| Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Navy | | | | | | | | | | | Date: February 2015 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Appropriation/Budget Activity<br>1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research* | | | | | R-1 Program Element (Number/Name)<br>PE 0602236N *I Warfighter Sustainment Applied Res* | | | | | | | |
| **COST ($ in Millions)** | **Prior Years** | **FY 2014** | **FY 2015** | **FY 2016 Base** | **FY 2016 OCO** | **FY 2016 Total** | **FY 2017** | **FY 2018** | **FY 2019** | **FY 2020** | **Cost To Complete** | **Total Cost** |
| Total Program Element | 0.000 | 49.083 | 46.923 | 45.056 | - | 45.056 | 46.549 | 47.301 | 47.345 | 47.372 | Continuing | Continuing |
| 0000: *Warfighter Sustainment Applied Res* | 0.000 | 49.083 | 46.923 | 45.056 | - | 45.056 | 46.549 | 47.301 | 47.345 | 47.372 | Continuing | Continuing |

**A. Mission Description and Budget Item Justification**

The efforts described in this Program Element (PE) are based on investment directions as defined in the Naval S&T Strategic Plan approved by the S&T Corporate Board (Sep 2011). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

This PE supports innovation-based efforts that will provide technology options for future Navy and Marine Corps capabilities. Efforts focus on advanced Naval materials; biocentric technologies; environmental quality; human factors and organizational design; medical technologies; and Naval training technologies. Within the Naval Transformation Roadmap, this investment maps to future transformational capabilities and the FORCEnet pillar of the Chief of Naval Operations and the Commandant of the Marine Corps vision for the future -- Naval Power 21.

The ONRG International Science Program mission is to search the globe for emerging scientific research and advanced technologies to enable the Office of Naval Research (ONR) and the NRE to address effectively the current needs of the Fleet/Forces, and investigate and assess revolutionary, high-payoff technologies for future Naval missions and capabilities. Within this Global mission, funding for the Naval Science Advisor Program ensures the Fleet/Force (F/F) helps shape the Department of the Navy (DoN) investment in Science and Technology (S&T), develops teaming relationships to rapidly demonstrate and transition technology, supports development of technology-based capability options for naval forces, and enables warfighting innovations based on technical and conceptual possibilities. Science Advisors provide insight into issues associated with Naval Warfighting Capabilities that influence S&T program decision making. The program develops leaders among civilian scientists and engineers in the Naval Research Enterprise (NRE). Upon completion of their tours, Science Advisors return to the NRE with first hand knowledge of the F/F, warfighting issues, and strategic decision making. The Office of Naval Research (ONR) Science Advisor program enables continuous communication and collaboration between the warfighters, the technical community, and strategic development commands.

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

| Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Navy | | | | | Date: February 2015 |
|---|---|---|---|---|---|
| Appropriation/Budget Activity<br>1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research* | | | R-1 Program Element (Number/Name)<br>PE 0602236N *I Warfighter Sustainment Applied Res* | | |
| **B. Program Change Summary ($ in Millions)** | **FY 2014** | **FY 2015** | **FY 2016 Base** | **FY 2016 OCO** | **FY 2016 Total** |
| Previous President's Budget | 49.688 | 46.923 | 44.755 | - | 44.755 |
| Current President's Budget | 49.083 | 46.923 | 45.056 | - | 45.056 |
| Total Adjustments | -0.605 | - | 0.301 | - | 0.301 |
| • Congressional General Reductions | - | - | | | |
| • Congressional Directed Reductions | - | - | | | |
| • Congressional Rescissions | - | - | | | |
| • Congressional Adds | - | - | | | |
| • Congressional Directed Transfers | - | - | | | |
| • Reprogrammings | 0.808 | - | | | |
| • SBIR/STTR Transfer | -1.413 | - | | | |
| • Program Adjustments | - | - | -0.041 | - | -0.041 |
| • Rate/Misc Adjustments | - | - | 0.342 | - | 0.342 |

**Change Summary Explanation**

Technical: Not applicable.

Schedule: Not applicable.

| Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy | | | | | | | | | | | Date: February 2015 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Appropriation/Budget Activity<br>1319 / 2 | | | | | R-1 Program Element (Number/Name)<br>PE 0602236N / *Warfighter Sustainment Applied Res* | | | | Project (Number/Name)<br>0000 / *Warfighter Sustainment Applied Res* | | | |
| **COST ($ in Millions)** | **Prior Years** | **FY 2014** | **FY 2015** | **FY 2016 Base** | **FY 2016 OCO** | **FY 2016 Total** | **FY 2017** | **FY 2018** | **FY 2019** | **FY 2020** | **Cost To Complete** | **Total Cost** |
| 0000: *Warfighter Sustainment Applied Res* | - | 49.083 | 46.923 | 45.056 | - | 45.056 | 46.549 | 47.301 | 47.345 | 47.372 | Continuing | Continuing |

**A. Mission Description and Budget Item Justification**

This PE supports the FNCs of Littoral Combat/Power Projection, Capable Manpower, Force Health Protection Future Capability, Enterprise and Platform Enablers (EPE) FNC; and innovation-based efforts that will provide technology options for future Navy and Marine Corps capabilities. Efforts focus on manpower and personnel; Naval systems training and education; human systems integration; littoral combat and power projection capabilities; advanced naval materials; medical technologies; environmental quality; biocentric technologies; high speed sealift; cost reduction technologies; and Sea Basing technologies. Within the Naval Transformation Roadmap, this investment supports eight transformational capabilities within the "Sea Strike", "Sea Shield", and "Sea Basing" operational concepts; the critical human system, "Sea Warrior"; and Naval business efficiencies within "Sea Enterprise."

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

| **B. Accomplishments/Planned Programs ($ in Millions)** | **FY 2014** | **FY 2015** | **FY 2016 Base** | **FY 2016 OCO** | **FY 2016 Total** |
|---|---|---|---|---|---|
| ***Title:*** ADVANCED NAVAL MATERIALS | 10.607 | 9.680 | 9.279 | - | 9.279 |
| ***Description:*** Advanced Naval Materials efforts include: developing advanced, high-performance materials; developing processes to reduce weight and cost; and developing enhanced sonar transducers.<br><br>The Office of Naval Research Global (ONRG) has a presence overseas, and a mission to search the globe for promising, emerging scientific research and advanced technologies to enable the Office of Naval Research to effectively address current needs of the Fleet and Force. This includes discovering the best science, such as innovative fundamental research which could help shape future naval investments and strategies, and leveraging great minds globally with positive engagement to support the Sailors & Marines of today and tomorrow.<br><br>***FY 2014 Accomplishments:***<br>- Continued multi-laser-processing technique development for the fabrication of ultra hard materials for wear resistance applications.<br>- Continued development of advanced, cost-efficient joining of titanium for >25% weight reduction of large seaborne structures.<br>- Continued development of acceptance testing methodologies for advanced transducer, single-crystal, high-strain materials and definition of standardized materials properties and composition ranges. | | | | | |

| Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy | | Date: February 2015 |
|---|---|---|
| **Appropriation/Budget Activity**<br>1319 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602236N / *Warfighter Sustainment Applied Res* | **Project (Number/Name)**<br>0000 / *Warfighter Sustainment Applied Res* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2014 | FY 2015 | FY 2016 Base | FY 2016 OCO | FY 2016 Total |
|---|---|---|---|---|---|
| - Continued development of compositional tuning of single-crystal, high-strain transducer materials, for specialized naval system applications.<br>- Continued marine titanium alloy design and processing development, exploiting anticipated cost reductions for high performance, reduced maintenance naval applications.<br>- Continued development of continuous, single wall, carbon nanotube composite materials for next generation air and naval platforms.<br>- Continued stainless steel carburization study to enhance corrosion performance.<br>- Continued development of surface preparation methods and characterization of corrosion performance for future naval ship materials.<br>- Continued evaluation of low temperature, carburized materials for marine application.<br>- Continued development of coating performance and knowledge database for Naval use.<br>- Continued development of mechanistic model for stress corrosion cracking in Nickel Aluminum Bronze (NAB).<br>- Continued development of innovative sonar transducers based on high-strain, high-coupling, piezoelectric single crystals.<br>- Continued development of novel processing technologies for increasing the fatigue strength and corrosion resistance of weldments for ship structures with reduced weight and maintenance requirements.<br>- Continued development of models and characterization methods for dynamic loading (water slamming and blast loading) in polymer composite materials.<br>- Continued acoustic damping coatings for ship tank application.<br>- Continued development of fiber-optic sensors, transducers and demodulation technology for structural health monitoring of ships and submarines.<br>- Continued development of continuous based monitoring techniques of new synthetic fuels and lubricants based on electromagnetic signature analysis.<br>- Continued development and application of distributed fiber optic Bragg gratings for structural health monitoring of ships and aircrafts.<br>- Continued development of novel growth methods to specialized single crystal transducer materials tuned to requirements of specialized naval systems.<br>- Continued assessment of the degree of sensitization potential of marine grade Al alloys.<br>- Continued investigation of criteria for stable pitting of stainless steel.<br>- Continued development of surface assessment technologies to measure surface profile and chlorine.<br>- Continued evaluation of advanced material coating for erosion control on helicopter main rotor blade leading edges.<br>- Continued studies on fuel cell corrosion. | | | | | |

| Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy | | Date: February 2015 |
|---|---|---|
| **Appropriation/Budget Activity**<br>1319 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602236N / *Warfighter Sustainment Applied Res* | **Project (Number/Name)**<br>0000 / *Warfighter Sustainment Applied Res* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2014 | FY 2015 | FY 2016 Base | FY 2016 OCO | FY 2016 Total |
|---|---|---|---|---|---|
| - Continued development of superhydrophobic surface modification technology.<br>- Continued studies on mitigation of pitting corrosion and stress corrosion cracking in marine aluminum alloys.<br>- Continued development of surface tolerant coating removal methods.<br>- Continued development of processing technologies to fabricate piezoelectric single crystals into complex transducer assemblies.<br>- Continued development of thermal management system(s) to arrest excessive heat fluxes and loads on amphibious ship by advanced Naval/USMC aircraft.<br>- Continued development of the rational engineering design of Al-alloys for naval applications.<br>- Continued to increase emphasis on research efforts to discover innovative fundamental technologies to shape future Naval investments and strategies, leveraging the globe to support the Sailors & Marines of today and tomorrow.<br>- Continued research and development of the physics and chemistry of the materials-environment interface, with the focus on materials with melting points above 3000C.<br>- Continued development of quantitative coasting quality assurance tools.<br>- Completed study of fluid-structure dynamics for flexible body armor. (FY16)<br>- Completed development of seamless joining technologies for large, complex shaped, conventional ceramic windows from small, inexpensive components using electrophoretic deposition of ceramic nanoparticles.<br>- Completed developing techniques for processing of nanostructured aluminum alloys and composites which do not require use of liquid nitrogen.<br>- Completed development of high-strength, high-hardness tool materials for friction-stir welding applications.<br>- Completed development of MEMS based sensor nodes, with energy harvesting and wireless communication capabilities, for system health management and prognosis.<br>- Completed development of integrated structural composites with blast resistance, manufacturing technologies, and low-cost organic resins with improved fire resistance.<br>- Completed development of continuous single wall carbon nanotube composite materials for next generation air and naval platforms.<br>- Completed development of energy efficient scalable processing of low cost titanium alloys.<br>- Completed development of intelligent corrosion sensor systems for intergranular corrosion cracking. (Transfers to the Future Naval Capability Program in FY14)<br>- Completed development of cavitation resistant ship rudder coatings based on the FY 2004 shipboard coating study.<br>- Completed development of portable, real-time, Non-Destructive Examination (NDE)/Non-Destructive Inspection (NDI) technology for heat damage detection in composite materials. | | | | | |

| Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy | | Date: February 2015 |
|---|---|---|
| **Appropriation/Budget Activity**<br>1319 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602236N / *Warfighter Sustainment Applied Res* | **Project (Number/Name)**<br>0000 / *Warfighter Sustainment Applied Res* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2014 | FY 2015 | FY 2016 Base | FY 2016 OCO | FY 2016 Total |
|---|---|---|---|---|---|
| - Continued development of advanced NDE, SHM and Prognostics Technologies for improved readiness and reliability of air and naval platforms based on new and emerging electronic and photonics materials and devices.<br>- Continued development of advanced structural composites with improved mechanical characteristics, blast resistance, and fire resistance, for more durable and reliable structures by optimizing the resin, the fibers and the interphases with new chemistries, additives and processes.<br>- Continued development and exploitation of new and advanced forms of carbon based nanostructures (Graphene, Nanotubes, Diamond and others) for next generation family of materials and structures with outstanding mechanical, thermal, electrical and energy applications.<br>***FY 2015 Plans:***<br>- Continue all efforts of FY 2014, less those noted as completed above.<br>- Complete multi-laser-processing technique development for the fabrication of ultra hard materials for wear resistance applications.<br>- Complete development of advanced, cost-efficient joining of titanium for >25%weight reduction of large seaborne structures.<br>***FY 2016 Base Plans:***<br>- Continue all efforts of FY 2015, less those noted as completed above.<br>- Complete investigation of criteria for stable pitting of stainless steel.<br>- Complete acoustic damping coastings for ship tank application.<br>***FY 2016 OCO Plans:***<br>N/A | | | | | |
| ***Title:*** BIOCENTRIC TECHNOLOGIES<br>***Description:*** Biocentric technologies provide novel solutions for naval needs based upon the applications of bio-inspired sensors, materials, processes and systems. Topic areas include, but are not limited to development of biologically-based signal processing for medical, surveillance and security applications; bioinspired robotics; synthetic biology to produce high-value naval materials or to develop sentinel organisms, and marine mammal diagnostics to support the Navy's Fleet Marine Mammal Systems.<br>***FY 2014 Accomplishments:***<br>Naval Biosciences:<br>- Continued development of innovative naval biosensors, biomaterials, and bioprocess technology. | 6.391 | 6.045 | 5.729 | - | 5.729 |

| Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy | | Date: February 2015 |
|---|---|---|
| **Appropriation/Budget Activity**<br>1319 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602236N / *Warfighter Sustainment Applied Res* | **Project (Number/Name)**<br>0000 / *Warfighter Sustainment Applied Res* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2014 | FY 2015 | FY 2016 Base | FY 2016 OCO | FY 2016 Total |
|---|---|---|---|---|---|
| - Continued engineering development and optimization of sea-floor sediment energy harvesting system for sustainable and autonomous powering of underwater sensor networks and AUV's.<br>- Continued studies of microbial fuel cells for shoreside or shipboard applications<br><br>Synthetic Biology for Sensing & Energy Production:<br>- Continued long duration, realistic field tests, and modeling studies of autonomous microbial fuel cell power systems for underwater sensor networks.<br>- Continued synthetic biology studies of engineered sentinel organisms for environmental surveillance and production of high-value naval materials (e.g., fuels, conducting polymers).<br><br>Life Sciences and Bioengineering:<br>- Continued marine mammal diagnostics efforts, including immunobioassays for stress and infection detection.<br>- Continued effort to evaluate breath analysis for non-invasive diagnostics in marine mammal medicine.<br>- Continued studies to evaluate candidate probiotics in Altantic bottlenose dolphins.<br>- Continued studies of dolphin regenerative cells for treating a variety of pathologies and disease states in these animals.<br>- Continued efforts to detect, treat, and prevent diseases in dolphins, including diabetes and kidney stones.<br>- Completed development of a second set of molecular diagnostic tests for recently discovered viral bacterial, and fungal pathogens of marine mammals.<br>- Completed microbe derived production of aviation fuel components from renewable wastes.<br><br>Neural, Sensory and Biomechanical Systems:<br>- Continued efforts on naval biosensor to detect brain structures and blood vessels through skull bones<br>- Continued efforts on advanced biomimetic sensing and neural control for human-robot interaction to enable effective collaboration of warfighters and autonomous systems.<br>-Continued integration of biomimetic sonar with bioinspired autonomous undersea vehicles (with high-lift propulsors) to achieve closed loop control.<br>- Continued efforts in bioinspired quiet, and maneuverable self-propelled line array using high-lift propulsors based on animal wing and fin biomechanics.<br>- Continued efforts for bio-inspired massively parallel vision systems.<br>- Continued studies to develop brain-based intelligent systems to support high level interaction between warfighters and autonomous systems.<br>- Continued studies to develop electrosence and biosonar for MOC and EOD missions | | | | | |

| Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy | | Date: February 2015 |
|---|---|---|
| **Appropriation/Budget Activity**<br>1319 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602236N / *Warfighter Sustainment Applied Res* | **Project (Number/Name)**<br>0000 / *Warfighter Sustainment Applied Res* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2014 | FY 2015 | FY 2016 Base | FY 2016 OCO | FY 2016 Total |
|---|---|---|---|---|---|
| - Continued development of improved recombinant antibodies for biothreat agents<br>***FY 2015 Plans:***<br>Naval Biosciences:<br>- Continue all efforts of FY 2014,less those noted as completed above.<br>- Initiate development of microbial fuel cells for powering a linear sensor array<br>- Initiate study of microbial electrochemical systems for shipboard desalination/waste-to-energy conversion<br><br>Synthetic Biology for Sensing & Energy Production:<br>- Continue all efforts of FY 2014,less those noted as completed above.<br><br>Life Sciences and Bioengineering:<br>- Continue all efforts of FY 2014, less those noted as completed above.<br><br>Neural, Sensory and Biomechanical Systems:<br>- Continue all efforts of FY 2014, less those noted as completed above.<br>- Initiate studies to develop electrosence and biosonar for MOC and EOD missions.<br>***FY 2016 Base Plans:***<br>Naval Biosciences:<br>- Continue all efforts of FY 2015, less those noted as completed above.<br><br>Synthetic Biology for Sensing & Energy Production:<br>- Continue all efforts for FY 2015, less those noted as completed above.<br><br>Life Sciences and Bioengineering:<br>- Continue all efforts for FY 2015, less those noted as completed above.<br><br>Neural, Sensory and Biomechanical Systems:<br>- Continue all efforts for FY 2015, less those noted as completed above.<br>***FY 2016 OCO Plans:***<br>N/A | | | | | |
| ***Title:*** ENVIRONMENTAL QUALITY | 2.802 | 2.846 | 2.627 | - | 2.627 |

| Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy | | Date: February 2015 |
|---|---|---|
| **Appropriation/Budget Activity**<br>1319 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602236N / *Warfighter Sustainment Applied Res* | **Project (Number/Name)**<br>0000 / *Warfighter Sustainment Applied Res* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2014 | FY 2015 | FY 2016 Base | FY 2016 OCO | FY 2016 Total |
|---|---|---|---|---|---|
| ***Description:*** Environmental Quality technologies enable sustained world-wide Navy operations in compliance with all local, state, regional, national and international laws, regulations and agreements, and support the Navy Transformational Roadmap in the areas of Sea Basing, Sea Strike and Sea Warrior. Compliant operations enable training evolutions and exercises that are critical for maintaining readiness.<br><br>***FY 2014 Accomplishments:***<br>- Continued development of new, advanced, environmentally benign AF/Anti-Corrosive (AC) costing systems for Navy platforms.<br>- Continued development of advanced environmentally sound technologies for shipboard waste treatment and pollution abatement systems.<br>- Continued field evaluation of prototype robotic Hull BUG to identify gaps needed to refine and advance the technology.<br>- Continued efforts on ballast tank and system design optimization that minimize fuel discharges from compensated systems, minimize sedimentation in clean ballast and compensated ballast tanks, and maximize exchange of organisms during ballast tank exchanges.<br>- Continued efforts on improved handheld, waterborne, underwater hull cleaning technologies.<br>- Continued studies on oil emulsion issues and development of novel bilge water treatment systems on existing and new ships.<br><br>***FY 2015 Plans:***<br>- Continue all efforts of FY 2014.<br>- Complete efforts on improved handheld, waterborne, underwater hull cleaning technologies.<br>- Complete efforts on ballast tank and system design optimization that minimize fuel discharges from compensated systems, minimize sedimentation in clean ballast and compensated ballast tanks, and maximize exchange of organisms during ballast tank exchanges.<br><br>***FY 2016 Base Plans:***<br>- Continue all efforts of FY 2015, less those noted as completed above.<br><br>***FY 2016 OCO Plans:***<br>N/A | | | | | |
| ***Title:*** HUMAN FACTORS AND ORGANIZATIONAL DESIGN | 5.273 | 5.412 | 5.124 | - | 5.124 |

| Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy | | Date: February 2015 |
|---|---|---|
| **Appropriation/Budget Activity**<br>1319 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602236N / *Warfighter Sustainment Applied Res* | **Project (Number/Name)**<br>0000 / *Warfighter Sustainment Applied Res* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2014 | FY 2015 | FY 2016 Base | FY 2016 OCO | FY 2016 Total |
|---|---|---|---|---|---|
| ***Description:*** The overarching objective of this activity is the achievement of FORCEnet and Sea Power 21 goals by developing human factors principles and cognitive models for human centric design, decision support systems for collaborative decision making, and adaptive command and control structures. The CNO's new Maritime Strategy and the Commander Fleet Forces Command complementary plan to revise organization of Maritime Operations Centers (MOC) place high priority on the aforementioned FORCEnet and Sea Power 21 goals. Specific objectives focus on improving small team, platform, task force, and battle group operations by developing advanced human factors technologies for incorporation into operational systems. The goals and payoffs are to enhance human performance effectiveness; improve the timeliness and quality of decision making; develop strategies to mitigate high workload and ambiguity; reduce manning; improve situational awareness and speed of command through a deeper understanding of human capabilities and limitations; and improvement of team decision making in ad-hoc, complex problem solving scenarios. The current specific objectives are:<br><br>a) Human Computer Interaction/Visualization: Develop an understanding of the limitations of human perceptual and attentional systems in relation to maximizing user performance when interacting with complex Naval displays. A combination of computational cognitive modeling and psychological studies are employed to determine the capacity limitations on human performance that will undoubtedly have impact in reduced manning requirements, including information-rich weapons platforms. Develop technology for improving human interaction with autonomous systems and for improving virtual reality systems for training purposes.<br><br>b) Command Decision Making (CDM): This is a new sub-project that consolidates the previous Collaboration and Knowledge Interoperability (CKI) and Organizational Design and Decision Support Systems sub-projects. The CDM sub-project is focused at the development of dynamic decision support systems that recognize and are responsive to changing mission and task demands, and adapt to present information appropriately. This focus is explicitly intended to deliver decision support that will be more timely and responsive to rapidly evolving operational needs. Current thrusts within the sub-project are to: 1) Conduct research on the application of theory to exploit relevant information for effective decision making; 2) Develop models that are operationally context and task sensitive; 3) Study and apply research for the effective management of highly complex & time critical decision making; 4) Develop and demonstrate decision support tools that address the timely management of risk and uncertainty. | | | | | |

| Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy | | Date: February 2015 |
|---|---|---|
| **Appropriation/Budget Activity**<br>1319 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602236N / *Warfighter Sustainment Applied Res* | **Project (Number/Name)**<br>0000 / *Warfighter Sustainment Applied Res* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2014 | FY 2015 | FY 2016 Base | FY 2016 OCO | FY 2016 Total |
|---|---|---|---|---|---|
| c) Social Network Analysis: Develop computational models, algorithms and technologies for the analysis of conflict and crisis environments and the development of strategies against novel threats, such as terrorism, information warfare, and deception operations. Develop computational approaches to handling very large, social and socio-cultural information and datasets. Develop computational social science approaches to the study of factionalism in social movements and the novel approaches to crowd calming and peacebuilding for civil affairs operations and disaster response. The following are non-inclusive examples of accomplishments and plans for projects funded in this activity.<br><br>This FY 2014 activity funding moves from Program Element 0602235N: Common Picture Applied Research efforts associated with the Human Factors activity and is being transferring into this PE0602236N: Warfighter Sustainment Applied Research to provide an easily navigable overview of all Human Factors investments in a single location.<br><br>***FY 2014 Accomplishments:***<br>Human Computer Interaction/Visualization:<br>Human Factors and Organizational Design were transferred from PE 0602235N in order for the PE to provide an easily navigable and consolidated overview of all Human Factors Investment in a single PE.<br>***FY 2015 Plans:***<br>Human Computer Interaction/Visualization:<br>Human Factors and Organizational Design were transferred from PE 0602235N in order for the PE to provide an easily navigable and consolidated overview of all Human Factors Investment in a single PE.<br><br>- Continue all efforts of FY 2014, less those noted as completed above.<br>Command Decision Making (CDM):<br>- Continue all efforts of FY 2014, less those noted as completed above.<br>- Initiate research building proactive decision support tools for Command and Control.<br><br>Social Network Analysis:<br>- Continue all efforts of FY 2014, less those noted as completed above.<br><br>Hybrid Human Computer Systems: | | | | | |

| Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy | | Date: February 2015 |
|---|---|---|
| **Appropriation/Budget Activity**<br>1319 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602236N / *Warfighter Sustainment Applied Res* | **Project (Number/Name)**<br>0000 / *Warfighter Sustainment Applied Res* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2014 | FY 2015 | FY 2016 Base | FY 2016 OCO | FY 2016 Total |
|---|---|---|---|---|---|
| - Initiate research to address visualization and synthesis from multiple data sources to support autonomous systems and small hybrid teams.<br>- Initiate research on human performance sources of cyber vulnerabilities of UxV systems.<br>- Initiate research in human systems integration to reduce workload and increase operator situation awareness in command information center. | | | | | |
| ***FY 2016 Base Plans:***<br>Human Computer Interaction/Visualization:<br>- Continue all efforts of FY 2015, (Human Factors and Organization Design - These items moved from PE 0602235N - Please Note statement "This FY 2014 active funding moves from Program Element 0602235N).<br>- Continued application of cognitive architecture modeling to the design of interface analysis tools.<br>- Continued research on the application of information architectures (DOD Architectures Framework), executable models (Petri Nets) and cognitive models to the systematic design of Human-Computer Integration.<br>- Continued effort to develop tools for more automated, cost-efficient modeling of human system interaction.<br>- Continued development of a testbed for validating cognitive models of operator performance in cross-modal (audio/visual) task environments.<br>- Continued development of the multitasking and metacognitive components of the Tactical Action Officer (TAO) model, especially as they apply to dual-tasks involving "chat" style instant-messaging interleaved with other watchstanding duties.<br>- Continued development of spatialized 3D-audio displays to mitigate cognitive load during the performance of dual-tasks.<br>- Continued investigation of human attentional limitations in understanding sped-up and serialized speech over multiple radio channels.<br>- Continued development of cognitive-model-based predictors of operator error in procedural tasks.<br>- Continued development of cognitive models of the TAO to be utilized within a virtual, Combat Information Center (CIC) simulated environment.<br>- Continued investigation of auditory attentional effects on watchstanding activities, especially in the context of monitoring multiple radio channels. Results will be used to provide recommendations for new communications protocols.<br>- Continued development of cognitive models of user interface affordance that could form the basis of usability analysis and evaluation. | | | | | |

| Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy | | Date: February 2015 |
|---|---|---|
| **Appropriation/Budget Activity**<br>1319 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602236N / *Warfighter Sustainment Applied Res* | **Project (Number/Name)**<br>0000 / *Warfighter Sustainment Applied Res* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2014 | FY 2015 | FY 2016 Base | FY 2016 OCO | FY 2016 Total |
|---|---|---|---|---|---|
| - Continued research on audio-visual cue integration for 360-degree periscope displays. Utilize eye-tracking, sleep studies and traditional behavioral measures to characterize human performance on periscope-related tasks under a variety of physiological conditions.<br><br>Command Decision Making (CDM):<br>- Continued to develop task management algorithms applicable to agile supervisory control of teams involving human and autonomous agents.<br>- Continued development of information infrastructure that is operational context sensitive to allow the dynamic prioritization of date based on its anticipated information value and mission criticality.<br><br>Social Network Analysis:<br>- Continued development of new threat scenarios incorporating Joint Force Maritime Component Commander operations, and counterinsurgency and humanitarian operations with the staff of the Naval War College. These new threat scenarios will provide the basis for Limited Objective Experiments in the Innovation Laboratory at the Naval War College.<br>- Continued development of Dynamic Network analysis (a terrorist network analysis tool) in an operational command setting at U.S. Pacific Command.<br>- Continued the improvement of terror network analysis decision tools for combatant command use and military planning, including testing of tools, development of metrics, and validation.<br>- Continued research on socio-technical aspects of community mobilization and complex humanitarian operations, including the use of novel platforms, social networks and the impact of novel technologies on human behavior in crisis and collaborative contexts.<br>- Initiate data collection activity using prototype panoramic camera aboard a sea vessel. Initiated research on integrating automated image processing technologies onboard the prototype panoramic camera.<br><br>Command Decision Making (CDM):<br>- Continue all efforts of FY 2015, less those noted as completed above.<br><br>Social Network Analysis:<br>- Continue all efforts of FY 2015, less those noted as completed above.<br>- Initiate development of testbeds and tool chainsfor rapid disaster analyiss and response.<br>- Initiate development of novel information feeds for Pacific Command. | | | | | |

| Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy | | Date: February 2015 |
|---|---|---|
| **Appropriation/Budget Activity**<br>1319 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602236N / *Warfighter Sustainment Applied Res* | **Project (Number/Name)**<br>0000 / *Warfighter Sustainment Applied Res* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2014 | FY 2015 | FY 2016 Base | FY 2016 OCO | FY 2016 Total |
|---|---|---|---|---|---|
| Hybrid Human Computer Systems:<br>- Continue all efforts of FY 2015, less those noted as completed above.<br>***FY 2016 OCO Plans:***<br>N/A | | | | | |
| ***Title:*** MEDICAL TECHNOLOGIES | 5.916 | 6.164 | 5.833 | - | 5.833 |
| ***Description:*** This program supports the development of field medical equipment, diagnostic capabilities and treatments; technologies to improve warfighter safety and to enhance personnel performance under adverse conditions; and systems to prevent occupational injury and disease in hazardous, deployment environments; including regenerative medicine technologies and therapeutic/restorative practices for the treatment of combat-related traumatic injuries. Navy investment in these areas is essential because Navy/USMC mission needs are not adequately addressed by the civilian sector or other Federal agencies. For example, civilian emergency medicine does not address casualty stabilization during long transit times to definitive care. The National Institutes of Health (NIH) focuses on the basic science of disease processes and not applied research related to development. Programs are coordinated with other Services through the Armed Services Biomedical Research Evaluation and Management (ASBREM) Committee, and Joint Technical Coordinating Group (JTCG) process, to prevent duplication of effort.<br><br>***FY 2014 Accomplishments:***<br>Undersea Medicine:<br>- Continued efforts to reduce operational injuries<br>- Continued studies on decompression sickness (DCS) and arterial gas embolism (AGE), to include novel approaches to the prevention, detection and treatment of DCS/AGE, particularly by nonrecompressive methods.<br>- Continued efforts to develop prophylactic agents preventing hyperbaric oxygen toxicity. Prolonged exposure to hyperbaric oxygen can be toxic to lungs, nervous system and eyes.<br>- Continued efforts to assess the impact of thermal (i.e., heat and cold) stress on operational performance. Underwater thermal extremes can affect diver performance and alter risk of incurring decompression sickness.<br>- Continued studies related to optimization of diver performance. Operational performance in the undersea environment can be hampered by a variety of environmental stressors.<br>- Continued studies related to optimization of submariner health and performance. Submarine crewmembers are exposed to a variety of unique stressors including prolonged deployments, effects of altered diurnal rhythms, non-standard breathing gases, lack of sunlight, etc that can impact health and performance.<br>- Continued research to explore novel pharmaceutical interventions for hyperbaric oxygen toxicity. | | | | | |

| Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy | | Date: February 2015 |
|---|---|---|
| **Appropriation/Budget Activity**<br>1319 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602236N / *Warfighter Sustainment Applied Res* | **Project (Number/Name)**<br>0000 / *Warfighter Sustainment Applied Res* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2014 | FY 2015 | FY 2016 Base | FY 2016 OCO | FY 2016 Total |
|---|---|---|---|---|---|
| Regenerative Medicine:<br>- Completed program, with Army, in regenerative medicine (Armed Forces Institute for Regenerative Medicine (AFIRM)).<br>- Continued program with Army, in regenerative medicine (Armed Forces Institute for Regenerative Medicine (AFIRM II))<br><br>Noise Induced Hearing Loss:<br>- Continued research to reduce noise at the source, i.e. jet engine quieting and flight deck noise reduction.<br>- Continued efforts to reverse NIHL.<br>- Continued studies related to biomedical effects of underwater sound. Military divers must operate safely and effectively in potentially complex underwater sound fields.<br>- Continued efforts for "stress inoculation" to mitigate the impact of exposure to stressful combat environments prior to deployment.<br>- Continued research to study the incidence and susceptibility of Noise Induced Hearing Loss (NIHL) and tinnitus, and to evaluate mitigation strategies.<br>- Continued research in prevention and treatment of NIHL and tinnitus (ringing in the ears).<br>- Continued research to improve personal protective equipment technology.<br><br>Noise Induced Hearing Loss-Jet Noise:<br>- Continued Jet Noise Reduction Project, Noise Induced Hearing Loss Program, to utilize analytical modeling and simulation tools anchored by experiment to develop and assess solutions enabling mitigation of jet induced noise from high performance tactical aircraft. | | | | | |
| ***FY 2015 Plans:***<br>Undersea Medicine:<br>- Continue all efforts of FY 2014.<br>- Initiate research on resuscitation therapies for near-drowning victims.<br><br>Regenerative Medicine:<br>- Continue all efforts of FY 2014, less those noted as completed above.<br><br>Noise Induced Hearing Loss: | | | | | |

| Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy | | Date: February 2015 |
|---|---|---|
| **Appropriation/Budget Activity**<br>1319 / 2 | **R-1 Program Element (Number/Name)**<br>PE 0602236N / *Warfighter Sustainment Applied Res* | **Project (Number/Name)**<br>0000 / *Warfighter Sustainment Applied Res* |

| B. Accomplishments/Planned Programs ($ in Millions) | FY 2014 | FY 2015 | FY 2016 Base | FY 2016 OCO | FY 2016 Total |
|---|---|---|---|---|---|
| - Continue all efforts of FY 2014.<br><br>Noise Induced Hearing Loss-Jet Noise:<br>- Continue all efforts of FY 2014.<br>***FY 2016 Base Plans:***<br>Undersea Medicine:<br>- Continue all efforts of FY 2015, less those noted as completed above.<br>- Initiate research into improved cognitive agility for divers and diving supervisors<br>- Initiate research into diver Human Systems Integration (displays and biometric monitoring)<br><br>Regenerative Medicine:<br>- Continue all efforts of FY 2015, less those noted as completed above.<br><br>Noise Induced Hearing Loss:<br>- Continue all efforts of FY 2015, less those noted as completed above.<br><br>Noise Induced Hearing Loss-Jet Noise:<br>- Continue all efforts of FY 2015, less those noted as completed above.<br>***FY 2016 OCO Plans:***<br>N/A | | | | | |
| ***Title:*** THE OFFICE OF NAVAL RESEARCH GLOBAL<br><br>***Description:*** ONR has a presence overseas, with an overarching purpose to search the globe for promising, emerging scientific research and development efforts to address the current needs of the Fleet/Forces, and investigate high-payoff technologies for future naval missions and capabilities. To accomplish this task, ONR capitalizes on global innovation and investment to solve U.S. Navy and Marine Corps science and technology (S&T) challenges, builds global S&T awareness to mitigate risk of potential technological surprise, ensures Fleet/Forces capability needs are communicated to the Naval Research Enterprise (NRE), and facilitates delivery of Naval S&T solutions to the Fleet/Forces. | 13.125 | 11.881 | 11.864 | - | 11.864 |

| Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy | | Date: February 2015 |
|---|---|---|
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| B. Accomplishments/Planned Programs ($ in Millions) | FY 2014 | FY 2015 | FY 2016 Base | FY 2016 OCO | FY 2016 Total |
|---|---|---|---|---|---|
| ONR Applied Research (6.2) requirements prior to FY 2014 were funded in another R-2 activity within this PE and also in PE 0602123N and 0206568N. Starting in FY 2014, these requirements have been consolidated into this separate R-2 activity to provide greater visibility for ONR international collaboration and research efforts.<br><br>The decrease from FY 2014 to FY 2015 is due to reprioritization of requirements. All efforts will continue to the greatest extent possible.<br><br>***FY 2014 Accomplishments:***<br>International Science Program:<br><br>The ONR International Science Program mission is to search the globe for emerging scientific research and advanced technologies, to enable the Office of Naval Research (ONR) and the Naval Research Enterprise (NRE) to effectively address current needs of the Fleet/Forces, and investigate and assess revolutionary, high-payoff technologies for future naval missions and capabilities. This is accomplished through PHD-level Associate Director scientists located in Asia, Europe and South America collaborating with international organizations and researchers through grants in innovative applied research, and establishing quality, relevant connections between international science and technology (S&T) centers of excellence and DON, DOD, and other US Government organizations. The direct impact of this investment is to capitalize on international applied research during unprecedented and dynamic global interdependence, increasing the ability to solve DON S&T challenges through shared knowledge and technologies with partners. Additionally, this investment builds global S&T awareness to reduce the risk of potential technological surprise, and supports theater security cooperation goals to sustain cooperative relationships with an expanding set of international partners and to enhance global security.<br><br>Fleet/Forces Science Advisors:<br><br>The Naval Science Advisor (SA) Program ensures the Naval Fleet/Forces shape the DON investment in applied research S&T, developing teaming relationships in support and development of technology-based capability options for Naval Fleet/Forces. Funding is also dedicated to applied research efforts in support of the various Naval Fleet/Forces operational commands.<br><br>The Science Advisors (SA) are a conduit between the Naval Fleet/Forces, ONR, Naval Research Lab (NRL) and the entire Naval Research Enterprise (NRE). Specific Fleet/Forces Science Advisors include the following: | | | | | |

| Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy | | Date: February 2015 |
|---|---|---|
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| B. Accomplishments/Planned Programs ($ in Millions) | FY 2014 | FY 2015 | FY 2016 Base | FY 2016 OCO | FY 2016 Total |
|---|---|---|---|---|---|
| - SA, Navy Warfare Development Command (NWDC), provides technical support for the generation and development of advanced warfighting concepts leading to innovative new strategies to address Navy challenges and opportunities.<br><br>- SA, CNO Strategic Studies Group (SSG) fully partners in the generation of revolutionary warfighting concepts for the Navy of the future. Along with the Technology Fellows, the SA develops the SSG Fall Program which includes researching and inviting lecturers to address the SSG and developing engaging and mind-opening exploration travel for the CNO Fellows and mini exploration travel for all SSG members.<br><br>- SA, Chief of Naval Operations Code N81 (OPNAV N81) focuses on disseminating the Navy's warfighting capability/risk analysis products to the broader S&T community resulting in an improved influence of requirements pull on S&T.<br><br>- SA, is part of the ONR internal strategy cell membership for updating the Navy S&T Strategic Plan.<br><br>- SA, Naval Mine and Anti-Submarine Warfare Command (NMAWC) works with the Commander NMAWC who is the lead for the FNC ASW sub-Integrated Program Team (IPT). The SA is directly responsible to the Commander for drafting/modifying capability gaps and enabling capabilities (EC) ideas, vetting them through the sub-IPT members, incorporating modifications, and providing the final recommendation to the Commander for presentation to the Sea Shield IPT. The SA advises Commander on Navy's Tactical ASW and MIW support and countermeasures. | | | | | |
| ***FY 2015 Plans:***<br>International Science Program:<br>- Continue all efforts of FY 2014.<br><br>Fleet/Forces Science Advisors:<br>- Continue all efforts of FY 2014.<br><br>- SA, OPNAV N2/N6 advises the Deputy CNO for Information Dominance, and Flag and SES leadership on Navy S&T programs that address information dominance; member of FNC Technical Oversight Group (TOG) Working Group which prioritizes and selects fifteen EC products that address nine FNC Pillars (i.e. FORCEnet, | | | | | |

| Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy | | Date: February 2015 |
|---|---|---|
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| B. Accomplishments/Planned Programs ($ in Millions) | FY 2014 | FY 2015 | FY 2016 Base | FY 2016 OCO | FY 2016 Total |
|---|---|---|---|---|---|
| Sea Strike, Shield, and Basing); member of the FORCEnet IPT, Rapid Technology Transition Team, and Joint Concept Technology Demonstration Team that reviewed technology programs for the Fleet.<br><br>- SA, OPNAV N9, serves as the command's principal advisor and the senior representative of the DCNO on initiatives with S&T and Research and Development (R&D) organizations in government, academia, and industry. Advises on technical developments in support of platform warfighting wholeness and informs DCNO on strategic and program issues as they relate to topics in decision forums; and on S&T factors outside the normal Navy program planning process that could afford strategic opportunities or affect or disrupt existing strategies, investments and plans.<br><br>- SA, Commander, Navy Air and Missile Defense Command, (NAMDC) serves as the command's principal advisor and the representative of the Commander on Integrated Air and Missile Defense (IAMD) initiatives with S&T and R&D organizations in government, academia, and industry. The SA works as part of the Third Fleet Sea Shield Fleet Collaborative Team representing NAMDC. The SA looks at the applied research and S&T aspects of IAMD and align them with the defense industry to pinpoint key requirements and emerging new technologies.<br>***FY 2016 Base Plans:***<br>International Science Program:<br>- Continue all efforts of FY 2015, less those noted as completed above.<br><br>Fleet/Forces Science Advisors:<br>- Continue all efforts of FY 2014.<br>***FY 2016 OCO Plans:***<br>N/A | | | | | |
| ***Title:*** TRAINING TECHNOLOGIES<br>***Description:*** Training technologies enhance the Navy's ability to train effectively and affordably in classroom settings, in simulated environments, while deployed, and to operate effectively in the complex, highstress, information-rich and ambiguous environments of modern warfare such as asymmetric warfare. Technology development responds to a variety of requirements, including providing more affordable approaches to training and skill maintenance. Improved training efficiency and cost-effectiveness is achieved by applying operations | 4.969 | 4.895 | 4.600 | - | 4.600 |

| Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy | | Date: February 2015 |
|---|---|---|
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| B. Accomplishments/Planned Programs ($ in Millions) | FY 2014 | FY 2015 | FY 2016 Base | FY 2016 OCO | FY 2016 Total |
|---|---|---|---|---|---|
| research, modeling and simulation, and instructional, cognitive, and computer sciences to the development, delivery, evaluation, and execution of training.<br><br>***FY 2014 Accomplishments:***<br>Cognitive Science of Learning:<br>- Continued research and assessment of advanced gaming technology for enhanced training.<br>- Continued creation and conduct of experiments to validate automated performance assessment and after action reviews.<br>- Continued a systematic program of applied research addressing unanswered questions regarding effective instructional strategies in artificially intelligent tutoring.<br>- Continued research in the neuro-biology of learning including integration of the role of white matter.<br>- Continued development of games that incorporate AI techniques to teach complex warefighter skills decision-making and problem solving.<br>- Continued development of intelligent avatars to interact with learners from different cultural, linguistic backgrounds, and preferences.<br>- Continued development of scenarios generators that produce integrated training (e.g., individual and collective) training.<br>- Continued development of optimal training strategies for intelligent jobs on mobile devices ( e.g., IPad).<br>- Continued development of immersive environments for training interpersonal and leadership skills.<br>- Continued design and conduct experiment to assess training effectiveness of intelligent tutor for training ship handling skills.<br>- Continued development of novel psychometric approaches to assess human performance in medical/ military simulations and simulators.<br>- Continued research in design features of medical and military simulators and simulations.<br>- Continued field studies and user tests evaluating new features and job aiding tools.<br>- Continued research into computational neuron-models in the design of training systems.<br><br>Enhancing Warfighter Cognitive Capability:<br>- Continued research to understand the structural relations among the latent variables of short-term memory, working memory, executive attentional control, and fluid intelligence.<br>- Continued research to assess the improvement in recruit classification provided by the addition of measures of fluid intelligence and working memory. | | | | | |

| Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy | | Date: February 2015 |
|---|---|---|
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| B. Accomplishments/Planned Programs ($ in Millions) | FY 2014 | FY 2015 | FY 2016 Base | FY 2016 OCO | FY 2016 Total |
|---|---|---|---|---|---|
| - Continued research to understand the role of intrinsic motivation in facilitating the transfer of working memory training to other cognitive capabilities.<br>- Continued research to assess the efficacy of game-based brain training using hand-held (fieldable) hardware platforms.<br>- Continued research to determine the relationship between induced gains in fluid intelligence and cognitive adaptability and agility, considered from the perspective of military decision-making.<br>- Continued task to develop multi-agent based architectures for modeling human behavior, improve techniques for human cognitive and behavioral modeling, and create highly realistic simulated teammates.<br><br>Computational Models of Human Behavior:<br>- Continued research into game based training to more effectively enable better warfighter understanding of languages and cultures to enhance their regional expertise.<br>- Continued research on software tools to facilitate building natural language tutorial dialogs for artificially intelligent tutoring.<br>- Continued the integration of cognitive and neuron-computational models of human learning. | | | | | |
| ***FY 2015 Plans:***<br>Cognitive Science of Learning:<br>- Continue all efforts of FY 2014, less those noted as completed above.<br><br>Enhancing Warfighter Cognitive Capability:<br>- Continue all efforts of FY 2014, less those noted as completed above.<br><br>Computational Models of Human Behavior:<br>- Continue all efforts of FY 2014, less those noted as completed above. | | | | | |
| ***FY 2016 Base Plans:***<br>Cognitive Science of Learning:<br>- Continue all efforts of FY 2015, less those noted as completed above.<br>- Initiate development of skill decay models for psychomotor, perceptual, and cognitive skills and refresher training strategies.<br>- Initiate development of intelligent avatars to interact with learners from different cultural, linguistic backgrounds, and preferences. | | | | | |

| Exhibit R-2A, RDT&E Project Justification: PB 2016 Navy | | Date: February 2015 |
|---|---|---|
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| B. Accomplishments/Planned Programs ($ in Millions) | FY 2014 | FY 2015 | FY 2016 Base | FY 2016 OCO | FY 2016 Total |
|---|---|---|---|---|---|
| - Initiate development of scenarios generators that produce integrated training (e.g., individual and collective) training.<br><br>Enhancing Warfighter Cognitive Capability:<br>- Continue all efforts of FY 2015, less those noted as completed above.<br><br>Computational Models of Human Behavior:<br>- Continue all efforts of FY 2015, less those noted as completed above.<br>***FY 2016 OCO Plans:***<br>N/A | | | | | |
| **Accomplishments/Planned Programs Subtotals** | 49.083 | 46.923 | 45.056 | - | 45.056 |

**C. Other Program Funding Summary ($ in Millions)**

N/A

**Remarks**

**D. Acquisition Strategy**

N/A

**E. Performance Metrics**

As discussed in Section A, there are a significant number of varied efforts within this PE. Each effort is measured against both technical and financial milestones. Each program effort and its projects are reviewed in depth for technical and transition performance against established goals. The Program Managers conduct routine site visits to performing organizations to assess programmatic and technical progress and most projects conduct an annual or biannual review by an independent board of visitors who assess the level and quality of the Science and Technology (S&T) basis for the project.