.
- Continued development of theoretical basis for composite materials behavior based on x-ray computed micro-tomography.
- Continued development of pultruded sandwich structures for improved mechanical characteristics and lower cost for Naval applications.
- Continued investigation of continuous growth of single and multi-wall nanotubes for next generation polymer matrix composite materials.
- Continued development of hybrid composites incorporating glass fibers and high strength steel fibers for joining application.
- Continued exploration of superplasticity in advanced high strain nanometer scale ceramic composites to provide the basis for the development of such materials in Naval applications.
- Continued to advance the understanding of deformation mechanisms in nanometer scale aluminum and steels to provide new high strength-high toughness alloys for Naval platforms.
- Continued development of models and simulations to understand and predict high deformation rate blast behavior for engineered topological structures.
- Continued development of materials and fabrication science for fugitive phase processes for engineered topological structures for ship blast protection.
- Continued development of understanding linking complex reaction paths and atomic diffusion in the formation of environmental and diffusion barrier coatings for high temperature thermal and environmental barrier coatings.
- Continued development of understanding and enhancing the dynamic response (constitutive behavior, failure) for marine composites and sandwich structures.
- Continued development of nanocomposites for enhancing mechanical properties of marine composites.
- Continued investigation of the role of hydrogen and nitrogen on mechanical properties of titanium alloys. (NRL)
- Continued studies on microstructure, mechanical, fatigue crack growth, and corrosion properties of friction stir welded Aluminum 5456. (NRL)
- Continued research on first-principles and experimental data to develop iron-nickel (Fe-Ni) atomistic potentials which will be used in the study of austenitic steels, currently we can show that Ni segregates on high Sigma grain boundaries. (NRL)
- Completed the development of a unified driving force for fatigue crack growth model and verified for alloy steel via laboratory studies. (NRL)
- Initiated evaluation of new high temperature resin for potential Unmanned Combat Air System (UCAS) high

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temperature composite applications.
• Initiated research tools design efforts in dynamic three dimensional control of structures.
• Initiated investigation of joining dissimilar ceramics and sintering of light metal composites. (NRL)

Functional Materials
• Continued extension of first principle calculations of sonar materials tensor piezoelectric and dielectric properties to complex solid solutions to provide the basic understanding and predictive capability for ultra high strain materials.
• Continued development of a theoretical model that describes coherent multiexciton generation by one photon in PbSe and PbS nanocrystals for new solar cells. (NRL)
• Continued studies on the electron doped cuprate superconductors (Nd2-xCexCuO4 and Pr2-xCexCuO4) by temperature dependent polarized electronic Raman spectroscopy across a wide region of the doping (Cerium) phase diagram. (NRL)
• Completed the synthesis of cadmium selenide (CdSe) and cadmium telluride (CdTe) nanorods as potential “nano-diode” devices. (NRL)
• Completed the development of polynorborene which surpasses the blast resistance of polyurea. (NRL)
• Completed the Autonomic Fire Suppression Engineering Development Model (AFSS-EDM). (NRL)
• Completed the development of prototype biofilm power generator with demonstrated current density of greater than 10 microamps per square centimeter. (NRL)
• Completed development of new thermal dip pen nanolithography method and instrumentation. (NRL)
• Completed development of a predictive model of infrared, Raman and optical signatures of a large ensemble of metastable B10C2 clusters as a function of gas-phase plasma temperature. (NRL)
• Initiated research tools design efforts in electromagnetic and acoustic bandgap materials and other functional materials.
• Initiated a project for the determination of a critical structural phase transition in a new class of superconducting materials. (NRL)
• Initiated a theoretical study on a variety of novel superconductors where superconductivity coexists with magnetism or spin fluctuations. (NRL)
• Initiated construction of a unique facility for exploring static electrical contact phenomena consisting of a servohydraulic load frame with an insulated load train. This equipment will enable studies on transmission of electrical current across dissimilar metal interfaces at extreme pressures and current densities beyond those investigated before. (NRL)

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• Initiated studies on dielectric breakdown strength of ferroelectric glass-ceramics to show that it is an order of magnitude higher than conventional ceramic dielectrics while maintaining high dielectric constant. (NRL)

Maintenance Reduction
• Continued exploration of advanced coatings with multifunctional corrosion/fouling properties.
• Continued exploration of theoretical concepts for corrosion control.
• Continued to identify stress corrosion control methods for friction stir welded high-strength aluminum alloys using advanced thermal treatments, chemical modifications, and surface mechanical processes to tailor compressive stresses.
• Continued to develop the science of sliding contact and lubrication using physical and chemical first principles.
• Continued to explore transgranular crack tip damage mechanism in ultra high strength steels.
• Continued to investigate the use of photorefractive crystals for the demodulation of a distributed fiber optic Bragg gratings structural health monitoring system.
• Continued exploration of multienergy processes for zero maintenance coatings.
• Completed hydrogen embrittlement resistant high strength alloys based on nickel-cobalt-chrome-molybdenum material systems.
• Completed development of ultrasonic Lambwave Natural Frequency Focusing technology for crack and corrosion detection in ship tubes and pipes without the need of insulation removal.
• Continued investigation of continuous growth of single and multiwall nanotubes for next generation polymer matrix composite materials.
• Initiated first lubrication-by-design experiments.
• Initiated high temperature, low frictional sliding coefficient materials for elevated operating temperature gas turbine engine bearings.
• Initiated development of laser induced fluorescence for heat damage detection.
• Initiated development of a Giant Magnetoresistance (GMR) array Nondestructive Evaluation (NDE) system for detection of hidden cracks in Navy aircraft.
• Initiated development of an ultrasonic imaging camera for composite patch inspections.

Energy Generation, Conversion, and Storage
• Continued analyzing synchronization of 19 diode lasers to produce intense beams.
• Continued efforts in nanostructures, novel electrolytes, and electrode materials to enable new power sources, improve capacity of rechargeable lithium batteries, and fuel cells.

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- Continued work on developing the scientific basis of nanostructure enhancement of direct energy conversion materials performance for power generation.
- Continued exploration and development of materials for high energy density passive power electronics.
- Continued design of a thermoacoustic piezoelectric generator working via a temperature gradient.
- Continued expanding the fundamental understanding of direct electrochemical oxidation in solid oxide fuel cells and the use of logistic fuels.
- Continued expanding research into new materials and processes for converting thermal to electric energy such as identifying new high figure of merit thermoelectric materials.
- Continued identification of new approaches to efficiently transfer thermal, electrical and optical energy from primary sources.
- Initiated research tools design efforts in Chemical Dynamics and High Temperature Probes.

Environmental Sciences
- Continued examination of scientific methods for pollution prevention, waste reduction, and hazardous material reduction for Naval Operations.
- Continued assessment of the fate and effects of chemical and biological contaminants in marine/estuarine environments.
- Continued broad based program in anti-fouling and fouling release coatings including investigation of effect of fluorinated block co-polymers and novel testing methodologies for coating efficacy.
- Continued effort on pierside robotic hull fouling control/surveillance technologies.
- Continued emphasis on ultrafiltration membranes for bioreactors.
- Continued effort to determine most promising foul-release approaches based on silicones to meet Navy durability requirements.
- Completed conducting membrane research to correlate filtration efficiency with nano-fibrous membrane porosity, thickness, fiber diameter and chemical composition.
- Completed efforts to improve membrane materials for high-flux and low-fouling efficiency with proper composite design, chemical modifications and materials selection.
- Completed efforts to measure the mechanisms for fouling release and to compare the skin friction properties of conventional and fouling release ship hull coatings.
- Completed exploring low-energy laser induced incandescence schemes to avoid soot vaporization and extend light scattering measurements to soot burn-out regime.
- Completed developing bryozoans as new model organism used in assessment of coatings.
- Completed using hydrodynamic drag measurements to quantify force vs. speed on pseudo barnacles attachment to various surfaces.

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- Initiated research tools design efforts in sampling and analytical methodologies.

FY 2006 Plans:

Structural Materials
- Continue all efforts of FY 2005 less those noted as completed above.
- Complete design, synthesis and development of welding consumables and process methodologies for joining superaustenitic stainless steels.
- Complete development of pultruded sandwich structures for improved mechanical characteristics and lower cost for Naval applications.
- Initiate exploration into the processing and microstructures of novel titanium alloys that may be enabled by new co-reduction of mixed metallic oxide processes.
- Initiate exploration of microstructural evolution during solid-state joining and localized processing of weldments in titanium alloys for improved toughness and fatigue resistance.
- Initiate development of progressive damage models for blast effects on composite marine structures.
- Initiate research into dynamic slamming load effects on marine composites.

Functional Materials
- Continue all efforts of FY 2005 less those noted as completed above.
- Complete projects in 1) Nanofilaments: Interfacial Interactions, Manipulation and Assembly and 2) Half-Metallic Electronic Materials. (NRL)
- Complete protection of carbon nanotubes against oxidation at elevated temperatures and transition into other spin-off programs. (NRL)
- Initiate exploration and prediction of new sonar materials based on first principle methods.
- Initiate study of new transduction mechanisms.
- Initiate examination of the effects of acoustic perturbations and interactions in reacting flows and determine how they can be used. (NRL)
- Initiate investigation of radically new hierarchical polymer lenses that mimic the focusing of an eye. (NRL)
- Initiate single molecule binding detection using optical trap. (NRL)
- Initiate effort to fabricate extended 2-D left handed materials (LHM) structures. (NRL)

Maintenance Reduction
- Continue all efforts of FY 2005 less those noted as completed above.

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- Initiate development of corrosion models.
- Initiate mechanistic studies of materials deterioration under chemical environment for ship materials and their interfaces.
- Initiate testing of a statistically relevant number of combinatorial specimens to rank defects, microstructure and their interactions for fatigue crack initiation and growth. (NRL)

Energy Generation, Conversion, and Storage
- Continue all efforts of FY 2005 less those noted as completed above.

Environmental Sciences
- Continue all efforts of FY 2005 less those noted as completed above.

FY 2007 Plans:

Structural Materials
- Continue all efforts of FY 2006 less those noted as completed above.
- Complete the development of understanding of deformation mechanisms in nanometer scale aluminum and steels for new high strength-high toughness alloys for naval platforms.
- Complete efforts to understand links between complex reaction paths and atomic diffusion in the formation of environmental and diffusion barrier coatings for high temperature thermal and environmental barrier coatings.
- Complete analysis of dynamic response for marine composites and sandwich structures.
- Initiate investigation of a rapid annealing of surface layers and their effects. (NRL)
- Initiate quantification of the Corrosion effects on fatigue to be incorporated into the Unified Damage Model and validate in a few environmental case on P-3 aircraft real loads data.

Functional Materials
- Continue all efforts of FY 2006 less those noted as completed above.
- Complete development of first principle methods to calculate second and third rank tensor properties of sonar materials such as lead zirconate titanate and lead magnesium niobate.
- Complete the piezo electric fracture analysis with experimental and model for verification.
- Initiate synthesis and property measurement of new sonar materials predicted by first principle methods.

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Maintenance Reduction
- Continue all efforts of FY 2006 less those noted as completed above.
- Complete exploration of transgranular crack tip damage mechanism in ultra high strength steels.

Energy Generation, Conversion, and Storage
- Continue all efforts of FY 2006 less those noted as completed above.

Environmental Sciences
- Continue all efforts of FY 2006 less those noted as completed above.
- Complete efforts to increase strength in silicone based polymers for anti-fouling/friction reduction coatings.

	FY 2005	FY 2006	FY 2007
MEDICAL/BIOLOGY	14,332	12,870	14,729

Efforts include: biosensors, biomaterials, bioprocesses; marine mammals; casualty care and management; fit and healthy force; casualty prevention; biorobotics; expeditionary operations training and education; and chemical-biological defense. Accomplishments and plans described below are examples for each effort category. Starting in FY 05, resources were realigned from this activity to fund Counter IED efforts in support of the Global War on Terrorism.

FY 2005 Accomplishments:

Medical Sciences
- Continued research to understand individual variability in stress response.
- Continued non-lethal weapons bioeffects research.
- Continued work on stress physiology, hyperbaric physiology, and biological effects of Naval operational exposures (e.g., directed energy).
- Continued work on genomics/genetic immunization for infectious organisms of military relevance and signal transduction.

Biological Sciences
- Continued studies of effects of noise on marine mammal hearing and behavior.
- Continued studies on fate and effects of energetic and other organic compounds in marine environments.

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- Continued research on virus-based nanoarchitectures.
- Continued work on microbial synthesis of energetic materials.
- Continued research on biofouling and biocorrosion.
- Continued studies of marine mammal biomimetic/biorobotic systems.
- Continued efforts to develop next-generation and supramolecular antibiotics.
- Continued development of genetically encoded markers of signal transduction.
- Continued work to power naval ocean instruments with sediment biofuel cells.
- Completed work on crystallization of light-emitting algae.
- Completed development of novel genetic transformation tools for marine algae and seaweeds.
- Completed studies of marine mammal biorobotic systems.
- Initiated research to understand physiological effects of Naval sonar exposures on marine mammals.

FY 2006 Plans:

Medical Sciences
- Continue all efforts of FY 2005 less those noted as completed above.
- Complete studies on fate and effects of energetic and other organic compounds in marine environments.

Biological Sciences
- Continue all efforts of FY 2005 less those noted as completed above.
- Complete studies of marine mammal biomimetic/biorobotic systems.
- Initiate studies of toxicity of Royal Demolition Explosive (RDX), High Melting Point Explosive (HMX) and Dinitrotoluene (DNT) in marine benthos.
- Initiate dolphin microarray and gene-based studies to facilitate immunobiology studies of stress response.

FY 2007 Plans:

Medical Sciences
- Continue efforts of FY 2006 less those noted as completed above.

Biological Sciences
- Continue efforts of FY 2006 less those noted as completed above.
- Complete research on virus-based nanoarchitectures.

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	FY 2005	FY 2006	FY 2007
OCEAN SCIENCES	83,344	81,786	88,059

Efforts include: Littoral Geosciences, Optics, and Biology; Marine Mammals; Physical Oceanography and Prediction; Ocean Acoustics; and University National Oceanographic Laboratory System (UNOLS). Accomplishments and plans described below are examples for each effort category. Starting in FY 05, resources were realigned from this activity to fund Counter IED efforts in support of the Global War on Terrorism.

FY 2005 Accomplishments:

Littoral Geosciences, Optics, and Biology
• Continued field programs to understand 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.
• Continued effort to improve accuracy of the "5-cm gravimetric geoid" and precise geodesy. (NRL)
• Continued effort to understand and predict coastal dynamics in environments where significant sediment heterogeneity occurs, impacting on hydrodynamic and morphodynamic processes, including six week, April-May, field efforts off Cassino Beach, Brazil, subject to sudden, large muddy beach deposits. (NRL)
• Completed development of techniques to exploit hyperspectral data from a geostationary platform to better understand coastal ocean dynamics. (Includes NRL investment/performance in this effort.)
• Developed better understanding of the extent and intensity of seafloor gas hydrate accumulations and coastal bio-optical response to air-ocean forcing. (Includes NRL investment/performance in this effort.)
• Initiated effort to use time sequencing NRL PHILLS (Portable Hyperspectral Imager for Low-light Spectroscopy) images of the same scene to derive dynamical properties of the ocean surface. (NRL)
• Initiated effort to investigate the use of combining Light Detection and Ranging and passive hyperspectral sensing to derive bottom characteristics and water column optical properties over water and terrestrial vegetation and trafficability maps over land. (NRL)

Marine Mammals
• Continued field trials of an integrative ecosystem study to provide environmental predictors of whale presence or absence to reduce impacts of Naval systems to marine mammals.

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Physical Oceanography and Prediction
• Continued to develop state of the art numerical model assimilation and initialization techniques, improved physical parameterizations, air-sea interactions, and fidelity for atmospheric and ocean prediction systems. (Includes NRL investment/performance in this effort.)
• Continued extensive internal wave field program off the New Jersey Shelf; field work will coincide with and compliment the Shallow Water Acoustics Program.
• Completed pilot program on topographic induced mixing in the Aegean Sea.
• Completed a workshop assessing the state-of-knowledge of “Rogue Wave” dynamics and prediction.
• Completed field studies of the Kuroshio Intrusions into the Ryuku Islands.
• Initiated an assessment of the role of emerging sub-mesoscale parameterization techniques for improving next generation high resolution/high accuracy environmental models.
• Initiated design evaluation for a persistent mobile sampling network based on autonomous undersea vehicle platform and sensor technologies.
• Initiated extensive 3-year field program on prediction of internal waves; Spring FY 05 field work in the South China Sea collected unique data sets on extremely large internal waves, acoustics in internal wave fields, transmission loss, and dissipation in areas of internal wave breaking.
• Initiated first field test of the Optimal Deployment Dri (ODDAS) in the South China Sea.
• Initiated 5-year program on the analysis of coherent structures in rivers and estuaries in support of the prediction and characterization of denied areas.
• Initiated an understanding of the bio-optical response to dynamical forcing processes and how to assimilate optical properties into a physical ocean model for predictive purposes. (NRL)

Ocean Acoustics
• Continued development of numerical methods to predict the effects of the sub-surface bubble layer on underwater acoustics propagation and scattering. (Includes NRL investment/performance in this effort.)
• Continued to research effect of solitons and internal wave bores on acoustic propagation and buoyancy. (Includes NRL investment/performance in this effort.)
• Continued incorporation of stochastic parameters into underwater acoustic propagation models. (Includes NRL investment/performance in this effort.)
• Completed development of the coupled hydrodynamic-acoustic model for sound generation from breaking waves. (Includes NRL investment/performance in this effort.)
• Initiated development of an improved Nonlinear Progressive Wave Equation model for shallow water applications. (NRL)

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• Initiated comparison of numerical methods that predict effects of sub-surface bubble layers on acoustics to laboratory measurements. (NRL)

FY 2006 Plans:

Littoral Geosciences, Optics, and Biology
• Continue all efforts of FY 2005 less those noted as completed above.
• Initiate programs to estimate optical properties of coastal ocean water from above-surface sensing, using in-situ data for validation.

Marine Mammals
• Continue all efforts of FY 2005 less those noted as completed above.
• Initiate new efforts on tracking of marine mammals using data fusion based on tags and remote sensing.

Physical Oceanography and Prediction
• Continue all efforts of FY 2005 less those noted as completed above.
• Initiate field efforts for a persistent mobile sampling network based on autonomous undersea vehicle platform and sensor technologies.
• Initiate a field and modeling program to predict mesoscale structures and rapidly-varying currents in the Indonesian Archipelago using Synthetic Aperture Radar (SAR), Hyperspectral and other remote data together with new data assimilation methods.
• Initiate field programs that demonstrate “persistent monitoring and measurement of environmental structures using gliders.
• Initiate workshops to define science needs for Sea Basing.
• Initiate the field experiment in Monterey Bay to examine the role of unresolved processes in model parameterizations
• Initiate the development of breaking wave detection techniques using Hilbert transformation of the space-time series of surface waves and the capability of establishing empirical functions connecting wave breaking properties to the generation and entrainment of bubble clouds. (NRL)

Ocean Acoustics
• Continue all efforts of FY 2005 less those noted as completed above.
• Complete incorporation of stochastic parameters into underwater acoustic propagation models. (Includes NRL investment/performance in this effort.)

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• Complete research on effect of solitons and internal wave bores on acoustic propagation and buoyancy. (Includes NRL undersea warfare investment/performance in this effort.)
• Complete development and comparisons with data of numerical methods to predict effects of sub-surface bubble layers on acoustic propagation and scattering. (NRL)
• Initiate studies of adaptive beam-forming using mobile, autonomous sensors.
• Initiate numerical simulations to investigate the analogs of condensed matter physics phenomena in ocean acoustics. (NRL)
• Initiate development of realistic seismo-acoustic model for sediment geology. (NRL)
• Initiate investigation of acoustically induced magnetic fields using modern experimental equipment and numerical techniques. (NRL)
• Initiate development of source waveform design for rough littoral seafloors. (NRL)
• Initiate development of "time-reversal" characterization of bubble field dynamics. (NRL)
• Initiate modeling of uncertainty in pressure field due to sound speed field uncertainty for a canonical shallow water waveguide using polynomial chaos and Bayesian methods. (NRL)

Ocean Class Research Vessel- $4,000
• Initiate assessment of optimum hull forms for Ocean Class platform/craft oceanographic research mission.
• Initiate assessment of novel mission equipment options to ensure technology infusion.
• Initiate preliminary and detailed design studies of the selected hull form.
• Initiate a review and prioritize science mission requirements in conjunction with oceanographic research community and University National Oceanographic Laboratory System (UNOLS) members.
• Initiate program management.

FY 2007 Plans:

Littoral Geosciences, Optics, and Biology
• Continue all efforts of FY 2006.
• Initiate incorporation of improved understanding of tropospheric and stratospheric bulk exchanges, air-sea interface, boundary layer interface, coastal ocean dynamics, gas hydrate accumulation, and biological responses into atmospheric and ocean prediction models and tactical aids. (Includes NRL investment/performance in this effort.)

Marine Mammals
• Continue all efforts of FY 2006.

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES
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• Complete study of an integrative ecosystem study to provide environmental predictors of whale presence or absence to reduce impacts of Naval systems to marine mammals.

Physical Oceanography and Prediction
• Continue all efforts of FY 2006.
• Initiate a Coupled Oceanographic-Acoustics modeling and field program to demonstrate the use of a fully coupled system in optimizing tactical reduction of uncertainty.
• Initiate an integrated modeling and field experiment on determining custom self-learning wave databases and forecast systems/ship-movement and engineering systems for Sea Basing.
• Initiate the pilot test of the novel data (synthetic aperture radar and Hyperspectral) assimilation forecast system developed under Indonesian experiment.
• Initiate an Estuarine-Littoral Processes Interaction field study.

Ocean Acoustics
• Continue all efforts of FY 2006 less those noted as completed above.
• Complete development of the Nonlinear Progressive Wave Equation model. (NRL)
• Complete investigations of analogs of condensed matter physics phenomena in ocean acoustics. (NRL)
• Initiate assessment of “time-reversal” propagation techniques for mitigation of environmental variability.
• Initiate field work on adaptive beamforming using mobile, autonomous sensors.

	FY 2005	FY 2006	FY 2007
SCIENCE AND ENGINEERING EDUCATION, CAREER DEVELOPMENT AND OUTREACH	39,837	35,140	37,736

Science and Engineering Education and Career Development activities include DON participation in science fairs, summer research interns/fellows at Navy laboratories, graduate fellowships for individuals expected to become members of the engineering faculty at Historically Black Colleges and Universities and Minority Institutions (HBCU/MIs), and curricular enrichment programs. Outreach includes the encouragement, promotion, planning, coordination and administration of Naval Science and Technology. Starting in FY 05, resources were realigned from this activity to fund Counter IED efforts in support of the Global War on Terrorism.

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES
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FY 2005 Accomplishments:

- Continued awarding prizes at 400 regional high school science fairs and three national competitions.
- Continued supporting 230 students as summer research interns at Navy laboratories.
- Continued providing graduate fellowship support to nine HBCU engineering faculty candidates.
- Continued funding Young Investigator research grants including 28 new three-year research grants.
- Continued the encouragement, promotion, planning, coordination and administration of naval Science and Technology.

FY 2006 Plans:

- Continue all efforts of FY 2005.

FY 2007 Plans:

- Continue all efforts of FY 2006.

	FY 2005	FY 2006	FY 2007
SENSOR, ELECTRONICS AND ELECTRONIC WARFARE (EW)	46,063	47,312	45,454

Efforts include: Sensing, diagnostics, and detectors; navigation and timekeeping; nano-electronics; wide band gap power devices; real-time targeting; Electro-Optical/Infra Red (EO/IR) electronics; EO/IR electronic warfare; EO/IR sensors for surface/aerospace surveillance; Radio Frequency (RF) sensors for surface/aerospace surveillance; solid state electronics; vacuum electronics; Advanced Multi-Function RF System (AMRFS); and RF electronic warfare. Starting in FY 05, resources were realigned from this activity to fund Counter IED efforts in support of the Global War on Terrorism.

FY 2005 Accomplishments:

- Continued effort to incorporate non-equilibrium considerations into modeling of realistic superconducting tunnel junctions when barrier is near the metal/insulator transition.
- Continued to explore optical super resolution techniques with atmospheric turbulence reduction techniques.
- Continued investigation of temporal-spatial sampling circuits and architectures for digital-to-analog conversion.

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES
PROJECT TITLE: DEFENSE RESEARCH SCIENCES

- Continued to improve room temperature 4.5-4.8 micron quantum cascade laser by reducing emission wavelength and further increasing power to meet laser source requirements for infrared countermeasures against heat-seeking missiles.
- Continued advanced height finding and detection algorithms for high frequency radar.
- Continued project to develop linear higher power microwave wide bandgap semiconductor bipolar transistors based on distributed polarization effect (graded composition) base growth and processing technology.
- Continued the evaluation and assessment of hardware-compatible space-time algorithms for Digital Science Process Scenario (DSP) applications to Transmit/Receive (T/A) arrays.
- Continued comprehensive study of compressive and tensile strain patterned semiconductor quantum wells using micromachining. (NRL)
- Continued proof of principle demonstration of microcavity chemical sensor. (NRL)
- Continued invention of a new technique for micromachining quantum wells using InAlGaAs (Indium Aluminum Gallium Arsenide) barriers. (NRL)
- Continued achievement of >1% power conversion efficiency in an organic plastic solar cell based on C60 and a transparent hole transporter, and a conducting polymer electrode.
- Continued demonstration of mid-IR type-II "W" laser diodes with record external quantum efficiencies (49% at 78K). (NRL)
- Continued development of technique that suppressed the formation of “killer” GaSb (Gallium Antimonide) pyramid defects in antimonide superlattice growth. (NRL)
- Continued demonstration of optical coherence in mid-IR 2DDFB (Two Dimensional Distributed Feedback) lasers with record beam quality for very broad stripes - e.g., 4 times the diffraction limit at w = 400 microns. (NRL)
- Continued development of Adaptive Pulse Compression and Adaptive Pulse Compression Repair Algorithms, which unmask small targets in the presence of large targets and are vastly superior to conventional pulse-compression methods. (NRL)
- Continued efforts in radiation effects studies to determine suitability of electronic components for space application. (NRL)
- Continued the design and fabrication of high performance silicon oscillators.
- Continued creation of techniques for guiding and transporting cooled and trapped rubidium atoms through hollow waveguides. (NRL)
- Continued the knowledge base for multi-phase array space-time sampling demonstrating that the spectral band can be doubled at no cost in element density for the linear array and for 15% more elements in the planar case.
- Continued research to extend and implement Magnetic Resonance Elastography for low spin density materials.

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(NRL)
• Continued development of Nyquist limits for multi-phase array sampling in 4-D spacetime for linear arrays and formulated the problem for planar arrays.
• Continued further development of microcavity gas sensor.
• Continued testing oscillator sources with delay in laser experiments and initiated synchronization study in coupled fiber lasers. (NRL)
• Continued space-time sigma-delta's algorithmic compatibility with matrix-feedback filter structures that will reduce required computation by an order of magnitude. Investigate spectral shaping of errors due to RF hardware mismatch. (NRL)
• Continued analysis of very low frequency oscillations, caused by the interaction between the transistor and one of the capacitors in the circuit and develop a theory based on singular perturbation theory to explain the origin of these oscillations as a switching between 2 coexisting high frequency states. (NRL)
• Continued determining the radiation-hardening mechanisms related to silicon nanoclusters in oxides. (NRL)
• Continued optimizing power and efficiency of high power, electron beam pumped argon-xenon (Ar-Xe) laser for Navy compact Defense Early Warning (DEW). (NRL)
• Continued synchronization analysis in coupled fiber experiments. (NRL)
• Continued numerical scattering simulations of canonical objects undergoing micro-motion dynamics and compare the results with the Doppler modulations observed. (NRL)
• Continued suite of semiconductor multilayer and superlattice based infrared (IR) sources and sensors in 3-5 micron range.
• Continued exploitation of atom condensates to reach physical limit of frequency precision and control.
• Continued development of bipolar wide bandgap semiconductor linear amplifiers.
• Continued the analysis and characterization of micro-motion Doppler modulation.
• Continued investigation of extension of interference model and adaptive structures to produce waveforms that are transparent to non-users.
• Continued research into the bulk thermodynamic properties of phononic crystals.
• Continued investigations of the modification of metal surfaces by nitriding and other processes to maximize hardness, wear and corrosion resistance for Navy gun barrel applications using the Large Area Plasma Processing System (LAPPS). (NRL)
• Completed tests of the ability of superconducting Analog to Digital Converters (ADC) to allow digital recovery of two distinct signals of arbitrary bandwidth (BW) from a wide spectral analog band with the same clarity as a tuned bandwidth ADC (already proven for case of a single signal in the band).
• Completed investigation of the electromagnetic impulse response of radar targets and invented a de-convolution technique that greatly improves radar resolution. (NRL)

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- Completed research to determine feasibility of locking a laser and etalon to precision frequency standards and generate stable reference optical and microwave frequency lines across a broad spectrum. (NRL)
- Completed investigation of piezoelectric effects in micromachined quantum wells.
- Completed increasing the performance of device power conversion efficiency of organic solar cells by optimizing overlap with solar spectrum using highly absorbing dyes and nanocrystals.
- Completed development of Inverse Boundary Element methods to reconstruct sources of off-board radiated acoustic pressures. (NRL)
- Completed study to understand the ultimate performance (highest possible Q) of intermediate scale silicon oscillators. (NRL)
- Initiated investigation of superresolution signal processing techniques for closely spaced and unresolved targets in Doppler, range and direction of arrival spaces for a variety of radars.
- Initiated non-cooperative target identification from multiple aspects.
- Initiated investigation of ultra high speed logic and multiple-quantum-well devices with a goal of >500 giga-hertz (GHz) samplers, in support of ADC, for advanced multifunction RF systems.
- Initiated investigation of physical basis for improved time and frequency standards using quantum-entangled ions and atoms.
- Initiated project to explore physical behavior of full arrays of nanoscale devices for logic, memory, and imaging, with a first step being the integration of Cellular Nonlinear Network (CNN) fast image processor with multi-spectral focal plane array sensors.
- Initiated exploration of functioning of sensitive miniature fluxgate magnetometers.
- Initiated experimental investigations into the bulk thermodynamic properties of photonic crystals. (NRL)
- Initiated investigations into developing highly radiation-tolerant electronic/optoelectronic devices from nanocrystals and quantum dots. (NRL)
- Initiated experiments and collecting fundamental data to study electromagnetic scattering from canonical objects undergoing micro-motions. Expand study of mathematical solutions of micro-motion induced Doppler modulations. (NRL)
- Initiated the synthesis and modeling of tailored response magneto-dielectric materials. (NRL)
- Initiated the development of multistatic interference models and resulting adaptive processing structures. (NRL)

- Initiated experiments on explosive and human (proxies) to determine reflectivity and time domain responses. Investigated and simulated imaging configurations based on current radar technologies and potential processing schemes. (NRL)

BUDGET ACTIVITY: 01
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• Initiated methods for preparation, functionalization and characterization of Silicon Carbide and Gallium Nitride (Sic and GaN)nanowire surfaces. (NRL)

FY 2006 Plans:

• Continue all efforts of FY 2005 less those noted as completed above.
• Complete development of Magnetic Resonance Elastography to characterize low spin density materials. (NRL)
• Complete determination of the feasibility of quantum cascade 2DDFB lasers with enhanced power and a high-quality beam. (NRL)
• Complete patterning of GaN photonic crystal devices on Silicon. (NRL)
• Complete the evaluation and assessment of hardware-compatible space-time algorithms for DSP applications to T/R arrays.
• Initiate monolithic integration of multifunctional materials to enable passive devices and sensors into wide bandgap semiconductor circuits.
• Initiate program to extend device physics and architectures to frequencies approaching tera hertz (THz).
• Initiate program to incorporate Magnesium Diboride (MgB2) and related intermediate temperature superconductors into active electronic device structures.
• Initiate development of stabilized optical sources and low-noise photodetectors for the fabrication of an ultrastable microwave-frequency source. (NRL)
• Initiate determination of whether the coupling between spins in quantum dots mediated by the virtual excitions is sufficiently strong for use in solid state implementations for quantum information.
• Initiate development of a blind adaptive beamforming approach for the HF radar case and compare with both the conventional and traditional approaches. (NRL)
• Initiate improvements to integrated nanomechanical device arrays to include scaling down resonator architecture and quantifying properties which establish phononic crystal properties. (NRL)
• Initiate development of electromagnetic ultra-near-field holography. (NRL)
• Initiate study to determine if the coupling between spins in quantum dots mediated by the virtual excitons is sufficiently strong for use in solid state implementations for quantum information. (NRL)
• Initiate development of approaches for probability of detection for deterministic signals in stationary noise and quantify for non-stationary noise. (NRL)

FY 2007 Plans:

• Continue all efforts of FY 2006 less those noted as completed above.

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES
PROJECT TITLE: DEFENSE RESEARCH SCIENCES

• Complete suite of semiconductor multilayer and superlattice based infrared (IR) sources and sensors in 3-5 micron range.
• Complete exploitation of atom condensates to reach physical limit of frequency precision and control.
• Complete development of bipolar wide bandgap semiconductor linear amplifiers.
• Complete the analysis and characterization of micro-motion Doppler modulation.
• Complete investigation of extension of interference model and adaptive structures to produce waveforms that are transparent to non-users.
• Complete research into the bulk thermodynamic properties of phononic crystals.
• Complete investigations of the modification of metal surfaces by nitriding and other processes to maximize hardness, wear and corrosion resistance for Navy gun barrel applications using the large area plasma processing system (LAPPS). (NRL)
• Complete analysis and characterize observed micro-motion features and components obtained in experiments. Create a framework for analysis of Doppler modulations (NRL)
• Initiate program to apply innovative mass nanofabrication techniques to previously developed nanodevice arrays.
• Initiate investigation of temporal-spatial noise shaping circuits and architectures for analog-to-digital conversion.
• Initiate study of the feasibility of a solid state implementation of a quantum computer. (NRL)

	FY 2005	FY 2006	FY 2007
WEAPONS	7,365	8,502	9,638

Efforts include: Undersea Weaponry; Energetic Materials and Propulsion; Expeditionary Operations; and Directed Energy. Accomplishments and plans described below are examples for each effort category. Starting in FY 05, resources were realigned from this activity to fund Counter IED efforts in support of the Global War on Terrorism.

FY 2005 Accomplishments:

Undersea Weaponry
• Continued conducting basic research related to critical S&T (including vehicle control, maneuverability, and stability) associated with the development of high-speed supercavitating vehicles (HSSV).
• Continued expansion of the University Laboratory Initiative (ULI) Program to provide a further infusion of educated and career-minded scientists and engineers in support of the National Naval Responsibility (NNR) for

BUDGET ACTIVITY: 01
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Undersea Weapons Research.
• Initiated computer code refinements and investigation of supercavitating vehicle dynamics and instability.

Energetic Materials and Propulsion
• Continued development of a fundamental understanding of initiation mechanisms of explosive crystals subjected to shock stimulus.
• Continued to develop fundamental understanding of nitramine and perchlorate decomposition mechanisms for propellant applications.
• Continued to develop spectroscopic capabilities to accurately determine aluminum combustion characteristics in various oxidizing environments.
• Continued to develop synthesis routes to difluoramino-based and organometallic-based highly energetic ingredients.
• Continued exploring the use of quantum mechanics and molecular dynamics to provide fundamental properties for energetic materials to predict initiation/detonation criteria for insensitive munitions applications.
• Completed work on quantification of active combustion control.
• Initiated efforts to explore alternative fuel concepts for Naval applications to include hydrogen, synthetic diesel, and biodiesel.
• Initiated development of multi-parameter sensor for multi-phase combustion flows (UAV and underwater Pulse Detonation Engine (PDEs)).
• Initiated investigation of JP-10 combustion-based Proton-Exchange-Membrane (PEM) fuel cells.
• Initiated investigation of multi-tube multi-nozzle PDEs and multi-tube common nozzle PDEs.
• Initiated investigation of nanometallic-hydrocarbon hybrid catalytic combustion for increased energy release rates.
• Initiated investigation of novel initiation techniques, optimize injection parameters, and demonstrate integrated single tube operation for PDEs.
• Initiated PDM II Advanced Energetics research in reactive, explosive, and propulsive energetic materials, including high energy ingredient synthesis & characterization, and fundamentals of initiation and decomposition mechanisms, to tailor energy release processes in order to achieve substantial performance gains and/or enhanced survivability in harsh environments.

Expeditionary Operations
• Initiated investigation of modeling and exploiting the nonlinear seismic interactions between buried land mines and their surrounding soil for purposes of landmine detection.
• Initiated investigation of catalysts that reduce the pre-processing requirements for using logistic fuels

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in solid oxide fuel cells.
• Initiated investigation of optimal efficiency for generation of electrical energy from human motion.

FY 2006 Plans:

Undersea Weaponry
• Continue all efforts of FY 2005 less those noted as completed above.
• Initiate evaluation of viable synthesis methodologies and characterize emerging underwater explosive ingredients.
• Initiate development of diagnostic capabilities to accurately determine aluminum combustion characteristics in oxidizing environments.

Energetic Materials and Propulsion
• Continue all efforts of FY 2005 less those noted as completed above.
• Initiate implementation of new & nanostructured materials design concepts for direct energy conversion and waste energy conversion.
• Initiate investigation of integrated pulse detonation engine-airframe for autonomous vehicles, and pulse detonation for passive weapons (noise, jamming).

Expeditionary Operations
• Continue all efforts of FY 2005.

Directed Energy
• Initiate research thrust in Directed Energy weapons.

FY 2007 Plans:

Undersea Weaponry
• Continue all efforts of FY 2006 less those noted as completed above.
• Initiate studies to determine the best investment of technologies for Unmanned Undersea Vehicle (UUV) Guidance and Control (G&C).

Energetic Materials and Propulsion
• Continue all efforts of FY 2006 less those noted as completed above.

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- Initiate development of PDE for underwater applications.

Expeditionary Operations
- Continue all efforts of FY 2006.

Directed Energy
- Continue all efforts of FY 2006.

CONGRESSIONAL PLUS-UPS:

	FY 2005	FY 2006
ACADEMY FOR CLOSING AND AVOIDING ACHIEVEMENT GAPS	963	0

Research and Development for: (1) systemic mentoring, including research participation, of 50-100 undergraduate college Science, Technology, Engineering, and Mathematics students known as scholars, (2) extensive educational enrichment services for 150-200 K-12th grade students during summer, and (3) conducting research, publishing, and delivering presentations and workshops for the community at large.

FY 2005 Accomplishments:
- Enabled 30 undergraduate scholars to conduct research at laboratories around the country.
- Enabled 18 undergraduate scholars to attend two national conferences (those of HBCU-Undergraduate Program and of the National Society of Black Physicists (NSBP)) and 30 pre-college students to attend the National Conference of the National Organization for the Professional Advancement of Black Chemists and Chemical Engineers (NOBCChE).
- Enabled 48 Elementary and Middle and 66 High School students to partake in the Summer Academic Enrichment Programs identified above.

	FY 2005	FY 2006
BIO-INSPIRED MATERIALS - APPLICATIONS IN CATALYSIS, MAGNETICS, ELECTRONICS AND MEDICINE	0	1,400

This effort supports bio-inspired materials - applications in catalysis, magnetics, electronics and medicine research.

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	FY 2005	FY 2006
BRAIN-BASED INTELLIGENT SYSTEM	1,929	0

Investigated the design of embedded low-power, self-instructing computational systems through architecture studies, analysis, and experimentation. If the research is successful, with subsequent development, these systems could be utilized for Navy applications that could improve human performance, increase training capabilities, and enhance human communication. The design of the proposed computational device is based on the emulation of neuroanatomy and the dynamics known to be present in the brain.

FY 2005 Accomplishments:

• Explored the circuit architectures of an array of neural cores which will replicate the functional elements of the brain and its interconnectivities. Configure these architectures to respond to a variety of signals without the need for prior specific programming or instruction.

	FY 2005	FY 2006
CARBON NANOTUBE-BASED RADIATION-HARD NON-VOLATILE RAM	0	7,000

This effort supports carbon nanotube-based radiation-hard non-volatile RAM research.

	FY 2005	FY 2006
CENTER FOR PHOTOCHEMICAL SCIENCES	0	1,000

This effort supports the Center for Photochemical Sciences.

	FY 2005	FY 2006
ENERGETICS S&T WORKFORCE REVITALIZATION INITIATIVE	0	2,800

This effort supports the Energetics S&T Workforce Revitalization Initiative.

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	FY 2005	FY 2006
FACIAL RECOGNITION TECHNOLOGY RESEARCH AND DEVELOPMENT	1,543	0

Research and Development of facial recognition technology for security application at entry locations on US military bases and facilities.

FY 2005 Accomplishments:

• Conducted research to combine advanced face recognition technology with a novel skin texture metric in order to develop a highly accurate and robust face biometric to verify the identity of personnel entry in a DoD facility.

• Validated research by measuring accuracy and speed of this technology for identification of personnel within vehicles who enter a smart gate.

	FY 2005	FY 2006
HYDROGEN FOR FUEL CELLS	966	0

Research into hydrogen generation for use as fuel for electricity production by environmentally-friendly fuel cells.

FY 2005 Accomplishments:

• Conducted efforts to design, implement and test new catalysts for hydrogen evolution from alcohols and other biofeedstocks under ambient conditions of temperature and pressure.

	FY 2005	FY 2006
INTELLIGENT AUTONOMOUS NETWORKS AND SYSTEMS PROGRAM (AD HOC DATA COMMUNICATIONS)	969	1,000

Commercialization of Ad Hoc Routing Protocols to develop an initial product capability delivering a network connection device for Class 2 UAV platforms within 18 months. This communication system will be positioned to support multiple types of Unmanned Vehicles.

BUDGET ACTIVITY: 01
PROGRAM ELEMENT: 0601153N PROGRAM ELEMENT TITLE: DEFENSE RESEARCH SCIENCES
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FY 2005 Accomplishments:

• Conducted commercialization of Ad Hoc Routing Protocols to develop an initial product capability delivering a network connection device for Class 2 UAV platforms.

FY 2006 Plans:

• This effort supports intelligent autonomous networks and systems program (Ad hoc data communications) research.

	FY 2005	FY 2006
NANOELECTRONICS AND NANOMETROLOGY INITIATIVE	0	2,500

The effort supports the Nanoelectronics and Nanometrology Initiative.

	FY 2005	FY 2006
NAVY USE OF UNOLS SHIPS	0	4,250

This effort supports Navy use of UNOLS ships research.

	FY 2005	FY 2006
NEUROBIOLOGICALLY INSPIRED COMPUTATIONAL ARCHITECTURES AND METHODOLOGIES	0	1,400

This effort supports neurobiologically inspired computational architectures and methodologies research.

	FY 2005	FY 2006
ROTATIONAL MOLDED DOUBLE WALL HULL USING THERMO-PLASTIC CROSSLINK MATERIAL	0	1,250

This effort supports rotational molded double wall hull using thermo-plastic crosslink material research.

BUDGET ACTIVITY: 01
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	FY 2005	FY 2006
UNOLS RESEARCH VESSEL	1,737	2,000

Acoustical studies in the Littoral zone have been seriously hampered by interference from noise caused by shipboard machinery and propulsion equipment and radiated through the hull of the vessel. At the present there are no United States research vessels which meet the International Council for Exploration of the Seas (ICES) 209 standard (radiated noise standard for research vessels). UNOLS vessels have been extensively used by NRL and ONR funded investigators to conduct such studies. This funding was used to augment the propulsion and machinery quieting for the University of Delaware vessel presently under construction in order to provide enhanced capability for Navy investigators.

FY 2005 Accomplishments:

• Conducted efforts to identify potential noise sources and implement ameliorating strategies to meet ICES standards.

FY 2006 Plans:

• This effort supports the UNOLS research vessel.

C. OTHER PROGRAM FUNDING SUMMARY:
NAVY RELATED RDT&E:
PE 0601152N In-House Laboratory Independent Research
PE 0601103N University Research Initiatives

NON-NAVY RELATED RDT&E:
PE 0601102A Defense Research Sciences (Army)
PE 0601101E Defense Research Sciences (DARPA)
PE 0601102F Defense Research Sciences (Air Force)

D. ACQUISITION STRATEGY:
Not applicable.