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

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

(U) COST: (Dollars in Thousands)

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

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

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

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

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

(U) PROGRAM ACCOMPLISHMENTS AND PLANS:

1. (U) FY 2001 ACCOMPLISHMENTS:

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

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Initiated FY01

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

Continued FY01

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

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

Completed FY01

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

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

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

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

Initiated FY01

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

Continued FY01

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

Completed FY01

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

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

Initiated FY01

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

Completed FY01

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

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

Initiated FY01

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

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

Continued FY01

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

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

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

Completed FY01

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

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

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

Initiated FY01

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

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

Continued FY01

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

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

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

Completed FY01

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

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

Initiated FY01

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

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

Continued FY01

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

Completed FY01

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

2. (U) FY 2002 PLAN:

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

Initiate FY02

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

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

Continue FY02

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

Complete FY02

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

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

Initiate FY02

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

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

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

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

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

Continue FY02

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

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

Complete FY02

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

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

Initiate FY02

- (U) Initiate algorithm development to incorporate captured use rates, improve source data quality, improve sustainment rate calculation, and establish stockage levels that are situationally dependent. This will provide a

technology foundation to credibly automate many of the manual functions that drive logistics supportability determination. The automation is critical to battlefield information sharing.

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

Continue FY02

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

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

Initiate FY02

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

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

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

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

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

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

Initiate FY02

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

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

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

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

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

Continue FY02

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

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

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

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PROGRAM ELEMENT TITLE: Warfighter Sustainment Applied Research

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

Complete FY02

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

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

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

Initiate FY02

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

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

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

Continue FY02

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

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BUDGET ACTIVITY: 2 PROGRAM ELEMENT: 0602236N

PROGRAM ELEMENT TITLE: Warfighter Sustainment Applied Research

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

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

Complete FY02

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

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

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

Initiate FY02

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

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

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

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

Continue FY02

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

Complete FY02

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

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

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

Initiate FY02

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

Continue FY02

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

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

Complete FY02

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

3. (U) FY 2003 PLAN:

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

Initiate FY03

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

Continue FY03

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

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

Complete FY03

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

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

Initiate FY03

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

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Continue FY03

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

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

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

Complete FY03

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

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

Initiate FY03

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

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Continue FY03

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

Complete FY03

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

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

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

Initiate FY03

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

Continue FY03

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

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

Complete FY03

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

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

Initiate FY03

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

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

Continue FY03

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

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

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

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

Complete FY03

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

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PROGRAM ELEMENT TITLE: Warfighter Sustainment Applied Research

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

Initiate FY03

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

Continue FY03

- (U) Continue to evaluate ways to protect hearing and balance through new protective systems. The research includes studies of new materials that reduce noise levels when applied to personal hearing protection as well as structural

insulations. Additional work will continue to develop clinical strategies and interventions such as new drugs to protect and restore hearing and balance progress.

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

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

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

Complete FY03

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

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

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

Initiate FY03

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

Continue FY03

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

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

Initiate FY03

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

Continue FY03

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

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

Complete FY03

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

(U) PROGRAM CHANGE SUMMARY:

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

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

(U) CHANGE SUMMARY EXPLANATION:

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

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PROGRAM ELEMENT: 0602236N
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(U) OTHER PROGRAM FUNDING SUMMARY:

(U) NAVY RELATED RDT&E:

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

(U) NON-NAVY RELATED RDT&E:

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

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

E. (U) SCHEDULE PROFILE: Not applicable.