NAVY
PROPOSAL SUBMISSION
INTRODUCTION

The responsibility for the implementation, administration and management of the Navy SBIR program is with the Office of Naval Research (ONR). The Navy SBIR Program Manager is Mr. Vincent D. Schaper, (703) 696-8528. The Deputy SBIR Program Manager is Mr. John Williams, (703) 696-0342. If you have any questions of a specific nature, you may contact one of the above persons. For general inquiries or problems with the electronic submission, contact the DoD Help Desk at 1-800-382-4634. For technical questions about the topic, contact the Topic Authors listed on the website on or before 1 December 2000. Mail one original and four copies of your Phase I proposal to the address below. Proposals must be received by **10 January 2001**.

U.S Mail packages send to:
Office of Naval Research
ONR 364 SBIR
Ballston Tower #2, Room 106
800 North Quincy Street
Arlington, VA 22217-5660

Overnight Mail Services or Courier packages send to:
Office of Naval Research
ONR 364 SBIR
Ballston Tower #2, Room 106
801 North Randolph Street
Arlington, VA 22203

The Navy's SBIR program is a mission-oriented program that integrates the needs and requirements of the Navy through R&D topics that have dual-use potential. All Navy SBIR topics fall within the DoD Science and Technology areas and the Navy Science areas, listed in Table 1. Navy topics will be funded from these areas according to a priority established to meet the Navy's mission, goals and responsibilities. Information on the Navy SBIR Program can be found at **http://www.onr.navy.mil/sbir**. Additional information pertaining to the Department of the Navy's mission can be obtained by viewing the website at **http://www.navy.mil**.

YOUR SUBMISSION TO THE NAVY SBIR PROGRAM:

When you prepare your proposal, keep in mind that Phase I should address the feasibility of a solution to the topic. The Phase I option should address the transition into the Phase II effort. The Phase II is the demonstration of the technology that was found feasible in Phase I. Only those Phase I awardees which have been **invited** to submit a Phase II proposal by that Activity's proper point of contact, listed in Table 2, during or at the end of a successful Phase I effort will be eligible to participate for a Phase II award (with the exception of Fast Track Phase II proposals). If you have been invited to submit a Phase II proposal to the Navy, obtain a copy of the Phase II instructions from the Navy SBIR website or request the instructions from the Navy Activity POC listed in Table 2. Phase III efforts should also be reported to the Navy SBIR program office noted above.

The Navy will provide potential awardees the opportunity to reduce the gap between Phase I and Phase II if they provide a $70,000 maximum feasibility Phase I proposal and a fully costed, well defined Phase I Option that does not exceed $30,000. The technical period of performance for the Phase I should be 6 months and for the Phase I option should be 3 months. The Phase I Option should be the initiation of the next phase of the SBIR project (i.e. initial part of Phase II). The Navy will also offer a "fast track" into Phase II to those companies that successfully obtain third party cash partnership funds ("Fast Track" is described in Section 4.5 of this solicitation). Phase I proposals, including the option, have a 25-page limit (see section 3.3). The Navy will evaluate and select Phase I proposals using scientific review criteria based upon technical merit and other criteria as discussed in this solicitation document. Due to limited funding, the Navy reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded.

Upon receiving an invitation, submission of a Phase II proposal should consist of three elements: 1) a $600,000 base effort, which is the demonstration phase of the SBIR project; 2) a separate 2 to 5 page Transition/Marketing plan (formerly called a "commercialization plan") describing how, to whom and at what stage you will market/transition your technology to the government, government prime contractor, and/or private sector; and 3) at least one Phase II

Option ($150,000) which would be a fully costed and well defined section describing a test and evaluation plan or further R&D if the Transition/Marketing plan is evaluated as being successful. Phase II efforts are typically two (2) years and Phase II options are typically an additional six (6) months. Some Navy Activities have different schedules and award amounts; you are required to get specific guidance from them before submitting your Phase II proposal. You must also submit your Phase II Proposal Cover Sheet, Commercialization Report, and Transition/Marketing plan electronically. Phase II proposals together with the Phase II Option are limited to 40 pages (unless otherwise directed by the TPOC or contract officer). The Transition/Marketing plan must be a separate document that is submitted through the Navy SBIR website under "Submission" and included with the proposal hard copy.

NAVY REQUIREMENTS:

(1) The Navy requires a DoD Proposal Cover Sheet (formerly Appendix A & B) to be submitted electronically through the Navy SBIR website or DoD SBIR website at: **http://www.dodsbir.net/submission**. *The company must print out the forms directly from the website, sign the forms and submit them with their proposal*. If you have any questions or problems with the electronic submission contact the DoD SBIR Helpdesk at 1-800-382-4634. Submit electronic Internet forms early. As the deadline for proposal submission approaches, computer traffic increases slowing down computer speed. **Do not wait until the last minute**.

(2) The Navy only accepts Phase I proposals with a base effort not exceeding $70,000 and with the option not exceeding $30,000.

(3) All Phase I award winners must electronically submit a Phase I summary report through the Navy SBIR website at the end of their Phase I.

(4) Phase II award winners must also submit Phase II summary reports through the Navy SBIR website.

NEW NAVY REQUIREMENTS:

(1) All Phase II proposals must have a Proposal Cover Sheet and Commercialization Report submitted through the DoD SBIR website and Transition/Marketing plan submitted through the Navy SBIR website.

(2) All Phase II award winners must attend a two day Commercialization Assistance/Business Plan Development Course from the Navy. This is typically taken at the beginning of the 2nd year of the Phase II.

ADDITIONAL NOTES:

1. The Small Business Administration (SBA) has made a determination that will permit the Naval Academy, the Navy Post Graduate School and the other military academies to participate as subcontractors in the SBIR/STTR program, since they are institutions of higher learning.

2. The Navy will allow firms to include with their proposals, success stories that have been submitted through the Navy SBIR website at **http://www.onr.navy.mil/sbir**. A Navy success story is any follow-on funds that the firm has received from a past Phase II Navy SBIR or STTR award. The success story should then be printed and included as appendices to the proposal. These pages will not be counted towards the 25-page limit. The success story information will be used as part of the evaluation of the third criteria, Commercial Potential (listed in Section 4.2 of this solicitation) which includes the Company's Commercialization Report (formerly Appendix E) and the strategy described to commercialize the technology discussed in the proposal. The Navy is very interested in companies that transition SBIR efforts directly into Navy and DoD programs and/or weapon systems. If a firm has never received a Navy SBIR Phase II it will not count against them.

3. Effective in Fiscal Year (FY) 2000, a Navy activity will not issue a Navy SBIR Phase II award to a company when the elapsed time between the completion of the Phase I award and the actual Phase II award date is eight (8) months or greater; unless the process and the award has been formally reviewed and approved by the Navy SBIR Program Office. Also, any SBIR Phase I contract that has been extended by a no cost extension beyond one (1) year will be ineligible for a Navy SBIR Phase II award using SBIR funds.

4. The Navy has adopted a New Phase II Enhancement Plan to encourage transition of Navy SBIR funded technology to the Fleet. Since the Law (PL102-564) permits Phase III awards during Phase II work, the Navy will provide a 1 to 4 match of Phase II to Phase III funds that the company obtains from an acquisition program. Up to $250,000 in

additional SBIR funds can be provided as long as the Phase III is awarded and funded during the Phase II. If you have questions, please contact the Navy Activity POC.

5. The Navy typically provides a firm fixed price contract or awards a small purchase agreement as a Phase I award; and a cost plus fixed fee or an Other Transition Agreement (OTA) as a Phase II award. The type of award is at the discretion of the contracting officer.

ELECTRONIC SUBMISSION OF PROJECT REPORTS:

The submission of an electronic Phase I Summary Report is required at the end of Phase I. The Phase I Summary Report is a non-proprietary summary of Phase I results and should include potential applications and benefits and not exceed 700 words. It should require minimal work from the contractor because most of this information is required in the final report. The summary of the final report will be submitted through the Navy SBIR/STTR Website at: http://www.onr.navy.mil/sbir, click on "Submission", then click on "Submit a Phase I or II Summary Report".

NAVY FAST TRACK DATES AND REQUIREMENTS:

The Fast Track application must be received by the Navy 150 days from the Phase I award start date. Any Fast Track applications received thereafter may be declined. All Fast Track applications and required information must be sent to the Navy SBIR Program Manager at the address listed above, to the designated Contracting Officers Technical Monitor (the Technical Point of Contact (TPOC)) for the contract, and the appropriate Navy Activity SBIR Program Manager listed in Table 2 of this Introduction. The dates and information required by the Navy are the same as the dates and information required under the DoD Fast Track described in the front part of this solicitation.

TABLE 1. NAVY MISSION CRITICAL SCIENCE AND TECHNOLOGY AREAS

TECHNOLOGY AREAS
Aerospace Propulsion and Power
Aerospace Vehicles
Battlespace Environment
Chemical and Biological Defense
Clothing, Textiles and Food
Command, Control and Communications
Computers, Software
Conventional Weapons
Electron Devices
Electronic Warfare
Environmental Quality and Civil Engineering
Human-System Interfaces
Manpower, Personnel and Training Systems
Manufacturing Technology
Materials, Processes and Structures
Medical
Sensors
Surface/Undersurface Vehicles/Ground Vehicles
Modeling and Simulation

SCIENCE AREAS
Atmospheric and Space
Biology and Medicine
Chemistry
Cognitive and Neural
Computer Sciences
Electronics
Environmental Science
Manufacturing Science
Materials
Mathematics
Mechanics
Ocean Science
Physics

PHASE I PROPOSAL SUBMISSION CHECKLIST:

All of the following criteria must be met or your proposal will be REJECTED.

(1) The DoD Proposal Cover Sheet (formerly Appendix A & B) and the DoD Commercialization Report (formerly Appendix E) have been submitted electronically over the Internet through the submission site.

(2) The Cover Sheet has been printed directly from website, signed, and is the first page of the proposal.

(3) The Company Commercialization Report was submitted electronically, printed, signed and attached to the back of the original and each copy of the proposal. This report is required even if the company has not received SBIR funding.

(4) The Phase I proposed cost for the base effort does not exceed $70,000. The Phase I Option proposed cost does not exceed $30,000. The costs for the base and option are clearly separate, and identified on the Proposal Cover Sheet, in the signed cost proposal, and in the work plan section of the proposal.

(5) An original and 4 copies of the proposal must be received on or before 10 January 2001. The Navy will not accept late or incomplete proposals.

NAVY 01.1 SBIR TITLE INDEX

Strategic Systems Programs (SSP)

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Marine Corps Systems Command (MARCORP)

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Naval Air Systems Command (NAVAIR)

N01-007 Advanced Antenna Array and FSS/FSV Design Software
N01-008 Automatic Test Equipment (ATE) Commercial-Off-the-Shelf (COTS) Replacement for Obsolete Instruments
N01-009 Low-Cost Sonobuoy Geographic Position Locator
N01-010 Large Format Resistive Arrays (LFRA) for Infrared Scene Projectors (IRSP)
N01-011 Web-Based and Traditional Classroom Lesson Design Guide
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N01-013 Mid-Air Collision Avoidance System (MCAS) Using Mode 5
N01-014 Environmental Assessments and Mitigation of Naval Operations (Air and Surface)
N01-015 Digital Data Download (D3) with Crash Survivable Memory
N01-016 Development of New Processes for the Refurbishment of Infrared Search and Track (IRST) Germanium (Ge) domes
N01-017 Shallow Water Bottom Characteristic Measurement Sensors
N01-018 Semi-Active Side-Lateral Engine Mounts for Control of Vibration and Shock Loading
N01-019 Advanced Rotorcraft Shipboard Landing Aerodynamic Interference Software Modules
N01-020 Software Cost and Schedule Estimating
N01-021 Low-Drag Aircraft Slip Resistant Surface Treatment
N01-022 Fasteners/Rivets for Watertight Integrity and Corrosion Prevention in Permanent Application
N01-023 Low-Cost Missile Environment Monitor
N01-024 Innovative Gas Turbine Engine Propulsion
N01-025 Fiber Optic / High Voltage Cables and Connectors
N01-026 Nondestructive Evaluation (NDE) of Composite Parts Prior to Cure

Naval Facilities Engineering Services Command (NAVFAC)

N01-027 Sprayable Polysulfide Elastomeric Development
N01-028 Flexible Marking Paint for Asphaltic Airfield Pavements
N01-029 Marking Paint for Portland Cement Concrete (PCC) Airfield Pavements with High Adhesion

Office of Naval Rsearch (ONR)

N01-030 Breaking the 1 Joule/cm3 Barrier for High Power Capacitors
N01-031 Digital Compensation for Distortion
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N01-034 Compact High-Power Electronic Components
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N01-044 Device Independent Voice-To-Voice Language Translation Software
N01-045 Blue Optoelectronics
N01-046 Sonar Stimulation for Virtual Targets in Netted, Tactical ASW Training on Legacy Submarines

N01-047 Optical Particle Size Spectrometer For Monitoring Particle Size And Concentration In Aircraft Sampling Inlets And Ducts

Space & Naval Warfare Systems Command (SPAWAR)
N01-048 Indications and Warning (I&W) Inference Engine for the Information Warfare (IW) Picture
N01-049 Enhanced Data Rate Performance for VLF/LF
N01-050 Bandwidth Efficient Remote Manipulation and Fusion of Huge Data Sets
N01-051 Optical Powering Of Systems
N01-052 Compressed Internet Protocol (IP) Data Via Geosynchronous Earth Orbit (GEO) Satellite Circuits
N01-053 Simulation Runtime Prediction System
N01-054 Precise Time and Frequency for Navy Applications
N01-055 IW (Information Warfare) Sensor and Wireless Network for Recovery of Wide-band Data
N01-056 Characterizing the Shallow Water Environment and Ambient Noise using In Situ and Remotely Sensed Information

Naval Sea Systems Command (NAVSEA)
N01-057 Effectiveness of doubler plates as a permanent repair under cyclic loads in a highly corrosive environment
N01-058 Wireless Interface to Programmable Logic Controllers (PLC)
N01-059 Portable, wireless transmitting accelerometer for measuring vibration
N01-060 Damage Tolerant Composite Scuttles and Hatches
N01-061 Development of Probabilistic Design Primary Loads (Vertical & Lateral Bending) for use in a Weight Optimized Structural Design of CVNX
N01-062 Relay Replacement
N01-063 Data-fusion for Advanced Cathodic Protection Monitoring and Control for Marine Structures
N01-064 Aircraft Carrier Oxygen Producer Lower Cost Alternative
N01-065 High Temperature Pipe and Equipment Insulation
N01-066 Fully Automated Cargo Handling System
N01-067 Reverse Osmosis (RO) for use in Polluted Waters
N01-068 Chaos Techniques to Predict Ship Motion for Amphibious Operations
N01-069 Shipboard Bio-mechanical Oil Water Separator
N01-070 High Volume Underway Replenishment Circulating Ropeway
N01-071 Water-Wet Pelletized Nitrocellulose Dehydration
N01-072 Improved Magnetostrictive Materials
N01-073 Development of Low-Cost Manufacturing Process for 1, 2, 4-Butanetriol (BT)
N01-074 Drag Reduction in Water
N01-075 Advanced, High Momentum Recoil System for Naval Guns
N01-076 Flexible, Low-Noise Air Management
N01-077 Projectile inertial navigator from COTS instruments
N01-078 Improved Sonar Dome Window Materials that are Acoustically Transparent across a Wide Frequency Range
N01-079 Run-Time Reallocation of Computing Resources in a Heterogeneous Networked Computing Environment
N01-080 Fault Location in an Intelligent Open Sensor Network
N01-081 New Sabot and Pusher Plate Concepts for Barrage Round
N01-082 Application of JINI Technology to Tactical System Integration
N01-083 Submarine Mast Detectability Reduction
N01-084 Technology for Torpedo Affordability
N01-085Investigation into the use of wireless technology to eliminate cabling in Submarine Command, Control, Communications and Computers (C4I) System Design
N01-086 Transient Shock Resistance of COTS Electronics
N01-087 Low Cost Compression Techniques Applied To Encrypted Data Distribution System
N01-088 Affordable High Performance Shock and Vibration Mitigating Mount
N01-089 Dynamically Optimized Team Performance
N01-090 TBMD Tactical Telemetry Transmitting System
N01-091 Interference Suppression Techniques Development for Future Combat Scenarios
N01-092 Dynamic Sensor/Weapon Alignment Algorithms
N01-093 Advanced Personal Communicator (APC)
N01-094 Model Based Tools and Methodologies for Embedded Systems Software Development.
N01-095 Main Beam Jamming Nulling in Phased Array Radars
N01-096 New Non-Cooperative Target Recognition (NCTR) Techniques Development
N01-097 Electrostatic Discharge Analysis of Reactive Material Formulations

N01-098 A Navigation Agent (NavAgent) Tool for Shipboard Navigation & Weapons Systems Integration
N01-099 Utilization of Atmospheric Refractivity Information to Improve Radar Operation in Littoral Environments
N01-100 Mission Planning for Tactical Shipboard EW Systems
N01-101 Maintenance Skills Training Through Distributed Learning Principles
N01-102 Risk-Based Maintenance Strategies to Reduce Total Ownership Costs
N01-103 Ultra Wideband Active Acoustic Conformal Array Module
N01-104 Underwater Velocity Indicator
N01-105 All Optical Towed Array Position Measurement System
N01-106 Propulsion Shaft Interrogation
N01-107 Concentric Stock Dynamometers for Measuring Flap Loads on Flapped Appendages

Strategic Systems Programs (SSP)

N01-001 TITLE: Radiation Hardened Electronics Packaging for Strategic Missile Guidance System Upgrades

TECHNOLOGY AREAS: Electronics

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT I: Strategic Systems Programs

OBJECTIVE: Develop and certify radiation hardened die packaging approaches and materials suitable for storage in a submarine-launched, ballistic missile environment.

DESCRIPTION: Guidance systems used on sea-based vehicles are often stored for long periods of time (10 to 30 years) in a semi-controlled environment. The electronics are utilized during the life of the system and must operate with a high degree of reliability when they are needed. The Navy anticipates that future upgrades to electronic components will require radiation-hardened die in packages that will ensure reliability and performance of the devices. The packaging approaches must ensure that the radiation hardness of the device is uncompromised and that the typical failure modes due to packaging are mitigated. Some of the failure modes to be addressed include moisture absorption, corrosion, solid-state diffusion of materials, package cracking, and lack of heat dissipation. The packaging approaches need to consider both plastic and ceramic packaging materials. Interconnections of the package to the board substrate need to be addressed, with emphasis on quality inspections and repair processes. Thermal expansion coefficient (TCE) and other material compatibility issues should also be addressed.

PHASE I: Concepts for packaging radiation-hardened die will be identified and analysis will be performed to predict the behavior of the packaged components subjected to the conditions encountered in the packaging, board assembly and end use environment. Coupon and sub-element tests will be performed to determine the feasibility of the packaging concepts.

PHASE II: The designs researched in Phase I will be refined and the packaging approaches will be developed. The manufacturing processes for producing the package designs will be developed and proven to be suitable for production. A specific application will be selected and the packaging concepts will be certified using procedures that are suitable for military electronics applications.

PHASE III: Productize the design and processes developed in Phases I and II. Transition this capability to the D5LE Program for packaging of radiation-hardened die.

COMMERCIAL POTENTIAL: Packaging solutions that provide uncompromised radiation hardening and high reliability for the Strategic Systems application will defacto solve the less stressing applications of commercial satellites, and both civilian and military space vehicles. Further, mitigation of the failure modes stated above, such as moisture absorption, has direct application to consumer electronics such as cellular phones and laptop computers.

KEYWORDS: electronics; packaging; radiation; missile; reliability; thermal expansion coefficient

Marine Corps Systems Command (MARCORP)

N01-002 TITLE: Ceramic Barrels for Small Arms

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Research and develop a ceramic composite material that exhibits superior wear and heat transfer properties with the intent of applying that technology to infantry small arms. Research, design, and, develop technologies that allow ceramic composite barrels to be reliably attached to infantry small arms.

DESCRIPTION: This topic seeks to advance the technology in small arms gun barrel design through the use of ceramics to reduce bore erosion, eliminate corrosion and significantly reduce the exchange of thermal energy between the combustion of the ammunition propellant and the barrel. In addition, the use of ceramics coupled with composite materials is expected to reduce the mass of existing gun barrel designs. As residual benefits of advanced gun barrel technology, the Marine Corps may be able to reduce their weapon life cycle costs by extending barrel life, eliminate spare barrel requirements and reducing on-hand inventory assets. Very recent technological developments in ceramic composite materials provide promising physical characteristics for small arms gun barrel applications, in particular the M249 Squad Automatic Weapon. This technology promises to solve the shock resistance problems encountered in past efforts with ceramic barrels or barrel liners. Research is necessary to determine the best method of producing a ceramic composite barrel that can replace an existing infantry machine gun barrel. Past research efforts in the area of ceramic barrels or barrel liners have encountered difficulty due to the material and dynamic response characteristics of the currently available ceramics. These efforts have also tended to focus on larger caliber weapons and the corresponding handling environments. The problems encountered due to rough handling and higher rates of fire encountered in the infantry combat environment have not been addressed. This effort will address these deficiencies.

PHASE I: Investigate ceramic composite manufacturing processes that exhibit superior wear and heat transfer properties to ensure that the necessary material physical characteristics for gun barrels are met. Research and develop optimal material process for ensuring that the ceramic composite barrel will be able to interface and reliably function with existing weapons. Via Modeling and Simulation ensure barrel designs have necessary structural and mechanical properties.

PHASE II: Fabricate ceramic barrels for a selected light/heavy machinegun and conduct live fire testing to verify chamber/port pressures, ballistic performance, thermal characteristics and reliability of the ceramic barrel technology. Conduct life cycle dynamic and environmental testing to ensure the ceramic barrel technology can survive the operational environments encountered in the Marine Corps.

PHASE III: Demonstrate producibility of ceramic barrel technology and develop fielding plan for replacing existing barrels on fielded small arms in the Marine Corps.

COMMERCIAL POTENTIAL: Ceramic barrel technology could be directly applied to the commercial small arms industry. In addition, this technology may have application to other industries requiring a wear resistant surface under high temperatures and pressures. Examples in the automotive industry being lightweight internal combustion engine cylinders, brake cylinders and bushings/bearings.

REFERENCES:
(1) Machine Guns and Machine Gunnery, MCWP 3-15.1 United States Marine Corps (1996)
(2) Technical data package: 9348199; MACHINE GUN, 5.56mm M249 W/E
(3) Handbook on Weaponry, Rheinmetall GmbH (1982)
(4) Engineering Design Handbook Guns Series Automatic Weapons, Headquarters, U.S. Army Materiel Command (1970)

KEYWORDS: Ceramic; Barrel; Liners; Lightweight; Composite; Erosion

N01-003 TITLE: Enabling Technologies for Eye-Safe Laser Range Gated System Development

TECHNOLOGY AREAS: Sensors

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: Coastal Battlefield Reconnaissance and Analysis

OBJECTIVE: Develop an eye-safe laser range gated system and associated enabling up-conversion technologies.

DESCRIPTION: Recent developments in lasers and improved non-linear materials and techniques offer an opportunity to develop viable LADAR range gated systems that will operate in the eye-safe infrared optical band. Both civilian and military potential users have long understood the value of applying laser range gating principles to develop systems that can "see" through battlefield conditions and weather obscurants like fog, rain and, snow. Although many LADAR systems have been designed, and a few deployed, the chronic problem with these active systems is the potential eye damage hazard to friendly forces and civilians. The eye safety issue has repeatedly eliminated superior performance range gated LADAR based systems from both civilian and military applications. CCD, CID, CMOS or similar array based imagers and classical night vision image intensifier technology has not provided suitable solutions for the receiver requirements of a Range Gated LADAR system that can operate in the eye-safe 1.5um band. Enabling technology advances are sought that lead to a small, fieldable, eye-safe laser range gated imaging system capable of operating at clear atmosphere ranges in excess of 1km. Proposals do not need to address all elements of the system but must identify how the system performance benefits from the technology offered. Full system or component solutions addressing transmitter, receiver, control & timing, or optics will be considered.

PHASE I: Design a system that incorporates enabling technology principles and component designs and relate the results to eye-safe laser range gated imaging system performance improvement through the use of modeling, analysis, empirical testing or construction. The results of the investigation must address technology risks and include a technology optimization path and system design that will provide a guide to Phase II activity.

PHASE II: Utilize the findings established in Phase I to develop, construct and test a prototype of the enabling technology and apply it to a functioning eye-safe laser range gated imaging system demonstration.

PHASE III: Advancement in eye-safe laser range gated imaging can serve both the civilian and military needs. Common application needs include navigation, law enforcement, security systems, hazardous environment monitoring, and surveillance. Additional military applications include reconnaissance, targeting, IFF, guidance, and near-covert operations support.

COMMERCIAL POTENTIAL: This system could provide useful information to a variety of industry areas including remote sensing, biomedical imaging, environmental and agricultural monitoring, pollution monitoring, navigation, and law enforcement,

REFERENCES:
(1) Witherspoon, Holloway, "Feasibility Testing of a range-gated laser illuminated underwater imaging system," Proceeding of the International Society for Optical Engineering, Vol 1302, Ocean Optics X, April 1990, pp 414-420.
(2) Witherspoon, Holloway, et. al., "Measured Degradation in Image Quality When Imaging Through A Wavy Air-Water Interface, Proceedings of the Society of Photo-Optical Instrumentation Engineers, Ocean Optics IX, April 1988.

(3) Witherspoon, Holloway, et. al., "Experimentally Measured MTF's Associated with Imaging Through Turbid Water," Proceedings of the Society of Photo-Optical Instrumentation Engineers, Ocean Optics IX, April 1988.
(4) Holloway, Lorenzo, Pham, "Gated Laser Video Sensor (GLVS) Large Area Smoke Experiment (LASEX) Report," NCSC Report, Oct 94
(5) Holloway, "Gated Laser Video Sensor Smoke Week Test Plan," NCSC Report, April 94
Witherspoon, Holloway, et. al., "Experimental Results of Single Pulse Imaging Through Turbid Water of up to 2 Meter Depth Using a Blue-Green Short Pulse Width Laser and a CID Gated Array Camera System." NCSC Technical Report.
(6) Blume, "Enhancement of the Gated Laser Video Sensor Image Synthesis Tool - Final Report,"
(7) Blume, "Gated Laser Video Sensor Image Synthesis Tool Simplified Model - Final Report," Oct 94
(8) Blume, "Gated Laser Video Sensor Image Synthesis Tool Simplified Model - Users Manual," Oct 94

KEYWORDS: Ladar; Range Gating; Gated Imaging; Laser Radar; Eye Safe Lasers

N01-004 TITLE: High Performance Composite Backing Armor System for the Advance Amphibious Assault Vehicle (AAAV)

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: AAAV

OBJECTIVE: Develop and demonstrate a low cost, high performance composite backing armor system. Cost savings should be realized through innovative fabrication methods and material substitutions. Every effort should be made to reduce cost while minimizing weight and thickness. The material system must be able to defeat a 20mm fragment simulating projectile at specified velocities. The material must also meet other vehicle requirements such as acceptable fire, smoke and toxicity levels, and be suitable for use in a marine environment.

DESCRIPTION: The AAAV requires lightweight components that can be affordably produced and assembled. The goal of this SBIR is to develop an effective armor system that can use low cost materials while minimizing overall weight. Reduction in fabrication or material cost of the armor solution translates into a meaningful reduction in the vehicle cost. The state of the art armors are constantly improving and there are numerous materials and combinations of materials to be explored. Proposals should focus on ways to reduce the overall installed armor costs through material, manufacturing, and/or installation innovations. This program may require access to classified information and a DD 254 will be required for a contract award.

PHASE I: Develop a composite armor solution capable of minimizing weight and cost. Develop a ballistic test plan for evaluating materials. The contractor shall have the prototype armor system tested by an approved, independent laboratory to verify performance against the test plan. The contractor shall have the prototype armor system tested to verify smoke and flammability properties. A manufacturing plan, identifying key quality characteristics, will be developed to achieve the cost goals while maintaining form, fit and function during production. This plan will include the development of equipment to fabricate materials and parts as well as specifications for machining and quality assurance. The contractor will also develop production cost estimates and a plan for Phase II implementation.

PHASE II: Further develop and test (confirm performance) a range of possible solutions. Design and build a prototype machine to allow pilot plant manufacturing of armor systems. Produce pilot quantities of material and demonstrate that the system produces material that meets the ballistic, fire, smoke and toxicity and quality requirements as well as marine environment suitability.

PHASE III: Produce and market viable low cost composite armor.

COMMERCIAL POTENTIAL: There is a great demand for personnel armor protection in the commercial market. The material and resulting manufacturing approach can be directly translated into products for law enforcement, banks, and armored cars where weight and cost are the two major factors in the market. This armor system would also be a strong candidate for future combat vehicles including the Army's new Medium Brigade.

REFERENCES:
(1) "Ballistic Materials and Penetration Mechanics", Laible, 1980.
(2) "Modern Ballistic Armor", Long, June 1987.

KEYWORDS: Lightweight; Armor; Advance Amphibious Assault Vehicle (AAAV)

N01-005 TITLE: Personnel Identification

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: Clear Facilities, ACAT IV (T)

OBJECTIVE: This topic seeks to develop an advanced sensor system or system of systems that will provide a capability for the determination of the location, and other tactical status information on friendly personnel inside a building from a remote location.

DESCRIPTION: The Marine Corps needs a capability to sense/determine the location, and other tactical status information on friendly personnel inside a building from a remote location. The system will allow the Identification of Friend or Foe (IFF) for targeting and threat analysis if the system can detect Foes. It is desired that the system work through the ground, for personnel in caves, tunnels, or underground bunkers. The system can be continuous, intermittent, passive, or utilize an active initiator system. The system needs to work at as long a range and through as many types of materials as possible. The minimum range desired is from the outside wall of the target building or the surface of the ground outside an underground location.

PHASE I: Determine insofar as possible the scientific, technical, and commercial merit and feasibility of a system design, and analysis to establish expected performance. Develop the technology with brassboard models of the critical components that demonstrates the applicability to infrared, electromagnetic, directed energy, acoustic or any other detectable or producible signatures. Perform a trade-off analysis of the available potential technologies, report the results of the analysis and recommend two best value alternatives for providing the above capabilities based on cost, schedule, technical performance and risk.

PHASE II: Build a prototype of the alternative from Phase I that is selected by the government. The prototype shall be produced to best commercial practices. Develop a commercial marketing plan for the system.

PHASE III: Further develop the system for both commercial and military applications. The resultant system shall be made commercially available by the close of Phase III.

COMMERCIAL POTENTIAL: Military, fire & rescue, and law enforcement organizations have a need to determine the location of their own people and material inside of buildings.

REFERENCES:
(1) Mission Need Statement for Clear Facilities Reference number, LOG 1.85, 02/20/96

KEYWORDS: Remote sensors; Sensors; Identification of Friend or Foe (IFF)

N01-006 TITLE: Short Wavelength Diode Array Illuminator

TECHNOLOGY AREAS: Sensors

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: Coastal Battlefield Reconnaissance & Analysis

OBJECTIVE: Develop a diode array illuminator in the green portion of the visible spectrum to allow for night illumination and water penetration imaging capability.

DESCRIPTION: Recent developments in laser diode arrays offer greater opportunity to develop viable plug-n-play compact modular illuminators. Current programs are already investigating the Near Infra-Red (NIR) operable illuminators. However the technologies and materials have only recently matured to push the operation further into the visible portion of the electromagnetic spectrum. Potential value of applying compact imaging capabilities to a variety of sensor systems has great advantage for military systems. Further combining this with possible range-gating capabilities would greatly impact current imaging systems.

PHASE I: Investigate enabling technologies and component designs and relate the results to a laser diode array stack that will provide sufficient illumination for night time and through the water imaging while maintaining compactness and modularity. The diode array options will be detailed into possible prototype designs and study will include the use of modeling, analysis, empirical testing or construction of risk reduction parts or sub assemblies. The results of the investigation must include a technology optimization path and system design that will provide a guide to Phase II activity.

PHASE II: Utilize the findings established in Phase I to design, develop, construct and test a prototype of the enabling technology and apply it to a functioning green wavelength laser diode array illuminator with matched specifications to support a variety of sensor systems.

PHASE III: Advancement in compact and modular illumination systems can serve both the civilian and military needs. Common application needs include navigation, law enforcement, security systems, hazardous environment monitoring, and surveillance. Additional military applications include reconnaissance, targeting, IFF, guidance, and other overt/covert operations support.

COMMERCIAL POTENTIAL: This system could provide useful information to a variety of industry areas including remote sensing, biomedical imaging, environmental and agricultural monitoring, pollution monitoring, navigation, and law enforcement,

REFERENCES:

(1) Holloway, Cartland, Sawvel, “Demonstration of Night Time Land Mine Detection Through Contrast Reversal Using Active Diode Array Illumination”, Report on Phase II Hardware Fabrication.
(2) Holloway, Petee Cartland, "Laser Diode Array Illuminator (LDAI) Initial Demonstration Test Plan” Coastal Systems Station Test Plan, August 99
(3) Holloway, Cartland, “Demonstration of Night Time Land Mine Detection Through Contrast Reversal Using Active Diode Array Illumination”, Report on Phase I Feasibility Study.
(4) Witherspoon, Holloway, "Feasibility Testing of a range-gated laser illuminated underwater imaging system," Proceeding of the International Society for Optical Engineering, Vol 1302, Ocean Optics X, April 1990, pp 414-420.
(5) Witherspoon, Holloway, et. al., "Measured Degradation in Image Quality When Imaging Through A Wavy Air-Water Interface, Proceedings of the Society of Photo-Optical Instrumentation Engineers, Ocean Optics IX, April 1988.

(6) Witherspoon, Holloway, et. al., "Experimentally Measured MTF's Associated with Imaging Through Turbid Water," Proceedings of the Society of Photo-Optical Instrumentation Engineers, Ocean Optics IX, April 1988.
(7) Holloway, Lorenzo, Pham, "Gated Laser Video Sensor (GLVS) Large Area Smoke Experiment (LASEX) Report," NCSC Report, Oct 94
(8) Holloway, "Gated Laser Video Sensor Smoke Week Test Plan," NCSC Report, April 94
(9) Witherspoon, Holloway, et. al., "Experimental Results of Single Pulse Imaging Through Turbid Water of up to 2 Meter Depth Using a Blue-Green Short Pulse Width Laser and a CID Gated Array Camera System." NCSC Technical Report.
(10) Blume, "Enhancement of the Gated Laser Video Sensor Image Synthesis Tool - Final Report,"
(11) Blume, "Gated Laser Video Sensor Image Synthesis Tool Simplified Model - Final Report," Oct 94
(12) Blume, "Gated Laser Video Sensor Image Synthesis Tool Simplified Model - Users Manual," Oct 94

KEYWORDS: Laser Diode Array; Diode Array; Ladar; Range Gating; Gated Imaging; Laser Radar

Naval Air Systems Command (NAVAIR)

N01-008 TITLE: Automatic Test Equipment (ATE) Commercial-Off-the-Shelf (COTS) Replacement for Obsolete Instruments

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: Air 1.0

OBJECTIVE: Develop an innovative approach for selecting and replacing obsolete instrumentation in legacy ATE without modifying test program sets (TPS) or the ATE operating system software. Develop a method where COTS replacement instruments co-exist with existing station instruments improving their maintainability. This will extend the life of the ATE system resulting in significant cost and timesavings to the Navy.

DESCRIPTION: Currently aging legacy ATE system test instruments are experiencing high obsolescence and high failure rates. They are also difficult and costly to maintain. A typical instrument may need replacement more than once over the life of a test system. The Government's present direction is to increase the use of COTS assets avoiding costly TPS or system software modifications. The ability to rapidly support ATE systems with COTS instrumentation will increase reliability, decrease maintenance, and improve logistics support.

PHASE I: Research and develop a methodology for use of a translator module utilizing existing COTS assets that will enable an effective replacement procedure for legacy ATE system test instruments. Establish a detailed framework for the approach, identifying software, hardware/firmware, reliability, maintainability, instrument replacement, and logistic issues. : Include details on the approach that will ensure flexibility of the Translator Unit in being adaptable to the communications interface busses that are used by the Navy ATE systems and those interface buses that are standard and available in the majority of COTS instruments on the commercial market. Also, give details on the features of the software/firmware of the Translator Unit to allow Navy engineers to perform software/firmware modifications that may be needed for lifetime support of the COTS/Translator Unit solution. Example of the firmware/software flexibility needed is the modification of the functional command strings or mnemonics of replaced obsolete instruments, which are incorporated in the drivers of the COTS instruments.

PHASE II: Design and fabricate a first article proof of concept translator unit based upon the Phase I efforts that demonstrates the potential capabilities of COTS replacement instruments in a legacy ATE system. A candidate first article proof of concept is the Signal Analyzer pn A31U13960-5, part of the AN/USM-467 Radar Communications Test System (RADCOM). Based on the Signal Analyzers specifications, dimensions and usage in the RADCOM, choose a suitable active COTS instrument which can fit and functionally replace it. The instrument chosen should not affect the airborne system Test Program Sets (TPS) or the RADCOM operating system and has a minimal affect on the maintenance software to the Signal Analyzer. Perform a proof of concept evaluation and define a conceptual model for hardware, software and firmware that will be required for adaptation of the selected COTS instrument. Deliver a First article adaptable COTS instrument and a Translator Unit, along with the required firmware/software and documentation that will be a suitable fit and function equivalent to the RADCOM Signal Analyzer.

PHASE III: Based upon a successful Phase II effort, develop a series of translator units for full validation and verification for compatibility of replacement instruments with older instruments.

COMMERCIAL POTENTIAL: These approaches will be applicable to all military or civilian organizations that need to integrate more than one instrument source into ATE systems. Applications include ATE system control by personal computers to minicomputers. ATE systems are already in widespread use in both military and civilian environment. A link between legacy ATE and test instrument replacements will offer greater flexibility to end users. Reducing total cost and improving ATE capability and flexibility are some of the projected benefits.

KEYWORDS: Automated Test Equipment; COTS Supportability; Composite Instrument Concept; Test Program Sets; Integration; Legacy ATE

N01-009 TITLE: <u>Low-Cost Sonobuoy Geographic Position Locator</u>

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO (A)

OBJECTIVE: Develop a low-cost technology to provide geographic positions of deployed sonobuoys to the monitoring platform.

DESCRIPTION: An accurate knowledge of geographic positions of deployed sonobuoys is critical for the conduct of coordinated antisubmarine (ASW) operations, high-altitude ASW, and detected target localization. Current operations require the monitoring aircraft to perform a Mark On Top (MOT), which is time consuming, provides insufficient accuracy, increases the vulnerability of the aircraft, and generally provides a tactical rather than a geographic position. In addition, future sonobuoys might be monitored by satellites or other vehicles incapable of performing a MOT. The purpose of this effort will be to develop a technology that provides the required sonobuoy geographic positions to the monitoring aircraft without performing a MOT. Solutions based on global positioning systems (GPS) may be proposed but must be compliant with DOD GPS security policy, which dictates use of the precise positioning service (PPS) signal. Low cost is considered to be less than $50 (recurring) per sonobuoy in production. The accuracy of the proposed solution should be comparable to that of the GPS standard positioning service (SPS) with selective availability (SA), which is approximately 100 m 2 drms (distance root mean square).

PHASE I: Investigate the feasibility of adding the proposed technology to obtain the desired geographic positional accuracy within the cost bounds and tactical constraints delineated above. Provide a report expounding the feasibility study, highlighting the limitations and optimization of such an idea. Demonstrate the feasibility using single-unit laboratory bench testing or small scale field-testing (depending upon the technology selected).

PHASE II: Modify government furnished sonobuoys to incorporate the selected localization technology. The modified units will not be required to be air deployable but will meet all form factor requirements of production sonobuoys. The units will be tested through over-the-side deployment from a research vessel.

Data reduction to extract the positional information may be conducted real time using test equipment or recorded for post-flight reduction.

PHASE III: Fabricate air deployable modified government-furnished sonobuoys and modify aircraft processors to perform the positional information extraction.

COMMERCIAL POTENTIAL: This technology will have commercialization potential in all applications in which GPS SPS positional accuracy is required when SPS capability is either unavailable or cannot be implemented due to system or cost considerations.

REFERENCES:

1. ASD (C3I) memo, 30 April 1992

KEYWORDS: Sonobuoys; GPS; Navigation; ASW; Localization; Sensors

N01-010 TITLE: Large Format Resistive Arrays (LFRA) for Infrared Scene Projectors (IRSP)

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: Joint Strike Fighter (JSF)

OBJECTIVE: Advanced infrared (IR) electro-optical (EO) imaging sensors employ increasingly sophisticated imaging and signal processing techniques/algorithms to support multiple mission objectives. Consequently, test and evaluation of these installed sensors requires dynamic full image projection of high-fidelity, physics-based, IR spectral scenes of background clutter and target characteristics commensurate with the sensors field of view (FOV), spectral response, and image frame rate. The proposed project will leverage recently developed commercial off-the-shelf (COTS) micro-emitter array technology. It will scale current 512x512 format arrays into larger format configurations of 1024x1024 and 1024x2048 for the full FOV 200-Hz frame rate projection capability needed to properly test IR EO sensors with imaging formats of 512X512 and greater. Greater than 200-Hz frame rates will be achieved through active windowing techniques for applications that require lower resolution (e.g., 256 x 256 pixels) stimulation.

Additionally, a LFRA needs to be driven/controlled by drive electronics with a sufficient bandwidth. Electronics with this capability currently do not exist. Therefore, as a secondary objective, the high bandwidth scene projector drive electronics being designed under a current SBIR Phase I effort will be utilized to control the proposed LFRA.

DESCRIPTION: A full FOV IR projection capability is needed to fully support Tri-Service developmental and operational testing of both fielded and next generation IR sensors with imaging formats of 512x512, 640x480, 480x1280, 1024x1024, and larger. The Array will be capable of projecting dynamic high-resolution, high-fidelity images into multiple types of installed advanced IR EO sensors under test. It will emit dynamic and radiometrically accurate IR images of targets and battlefield/test environments that replicate scenes as presented to the sensors in real world scenarios. The form, fit, and function will provide the portability, mobility, and reconfigurable capabilities needed to fully support installed system testing in Tri-Service test chambers, hangars, and ground/air test range environments.

Installed system testing provides a versatile, controllable, repeatable, and cost-effective augmentation and/or alternative to more costly flight and range testing. Radiometrically correct computer generated scenes are easily controlled by the test facility infrastructure and/or system operators to develop and render simulations of both typical and inaccessible threat areas and environmental conditions. These scenes can represent a variety of user-selected terrain, threats, countermeasures, backgrounds, and weather conditions under dynamically changing conditions.

Test and evaluation (T&E) organizations from each of the three Services currently utilize resistive array based IRSPs for developmental testing of tactical IR sensors in the laboratory environment. The IR resistive array consists of a packaged integrated circuit electrically bounded to several hundred thousand micro-resistors (micro-emitters) each of which emits IR energy when a current is passed through it. Combining the resistor array with a scene generator, drive electronics, and optics provides an IRSP with the capability to project realistic IR scenes into the entrance aperture of a sensor under test that are dynamic and radiometrically correct. Consequently, the resistive array based IRSP has proven to be the most versatile, accurate, and cost-effective means of testing IR sensors in test laboratories, chambers, and ground/air test ranges.

IRSPs using resistive arrays containing up to 672x544 pixels represent the current state of the art in IR scene projection. These devices are sufficient for testing many currently fielded sensor systems. However, they do not provide the necessary resolution and FOV coverage to adequately test advanced sensors that are currently under development (i.e., advanced target acquisition sensors, threat warning sensors, IR search and track sensors, surveillance and reconnaissance sensors, and missile seekers). This project will facilitate the transition of existing mature resistive array technology to larger format resistive array based IRSPs for testing next generation IR sensor systems that will require testing in FY01-03.
Under this task, the contractor will develop innovative approaches to fabricate and demonstrate LFRAs that perform projection at real-time frame rates of up to 200 Hz, thereby reducing the total cost of pre-test-flight sensor testing. Cost reductions can be expected by:
- Reducing the number of rescheduled open range test flights caused by sensor system malfunctions.
- Ensuring image processing techniques and algorithms (e.g., missile detection, target tracking) perform correctly prior to committing to flight test.
- Providing pilot and operator training using wide field of view IR sensor simulations.
- Supporting sensor developers with the ability to test engineering management development (EMD) sensors under dynamic and accurate simulations/stimulations.
- Providing aircrew with the ability to test the effectiveness of evasive tactics, thereby increasing safety of flight

PHASE I: Leverage emerging COTS technology to produce a design(s) with imaging resistive arrays for a scene projector with a pixel matrix of 512x512, 640x480, 480x1280, 1024x1024, and larger with emphasis on uniformity, frame rate, pixel yield, heat load, output, and production process. The contractor will develop innovative approaches to fabricate and demonstrate Arrays that perform projection at real-time frame rates of up to 200 Hz. Show design trades for maximizing individual characteristics, and show concept for packaging and cooling. Provide a final report with conceptual design/block diagram that addresses an interface compatibility with a high bandwidth scene projector.

PHASE II: Develop the necessary environmental control system to provide necessary cooling to the array. Demonstrate the Array and characterize performance. Design and fabricate (or modify) compatible drive electronics and electrically interface the demonstration system with existing Navy scene generation equipment. Utilize government-furnished equipment (GFE) optics to demonstrate projection onto the GFE radiometer. Research commercially available drive electronics for suitability and conduct trade studies to validate the choice of drive electronics.

PHASE III: Transition the Array technology to a production capable item. The contractor is expected to expand the applicability of the resistive array to other sensor test programs, as well as commercial applications.

COMMERCIAL POTENTIAL: Commercial applications include the testing of fire and chemical alarms, remote sensor testing, and other areas such as highway/environmental monitoring sensors, which use of IR sensors.

REFERENCES:

(1) R.G. Lane, "Innovations in Infrared Scene Simulator Design," SPIE Proceedings, 3368, pp. 78-88, 1998.
(2) B. E. Cole, et. al., "Large-Area Infrared Microemitter Arrays for Dynamic Scene Projection," SPIE Proceedings, 3368, pp. 57-70, 1998.
(3) P. Pritchard, et. al., "Design and Fabrication Progress in BAe's High-Complexity Resistor-Array IR Scene Projector Devices," SPIE Proceedings, 3368, pp. 71-77, 1998.

KEYWORDS: Infrared Projection; Stimulation; Emitters; Missile Detection and Warning, Real-Time Data; Signal Analysis

N01-011 TITLE: Web-Based and Traditional Classroom Lesson Design Guide

TECHNOLOGY AREAS: Human Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: AIR 1.0

OBJECTIVE: Develop a computer-based instructional design tool built on a set of heuristics and guidance on how to design effective lessons for traditional (classroom) and web-based (distributed) training environments.

DESCRIPTION: Traditional methods of presenting instructional materials with a trained instructor had the advantage of adjusting teaching methods, presentation speed, level of intensity, and format according to class response and feedback to provide an optimal atmosphere for learning. Careers have been spent on developing one-on-one teacher-pupil relationships, techniques, and methods for improving presentations that require some form of class participation or response. These responses have also been the measuring sticks that have traditionally been used to grade instructors. However, with the advent of computer-based lessons, there is no advantage to pupil feedback. The objective is still to optimize the learning atmosphere by which the course material is presented but now without the aid of instructors.

At present there is a gap in computer-based learning methods between how to present the learning objectives and in the development of instructional materials. DOD has not assembled training development handbooks that contain specific guidance on how to aid enlisted personnel in designing lessons for traditional classroom or web-based delivery that will optimally cause learning to occur. These design decisions include lesson strategy, specific methods, and interface guidance. It is expected that a substantial body of literature is available in fields such as instructional technology, message design, distance education, and cognitive psychology that could be applied to DOD training course design.

For example, recent literature discusses direct object manipulation (DOM) and direct concept manipulation (DCM) as interface strategies in interactive multimedia instruction (IMI). DOM is the use of the mouse to manipulate the objects on the screen. DCM is the application of rules and formulas using the keyboard to manipulate the concepts which affect the objects on the screen. DCM is more successful as a general learning tool because it requires the student to understand. DOM is more fun because it provides direct interaction and it is effective in hands-on training. The design guidance recommendation for IMI design is to consider using DCM for acquisition of the building block knowledge and skills and use DOM for hands-on practice. Currently, the keyboard and the mouse are used at the whim of the lesson designer. Correct use of each is accidental. Effectiveness in one instance does not mean predictable effectiveness in further instances.

This literature is widely dispersed and not generally available to DOD enlisted personnel engaged in the design of military instructional materials. Critical examination of the existing literature with regard to web-based and traditional classroom applications is expected to reveal heuristics for the development of lesson design guidance for traditional and web-based delivery.

PHASE I: Determine if creating a web-based atmosphere to teach others how to optimize a learning environment is feasible. Provide a comparative analysis using existing literature for the purpose of developing a methodology/algorithm in designing lessons. The analysis should compare such areas as instructional technology, message design, cognitive psychology, distance learning, distributed training, and reports on experience in lesson design. Provide a recommendation in creating an approach toward web-based computer lesson development using the above mentioned approaches. Identify research gaps in the literature.

PHASE II: Provide draft lesson design guidance.. The guidance should be in military handbook format and include an organizing structure for applying design guidance for web-based or traditional classroom delivery. The draft lesson design guidance should be understandable to DOD enlisted personnel engaged in the development of military instructional materials. The draft lesson design guidance should also define the research gaps identified in Phase I.

PHASE III: Develop a computer-based instructional design tool. It is expected that this tool will be adopted by Government and commercial instructional material developers as guidance on how to design lessons in the traditional and distributed instructional environments. Specifically, the outcome of this product will be adopted in MIL-HDBK-29612, Instructional Systems Development and Systematic Approach to Training. This adoption would be made available in print and web-based formats.

COMMERCIAL POTENTIAL: Commercial instructional systems developers could apply the guidance for lesson design of traditional classroom and distributed (web-based) courseware in commercial and Government training.

REFERENCES:
(1) MIL-HDBK-29612-2, Instructional Systems Development/Systems Approach to Training and Education.
(2) eBaron, J. F., & Bragg, C. A. (1994). Practicing What We Preach: Creating Distance Education Models to Prepare Teachers for the Twenty-first Century. The American Journal of Distance Education. Vol. 8, No. 1, pp. 5-9.
(3) Madden, J. (1998). Implementation Issues Involved with Successful Distributed Learning Programs. Interservice/Industry Training, Simulation, and Education Conference Proceedings. I/ITSEC'98.

KEYWORDS: Lesson-Design; Web-Based Training; Distributed Learning; Cognitive-Processes; Message-Design; Heuristics

N01-012 TITLE: Wire Chafing Diagnostic Technology for Aircraft

TECHNOLOGY AREAS: Air Platform

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO (A): PMA-271, 273, 276

OBJECTIVE: Develop and package wire diagnostic technology that can detect wire chafing on the aircraft well before exposure of the bare conductor and without removing or disconnecting the wires under evaluation.

DESCRIPTION: The Navy is developing wire health monitoring technology. One challenge area in this technology development is detecting wire chafing prior to the exposure of the bare conductor. Wire chafing represents 37 percent of aircraft wire hazardous incidents; These hazardous incidents require the removal or repair of the chafed wire. This effort will develop, demonstrate, and package technology that can be used to detect and locate chafed wire on present day aircraft.

PHASE I : Define a wire chafing diagnostic approach and develop the implementation plan. Validate the approach analytically or provide test data or bench top hardware that would validate the approach.

PHASE II : Design, develop and demonstrate a technology that can reliably detect wire chafing on aircraft without removing or disconnecting the wires under evaluation.

PHASE III: Package and integrate the wire chafing diagnostic technology for use in an aircraft wire health monitoring system.

COMMERCIAL POTENTIAL: The results of this work can be commercialized to detect wire chafing in space, sea, air, and land vehicles; This will result in an increase in safety and reliability for these vehicles while reducing maintenance troubleshooting times and maintenance costs. Commercial airlines are specifically interested in diagnostic technologies for aging wire. Also, the results of this work can be applied to consumer products and industrial applications.

KEYWORDS: Wire Chafing; Wire Insulation; Aircraft Wiring; Condition Based Maintenance; Cables; Wiring Harnesses

N01-013 TITLE: Mid-Air Collision Avoidance System (MCAS) Using Mode 5

TECHNOLOGY AREAS: Electronics

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: AIR 1.0 (PMA-209, 213)

OBJECTIVE: Use identification friend or foe (IFF) Mode 5 waveforms to provide a secure high-capacity datalink for collision avoidance on Navy platforms. Work with IFF programs to determine the best path for embedding MCAS functionality into IFF transponders with Mode 5.

DESCRIPTION: New or retrofitted military aircraft are required to install collision avoidance system (CAS) capability. A stand-alone CAS solution with new avionics/antennas/wiring, such as the traffic alert and collision avoidance system (TCAS) on passenger aircraft, is costly and exceeds space and weight limitations for military aircraft. Also, TCAS and similar commercial solutions use nonsecure CAS waveforms that can be easily exploited, do not provide the resolution and update rate needed for collision avoidance for tactical training/missions, and are not suited for military helicopter operations.

The next major upgrade to IFF transponders in Navy platforms will be form/fit Mode 5 functionality with higher capacity secure waveforms. Integration of Mode 5 will provide position and other information to transponders that are needed for MCAS but are not currently available. Tactical platforms will most likely be the first aircraft to receive Mode 5 and also need MCAS due to the lack of a suitable commercial solution. Adding MCAS capability to transponders via Mode 5 waveforms offers enormous potential to reduce the cost and complexity of providing CAS to tactical aircraft and offers a higher capacity secure waveform that will not be easily exploited. Embedding MCAS into Mode 5 IFF transponders offers great space and weight savings over a stand-alone CAS solution, thus enhancing aircraft payload and mission capabilities. NOTE: Teaming and nondisclosure agreements will be required with IFF transponder vendors such as BAE Systems. NATO clearances are required for access to Mode 5 references

PHASE I: Determine if an IFF Mode 5 waveform can be used to resolve an MCAS solution by determining the range resolution and refresh rate Mode 5 offers MCAS. Determine the transponder requirements needed to integrate into an existing IFF system without impacting transponder size, weight, performance, or growth requirements. Research existing military systems and provide hardware, software, technical, and functional limitations/restraints in attempting to implement the solution. Provide a feasible solution to this problem in the form of functional block diagrams, proposed interfaces, and preferred options.

PHASE II: Integrate MCAS via Mode 5 into an IFF transponder in a laboratory environment and test CAS functionality for military platforms. Choose an MCAS host platform and determine how MCAS Mode 5 collision information will be displayed to pilots. Demonstrate MCAS in the host platform to validate its performance in military platforms and its lack of impact on transponder IFF performance. Research how MCAS will interface with the host platform through existing transponder connectors. Choose an IFF transponder for MCAS implementation.

PHASE III: Transition MCAS capability into tactical aircraft including F/A-18, AH-1Z, UH-1Y, SH-60R, and CH-60S.

COMMERCIAL POTENTIAL: A collision avoidance solution that can be embedded into existing aircraft transponders offers enormous cost savings to aircraft that do not have space and weight available for standard commercial CAS such as TCAS. MCAS using Mode 5 could eventually be embedded in commercial systems as commercial transponders and military IFF transponders use the same technology and already share modes 3/A, C, and S. Commercial vendors are aware of future IFF requirements with planning being done to determine upgrade path to Mode 5. The push for COTS use in military aircraft will cause future transponders to share more modes as is being done with Mode S. Adding MCAS capability via Mode 5 to military products would also enhance foreign military (FMS) sales potential as well as provide further continuity with NATO applications.

REFERENCES:
(1) STANAG 4193, Recommended Waveforms for Improvement of the Mark XII Identification Friend-or-Foe System Outline and Installation (KIT-1C), Parts I and V (including Annex A,B).
(2) DoD AIMS 97-1000 (w/ Addendums 1 & 2), Performance/Design and Qualifications Requirements Technical Standard for the ATCRBS/IFF/Mark XII Electronic Identification System and Military Mode S, 18 March 1998.
(3) ARINC 429, Mark 33 Digital Information Transfer System (DITS).
(4) AVRADA, Interface Control Document 8309, Rev. 0 (1553 Interface).
(5) RTCA/DO-181A, Change 3, Minimum Operational Performance Standards for Air Traffic Control Radar Beacon System/Mode Select (ATCRBS/Mode S) Airborne Equipment, 18 October 1998.

KEYWORDS: Mid-Air; Collision Avoidance System; MCAS; TCAS; IFF; Mode 5

N01-014 TITLE: Environmental Assessments and Mitigation of Naval Operations (Air and Surface)

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO (A): PMA-299, PMA-264

OBJECTIVE: Investigate, design, develop and deliver an open-architecture WEB-enabled systems engineering environmental management tool that provides the acquisition community oversight on potential environmental impacts (direct, indirect, and cumulative) and offers reasonable alternatives during the life cycle of their program.

DESCRIPTION: A grave concern exists over the potential adverse impact that Naval Operations (Developmental Testing, Operational Testing, or Fleet Exercises) may have on the underwater environment and its species. Reference 1 stipulates that the "DoN must act with care to ensure that in carrying out its mission of providing for the national defense, it does so in a manner consistent with national environmental policies." Furthermore, it is recognized that the National Environmental Policy Act (NEPA) process requires a systematic examination of the likely environmental consequences of implementing a given proposed action. Thus, it is mandated that this examination be integrated with on-going system development actions at the earliest possible time, ensuring that:
1. Practical means and measures are utilized to protect, enhance, and restore the quality of the environment

2. All Americans have a safe, healthful, productive, and aesthetically and culturally pleasing surroundings
3. Widest range of beneficial uses of the environment are attained without degradation, risk to health and safety, or other undesirable and unintended consequences
4. Historic, cultural, and natural aspects of our national heritage are preserved and, maintain where possible, an environment that supports ecological variety and diversity
5. A balance between population and resource use is achieved allowing high standards of living and a wide sharing of life’s amenities
6. The quality of renewable resources is enhanced and the maximum attainable recycling of depletable resources is practiced.

Consequently, this proposal seeks to investigate, design, and develop an open-architecture WEB-enabled systems engineering environmental management tool that provides end users with visibility into the environmental impacts and alternate courses of action that would mitigate any proposed action. This tool would provide continuous monitoring and refinement of the acquisition program and in particular the design development phase that will ensure an executable program by integrating the natural and social sciences and environmental considerations throughout the life cycle of the program (concept exploration through disposal).

PHASE I: Investigate and research characteristics of the underwater environment and species within the coastal borders of the Continental United States and, as a goal, include current Navy undersea test ranges. Research commonalties and dissimilarities among the potential environments and species as a function of time, season, and geographical location. Investigate active sound propagation effects produced by active sonars and sonobuoys employing underwater sound propagation models. Evaluate statistical metrics that ensure full compliance with Federal Law and DoD regulations, policies, and directives. Design a WEB-enabled system engineering environmental management software tool that standardizes and validates all requirements. Determine the feasibility of implementing the selected design, cost, and schedule.

PHASE II: Upon successful completion of Phase I, develop a WEB-enabled systems engineering environmental management tool prototype for an INTEL-based platform running Windows NT and a Unix-based workstation running Solaris. Further define and refine the technical and performance measures identified in Phase I. Refine established commonality among the environmental community in order to maximize communications, data exchange, and connectivity.

PHASE III: Develop the WEB-enabled systems engineering environmental management tool for prototype testing within the NAVAIRSYSCOM and its field activities for use as an environmental management tool. Develop and standardize inputs and outputs for underwater acoustic propagation models employed in order to provide a robust statistical analysis. Develop a database for current and emerging active sonars, sobobuoys, and explosive sources. Test the product with on-going developmental programs resident in NAVAIRSYSCOM. Develop preliminary training materials and user documentation. Obtain inputs from end-users in order to refine and develop a more robust tool. Incorporate new features and interfaces as determined from end-user inputs.

COMMERCIAL POTENTIAL: Compliance with environmental laws, regulations, policies and directives is not limited to DoD. Private industry is also faced with the same requirements. The same benefits hypothesized for DoD are expected to be available to private industry.

REFERENCES:
(1) SECNAVINST 5090.6, “Evaluation of Environmental Effects From Department of The Navy Actions”, 26 Jul 91.
(2) DoD Directive 6050.1, “Environmental Effects in the United States of DoD Actions”, 30 Jul 79.
(3) DoD Directive 6050.7, “Environmental Effects Abroad of Major Department of Defense Actions”, 31 Mar 79.
(4) 40 CFR Parts 1500&#64979;1508, “Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act”.
(5) Executive Order 12114, “Environmental Effects Abroad of Major Federal Actions”, 4 Jan 79.

32 CFR Part 775, "Department of the Navy Procedures for Implementing the Natural Environmental Policy Act"

KEYWORDS: Environmental Compliance; Environmental Impact; Environmental Assessment; Environmental Analysis; Systems Engineering; Program Management

N01-015 TITLE: Digital Data Download (D3) with Crash Survivable Memory

TECHNOLOGY AREAS: Information Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO (T): PMA-209, PMA-234, PMA-290

OBJECTIVE: Digitally record structural, engine/propulsion, electrical/avionics, environmental, exceedance, and event data to crash survivable memory. The system should be capable of interfacing with present and future commercial and military aircraft health and usage systems such as the Advanced Memory Unit (AMU), Integrated Mechanical Diagnostics (IMD), and Aircraft Health Monitoring System (AHMS). Provide an innovative crash survivable memory solution by combining the Structural Data Recording Set (SDRS) and the Crash Survivable Flight Incident Recorder (CSFIR) capabilities into a common recorder. Reduce system cost/weight and satisfy multi-service, commercial and civil aviation data recorder requirements. Add the capability to record current and future parameters from aircraft data buses and wireless microsensors to further reduce weight, maintenance, and total ownership cost (TOC) while enhancing aircraft availability, maintainability, longevity, and safety.

DESCRIPTION: D3 will be an open architecture common system capable of interfacing with various aircraft health and usage systems (including AMU, IMD, AHMS) and recording different types of aircraft data that now require numerous recorders. The data will be in a format structured by the fatigue life expended (FLE) processing group to enable proper computing of structural life expended for each airframe and other life-limited structural components. D3 will be capable of recording the data necessary for properly assessing the performance and health of the propulsion systems on each aircraft and provide diagnostic and trending solutions obtained from the AHMS or IMD systems. Recorded data will be used for post-flight diagnostics and prognostics to direct and/or assist with maintenance actions, and to detect and predict failures. D3 will also record data for assessing the performance and health of the environmental control system, the electrical system, and selected avionics on each aircraft as the data is provided by the AHMS, IMD, and other systems. Also, D3 will record FAA Standard and Naval Air Training and Operating Procedures Standardization (NATOPS) exceedances and/or other specified operational limits, for monitored parameters as processed by the AHMS and IMD systems. D3 will record all anomalous events as captured by the flight crew or ground maintenance personnel, in addition to automatic capture of exceedances. The recording will capture event data along with a predetermined amount of data around each event in order to reconstruct the occurrence. PCMCIA cards will be used as the main downloading medium for D3.

D3 will combine SDRS and CSFIR capabilities into an innovative common solution, eliminating multiple and redundant airborne recorders and meeting FAA and Naval Aviation Flight Loads Data Recorder (FLDR) requirements. This would eliminate the recorder converter, motion pickup transducer, memory unit, and signal data converter used for the SDRS and the CSFIR signal data recorder reproducer, and voice and data recorder (VADR). New parameters required by industry, FAA, the platforms or Navy Safety Center will be added via D3 software changes. It is desired to have maximum flexibility in the placement of the D3 capability. To minimize size and utilize existing avionic systems (such as the AMU or similar drive/recorder systems), ruggedized, miniature, new technology microcomputers/chips could be a possible solution. In the event of catastrophic aircraft failure, these new technology crash survivable memory chips will ensure data recovery, which can be used to simulate the events that led to the aircraft mishap. To further reduce weight and volume, new sonar beacon (Pinger) miniaturization technology will be incorporated into D3 as an alternative to current water recovery beacons.

D3 will also be capable of wireless data recording as part of the innovative design. Aircraft diagnostic/prognostic recording systems currently require a great deal of platform integration and wiring, which makes up a large percentage of overall system complexity, cost, and weight. The use of new technology wireless microsensors/transducers has enormous potential to simplify new and retrofitted diagnostic/prognostic systems by eliminating the currently required cabling and interconnects, enhancing robustness and ease of sensor placement, and reducing system weight. This new wireless technology will be adapted and utilized for effective data transmission without compromising aircraft signature and location. One possible option is programmable surface acoustic wave correlator (PSAWC) technology. The data collected with wireless microsensors and recorded on D3 will be used to assess aircraft system health, reduce scheduled and unscheduled maintenance, and increase the availability of aircraft.

In summary, D3 innovation includes designing an open architecture recording system that combines SDRS/CSFIR capability, uses new technology crash rugged chips for reduced volume/weight, uses wireless technology for less wiring and ease of sensor placement, and eliminates existing WRAs for reduced volume/weight.

PHASE I: Propose an open architecture recorder design, which incorporates a system design interface compatible with AHMS, AMU, and IMD in order to record health and usage data, and which utilizes the existing download media (PCMCIA cards). Proposal should include the Integration of CSFIR and SDRS software, should eliminate redundancy, and allow flexibility for the addition of future user recording criteria. The hardware should incorporate new crash hardened microcomputer/chip technology. Determine the application for new technology wireless microsensors to replace existing sensors and transducers used for SDRS and CSFIR data acquisition. Establish the requirement for additional wireless microsensors to collect data not currently being recorded or monitored by industrial processes and machinery or by legacy aircraft systems (structures, engines, electrical, avionics, etc.). Propose a prototype design concept and a configuration structure.

PHASE II: Based on Phase I results, proceed with D3 development into a design configuration verification for commercial applications. Conduct lab testing to verify the design concept. For aircraft applications, the system should be able to interface with airborne monitoring systems (i.e…AHMS, IMD, and AMU) for recording aircraft in-flight data. Allow for rapid download capability. Demonstrate the system design at the application level to validate how it will perform in a commercial and military environment. An industrial application may involve a multi-process automated product assembly line operating under hazardous environmental conditions and utilizing several sensors in which in-process and throughput data storage is required. A commercial and / or military aviation application may involve monitoring various aircraft health and usage systems (including AMU, IMD, AHMS) and recording this data to crash survivable memory.

PHASE III: Transition D3 capability into a production system. Fine-tune the design for it's particular application. Aviation application – install on legacy (retrofit applications, i.e…737, DC-10, Concorde, P-3C, C-2A, etc…) and new (777, High Speed Transport, V-22, F/A-18E/F, and Joint Strike Fighter) aircraft. Industrial application – factory assembly lines, power plants, high-pressure manufacturing and high temperature manufacturing.

COMMERCIAL POTENTIAL: The D3 system has great cost savings potential for commercial applications. D3 benefits could be utilized in commercial aviation (aircraft diagnostics/prognostics programs are expanding rapidly and the FAA requires crash survivable recorders), industrial applications (where hazardous and/or harsh environments exist), and the civil aircraft market. The resulting breakthroughs in this recording area will also increase safety and operational availability while reducing system weight and complexity.

REFERENCES:

(1) PMA-209 “Data Centric Roadmaps” brief, 8 June 00
(2) EUROCAE ED-55/ED-56A
(3) PMA-209 Draft Flight Data Recorder Performance-Based Specification, June 00
(4) Technical Standard Order C-123A/C-124A
(5) AIR-4.1.2 IMD Early Operational Assessment PR N00019-95-P1-PE006/AS-H53E-0001
Management Sciences, Inc. Sentient Space Interface Module and Sentient Instrument Controller technical data sheets
(6) Smiths Industries Integrated Data Acquisition and Recorder Systems (IDARS) characteristics summary
Invocon, Inc. Wireless Airborne Instrumentation System (WAIS) and Advanced Microminiature Wireless Instrumentation System data sheets

KEYWORDS: D3; DDD; Digital Data Download; Crash Survivable; Wireless; Recorder

N01-016 TITLE: <u>Development of New Processes for the Refurbishment of Infrared Search and Track (IRST) Germanium (Ge) domes</u>

TECHNOLOGY AREAS: Air Platform, Sensors

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO (T)

OBJECTIVE: Develop a process to refurbish hemispherical Ge domes, which will restore infrared (IR) transmission and meet the operational performance specifications of the IRST system.

DESCRIPTION: After extensive use in adverse environments such as sandstorms, rain, fog, and airborne particulates, the IR domes have developed pits and surface anomalies, which lead to a reduction in the average transmission to below acceptable limit. There is no process currently in use to restore these non-operational IRST domes. New domes are quite costly since they are constructed of single-crystal germanium (Ge) with very sophisticated inner and outer surface coatings. A process is needed that is capable of restoring the Ge domes to a state or condition that will pass all of the imaging and environmental specifications set for the original dome design. Since there is a possibility that a restoration process may result in some image distortion, it should be detailed in the contractor’s analysis and any process to mitigate or minimize the distortion provided. Further, the refurbishment process must take into consideration the tight tolerance to maintain focal length. A refurbishment process that results in a change in dome thickness, and therefore focal length, should be detailed. If possible, a process to rebuild the Ge dome to its original thickness should be included in the contractor's report. The IRST system operates in the 7.5-13 um region. Ge is a wide-band gap semiconductor with a refractive index of n=4.00 (10 um) and is naturally 54 percent transparent to IR light in the wavelength range of 2-14 um. No IR energy is lost in the material but a reduction of 56 percent transmission occurs due to reflections at the front and back surfaces of a highly polished Ge window. Antireflective (AR) coatings deposited onto these surfaces can help to virtually eliminate surface reflections and increase IR transmission to greater than 95 percent over specific wavelength ranges. The contractor must include recommendations for the alternative AR substrate materials that will both maximize IR transmission in the designated IR wavelength and provide durability to withstand the operational environment conditions of the F-14D.

PHASE I: Determine if a process for the afore mentioned requirements can be developed. Research existing processes and provide a conceptual analysis of the proposed process. Provide pertinent calculations, which demonstrate, the knowledge required to design, develop and produce a process to repolish and recoat existing IRST Ge domes that have not passed the “focus” test.

PHASE II: Produce and verify a process that will refurbish the Ge domes to an operationally ready state. All processes that have been recommended during Phase I will be fully evaluated and verified by test case. The result of this phase is a detailed process for refurbishment of existing domes to an operationally ready state. Refine a process to rebuild the domes to their original thickness while maintaining the required performance specifications of the IRST system. A test case should be generated to validate the rebuild/refurbish process developed by the contractor.

PHASE III: Restore all IRST domes to the original specifications required by the IRST system. The restoration shall, at a minimum, make ready for issue (RFI) all domes that have previously been removed from the inventory. Domes that cannot be restored should be evaluated for further reconditioning or recommended for condemnation.

COMMERCIAL POTENTIAL: The electric power utility industry utilizes IR sensors in the same bandwidth as the IRST sensor to perform evaluation on above ground power transmission lines for insulation leaks. These power line insulator leaks result in power transmission loss costing the electric utility companies millions of dollars annually. To identify failures in power line insulation, public utilities use specially configured aircraft that fly over the nation's power lines using an IR sensor to detect the leaks. They note the location of the failed insulation along the power line and send the information to the power company for repair. The IR systems used in the utility company’s aircraft generally have the same type of IR window used in an IRST system. While less harsh (lower speed), the utility company aircraft’s IR system is subject to much of the same environment as the F-14D IRST. However, the utility companies operate their aircraft IR systems more than the Navy uses the IRST. Further, the flights are made at lower altitudes where airborne particulate matter has a greater opaqueing effect on the IR window. As a result, failure of the IR window occurs as often if not more often than in the Navy. Development of a refurbishment process can be directly applied to this particular commercial application.

REFERENCES:
(1) Wu, R.L.C., Ingram, D.C., and Woollom, J.A., Final Report: "Diamondlike Carbon Coatings for Optical Systems,” U.S. Army Materials Technology Laboratory, Contract No. DAAL04-86-C-0030, October 1988.
(2) Enke, K. Materials Science Forum Vols. 52&53 (1989) pp. 559-576, Trans. Tech Publications, Switzerland.
(3) Angus, A.C., Kodil, P., and Domitz, S., in Plasma Deposited Thin Films, edited by Mort, J. and Jansen, F. (CRC, Boca Raton, FL, 1986) Chapter 4.

KEYWORDS: Infrared Dome; Lens Resurfacing; Germanium Window; Diamond-like Carbon; DLC; Infrared Window

N01-017 TITLE: Shallow Water Bottom Characteristic Measurement Sensors

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO (A): PMA-264, PMA-299, PMA-290

OBJECTIVE: Develop and fabricate a sensor to measure the bottom characteristics for active systems in shallow water ocean areas.

DESCRIPTION: Active sonar detection and classification systems require detailed knowledge of the reverberation field in order to operate effectively. Knowledge of the reverberation direction and amplitude is important in selecting sonar transmitter parameters, setting receiver beam widths and steering angles, and establishing sonar deployment geometry. An innovative approach to measure the parameters to define the reverberation field in-situ is sought. For example a frequency dispersive source and a vertical line receiver with appropriate models could enable a system to measure bottom loss and scattering strength as a function of grazing angle. These parameters with emerging inversion programs could provide the tools necessary to measure reverberation sufficiently to support air antisubmarine warfare (ASW) tactical decision aides (TDAs). Emphasis should be placed on a compact, affordable, automatic measurement sensor capable of being used in expendable air deployed measurement devices. It is anticipated that the sensor will require a sound source, receiving array, and processing algorithms within the device. The sensor should be capable of operating at frequencies below 1000 Hz but as a goal be capable of operating between 50 Hz and 10 kHz. The sensor must survive the shock, vibration, and temperature environments of an air deployed device, and be capable of providing both monostatic and bistatic directional measurements in water depths to 1000 ft. Innovative design goals are as follows: the sensor must not take up more than one-half of the space available in an A-size sonobuoy and the total cost of the sensor should be held to $1,500 to $2,000 for the 1000th unit.

PHASE I: Develop a conceptual design for a directional reverberation measurement sensor that meets Navy needs. Include transducer elements, electronic interface circuitry, and processing algorithms that will implement the proposed concept. Also conduct a study to investigate the feasibility of integrating this sensor into an A-size sonobuoy configuration.

PHASE II: Develop detailed designs for the Phase I sensor and fabricate a limited number of sensors suitable for open ocean proof of concept testing. Conduct preliminary testing in a laboratory and in ocean shallow water environments and report the results of this preliminary testing to the Government.

PHASE III: The sensor, upon meeting Navy requirements, will be transitioned into the airborne sensor production program and/or into a multipurpose environmental measurement probe program.

COMMERCIAL POTENTIAL: Potential commercial use is as a bio-defouling agent. Technology can be used to clean clogged sewage pipes or to discourage marine life from establishing residence inside a water intake device. This technology could also be used to monitor the level and direction of reverberation noise caused by offshore oil exploration/drilling or other underwater commercial activities to assure compliance with EPA regulations.

REFERENCES:
(1) TAMDA (Tactical Acoustic Measurement and Decision Aid) Program, funded by CNO (N096) FY-99 to FY-01 and in CNO (N88) POM FY-02 to FY-07.

KEYWORDS: Active Sonar; Ocean Environment; Noise; Reverberation; Sensor; Expendables

N01-018 TITLE: <u>Semi-Active Side-Lateral Engine Mounts for Control of Vibration and Shock Loading</u>

TECHNOLOGY AREAS: Air Platform

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO (T): PMA-231

OBJECTIVE: Produce a drop-in semi-active side-lateral engine mount system for carrier-based turboprop aircraft. The engine mount system should stiffen intelligently during landings, catapult launches, and in-flight turbulence, yet soften to limit transmission of engine vibration to the airframe at propeller rpm and harmonics.

DESCRIPTION: The DOD makes extensive use of rack mounted avionics systems in many of its turboprop aircraft. These racks are typically either hard mounted to the airframe or mounted on rubber vibration isolator (passive) mounts. The passive mounts provide some vibration reduction but minimal shock impact reduction. It has been discovered that in the case of the E-2C aircraft, one of the primary transmission paths of engine vibration and harmonics is via the side-lateral mount. However, when this mount is softened to the point of absorbing significant levels of vibration, the mount is too soft to prevent the engine from contacting its housing during high g shock events such as carrier landing, catapult takeoff, and in-flight turbulence. Currently, a very stiff mount must be used.

With the DOD emphasis on commercial-off-the-shelf (COTS) equipment, a comprehensive reduction of the existing vibration and shock environment must be fostered throughout all E-2C subsystems. Given this environment, both new COTS avionics components and the current components should see improved reliability (i.e., higher mean time between failures (MTBF)). In order to reach this state though, a smart side-lateral mount system that is able to reduce vibration levels yet maintain engine alignment during shock impact loading must be developed.

PHASE I: Research and analyze the vibration nulling requirements for the E-2C aircraft. Determine shock and vibration transmission characteristics of existing side-lateral mount. Determine force, stroke, response time, and power requirements; installation size/weight constraints; and environmental requirements (heat, cold, salinity, moisture, etc.) for a drop-in smart side-lateral mount. Formulate a control strategy. Determine if the requirements for the E-2C can be met with various materials and new designs. If necessary, perform limited testing on any existing semi-active hardware where appropriate.

PHASE II: Conduct or acquire data from flight tests using load cells to determine operational loads on existing mounts. Design and build a prototype drop-in semi-active side-lateral mount and test in the laboratory, including control and power subsystems. Test on an engine stand if available or conduct limited flight tests if aircraft can be made available.

PHASE III: Demonstrate that the technology produced during Phase II can be effectively mass produced and incorporated efficiently into tactical aircraft.

COMMERCIAL POTENTIAL: New semi-active engine mounts may be used on many of the current commercial piston and turboprop aircraft as well as helicopters. This combination of improved vibration isolation while maintaining static alignment conditions under shock loads will also be applicable to better-isolating all types of military and commercial power trains from the rest of the vehicle. This includes those found in virtually all automotive and marine applications, including submarines.

KEYWORDS: Semi-Active Damping; Vibration Control; Shock Impact Reduction; Engine Mount; Isolator; Semi-Active; Stiffness; Damping

N01-019 TITLE: <u>Advanced Rotorcraft Shipboard Landing Aerodynamic Interference Software Modules</u>

TECHNOLOGY AREAS: Information Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO (A)

OBJECTIVE: Develop advanced rotorcraft aerodynamic interference models to support rotorcraft/ship dynamic interface analysis and testing.

DESCRIPTION: The dynamic interface problem refers to shipboard landing of rotorcraft and represents one of the most challenging technical areas of research and development. It involves determining the operational limits of a specific aircraft operating aboard a specific class ship. Factors like ship airwake/turbulence, ship motion, restricted landing deck size, and possible restricted visual cues complicate the landing task as well as the task of simulating the shipboard landing. The interaction of the ship's airwake with the rotor, the interaction of the rotor downwash with the ship's deck, and the resulting ground interference on the airframe and rotors complicate the analysis of the shipboard landing environment. The problem is further complicated by the tiltrotor due to the interaction of the two main rotors with each other and with the deck or with only one rotor over the deck. Limited work has been conducted to develop a dynamic interface simulation capability, including making at-sea, ship airwake measurements. Currently, no simulator can be used to develop rotorcraft/ship operational envelopes. High-fidelity interactional aerodynamic models are required to predict conventional helicopter or tiltrotor dynamic response during a shipboard landing.

PHASE I: Perform a feasibility study to investigate solutions which characterize multi-dimensional aerodynamic turbulence. Show how the best solution concept can be applied to each problem element associated with aerodynamic interference in the rotorcraft shipboard landing scenario. Identify and provide a description of the specific problem areas associated with rotocraft/ship dynamic interface modeling. Propose an approach and timeline for resolving these problem areas with software modeling.

PHASE II: Develop the improved aerodynamic interference models to support the rotorcraft shipboard landing task simulation. Demonstrate the interactional aerodynamic model against available wind tunnel and flight test data for hovering in and out of ground effect for land and ship environments. Demonstrate the model ability to predict rotorcraft ship operational envelopes to enhance future dynamic interface flight-testing.

PHASE III: Provide a validated rotorcraft aerodynamic interference model to support multi-service aircraft/ship operational requirements.

COMMERCIAL POTENTIAL: The improved rotorcraft aerodynamic interference model could be used to facilitate future commercial airline landing zone planning and commercial rotorcraft/ship landing training and planning.

REFERENCES:

1. Williams, S. and Long, K., ADS-33 and Shipboard Rotorcraft Operations: A USN Flight Test and Simulation Perspective, AHS 53rd Annual Forum, Va Beach, VA, Apr 29- May 1,1997
2. Padfield, G. and Wilkinson, C., Handling Qualities Criteria for Maritime Helicopter Operations, AHS 53rd Annual Forum, VA Beach, VA, Apr 29 -May 1, 1997
3. Carico, Dean, Integrated New Test Aircraft Capability, ITEA 1995 Symposium, Huntsville, AL, Oct 1995

KEYWORDS: Interactional Aerodynamics; Aerodynamic Interference; Dynamic Interface; Ship Airwake; Simulation; Rotorcraft

N01-020 TITLE: <u>Software Cost and Schedule Estimating</u>

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Demonstrate automated software tools, associated procedures for use of the tools and a user-training program that will estimate software cost and schedule with a standard deviation of 10% or less. Maximum possible automation of the implementation of the tools and procedures is required. Tools and procedures must be customizable to account for advances in software development methods in order to maintain their accuracy. These processes and tools must be effective for new developments, upgrades and maintenance of existing systems and must be applicable to all software efforts of Naval Aviation.

DESCRIPTION: In both DoD and the commercial world, accurate upfront estimates of cost and schedule for software projects have always suffered from extreme inaccuracies. With the continually escalating size of software projects and their increasing importance in the implementation of new systems, this severe deficiency in the ability to accurately estimate costs and schedules is crippling the ability of DoD and the commercial world to effectively plan for future development efforts. Studies have shown that in DoD, approximately one-third of all projects above 500,000 lines of code will be terminated and over a third of the remainder will have schedule and cost overruns in excess of 25% (Ref 1). As projects grow in size, these numbers become even grimmer. For very large projects in excess of 5,000,000 lines of code, approximately 55 percent are terminated before completion and over 30 percent are over cost and behind schedule by over 25% (Ref 1). In such an environment, it is virtually impossible for Naval Aviation to effectively plan for the allocation of its resources in the development of new and upgraded systems for the Fleet. It is essential that more effective methods of estimating software cost and schedule be developed. This will provide decisions makers with the essential upfront data required to make an effective cost-benefit analysis before initiating new projects. The ability to develop an accurate upfront estimate would significantly reduce the number of project terminations by providing decision makers with accurate data in making a cost benefit analysis before initiating a project. The current methods result in many projects being initiated, which would not have been the case if there had been a realistic up front appreciation of their final cost. This results in a huge waste of resources, which could have been available to support more essential projects.

Currently a wide variety of manual, automated parametric models, or some combination of the two is utilized across DoD to attempt to predict initial and updated estimates. There is also an extensive selection of literature and studies on the subject by authors such as Barry W. Boehm (Refs 2, 3), T. Capers Jones (Ref 4) and others. While in theory the various methods utilized by the assorted parametric models and proposed in the literature appear to offer reasonable approaches to solve the software cost and schedule estimation problem, in reality their effectiveness has been limited. Some studies indicate that when a parametric model is calibrated in an attempt to increase accuracy, the results are still unsatisfactory or mixed (Ref 5). Another problem with the assorted software estimation tools and methods is the extremely rapid pace of advancement in software development compared to other engineering disciplines. This often means that by the time an organization is able to assess the effectiveness of an advancement in software development, such as new languages, tools or methodologies, and determine how it has impacted their productivity to the point where it can use the data to attempt to improve estimate accuracy, a new method appears which makes the previous method obsolete6. This makes it very difficult for parametric models and other estimation methods to maintain accuracy.

1. As previously stated, the objective of this research project is to develop an automated software tool and/or toolset along with associated implementation practices which will account for the previously discussed issues and enhance the ability of NAVAIR to accurately estimate software costs and schedules. Additionally, any automated tools developed as part of this effort must also meet the following additional requirements. Any software tools shall operate in the Windows 95/98/NT/2000 or their successors environment.
2. Include the ability to customize any automated tools and procedures to account for new software development methods in order to maintain estimate accuracy.
3. Include both the costs associated with the software development for the Prime Contractor and their subcontractors, along with those associated with the Government and its support contractors.
4. The Cost and scheduling procedures and tools shall define cost, schedule and labor required for each of the following phases:
a. Systems Requirements Analysis (Desired)
b. Software Requirements Analysis (Required)
c. Software Design (Required)
d. Coding (Required)
e. Unit Test (Required)
f. Systems and Integration Testing (Required)
g. Development Testing /Operational Testing (DT/OT) (Required)
h. Fielding and Training Costs (Desired)
i. Any additional phases required to fully cover the entire software development effort.
5. The cost and scheduling procedures and tools shall define cost and labor for each of the following labor categories:
a. Management
b. Project Tracking and Oversight
c. Subcontractor Management
d. Contract and Financial Management
e. Administrative support
f. Software Quality Assurance
g. Independent Verification and Validation
h. Requirements Analysts
i. Software Designers
j. Software Coders
k. Testers
l. Documentation

m. Any additional labor categories required to cover all labor performed in support of the software development effort by the Prime and their subcontractors along with the Government oversight team and any of its support contractors.
6. Procedures and tools to update the initial cost and schedule estimate based on the current status of the program.
7. Fully document how to utilize the tools and procedures.
8. Develop a training program on how to utilize the procedures and tools to perform software cost and schedule estimation.
9. Additional areas where it is desired that the procedures and tools support cost and schedule estimating:
a. Facilities costs. These include the costs for the software development environment, software integration facilities, simulation testing resources and personnel required to maintain these systems for use by the software development team.
b. Travel
c. Training

PHASE I: Conduct a feasibility study that identifies the design for the automated tools and procedures necessary to implement the software cost and schedule estimating program. Define what research is necessary in Phase II to gather and analyze data necessary to fully define the design for the processes and tools. Identify any existing commercial or government tools and procedures intended to be utilized to implement some portion of the design. Define a plan of action and milestones for developing the processes and tools necessary to implement the design in Phases II and III.

PHASE II: Perform any research and analysis defined in Phase I necessary to complete the design. Develop the prototype tools and procedures necessary to meet the design defined in Phase I. Demonstrate the ability of automated tools, toolsets, and processes that have been developed, modified, customized, or reused as part of the development to meet the previously defined requirements of the system.

PHASE III: Complete documentation and training program for software cost and schedule estimation. Conduct training of Naval Aviation personnel in the implementation of the procedures and tools.

COMMERCIAL POTENTIAL: As previously stated, software cost and schedule estimation is an area that suffers from high inaccuracies and subsequent high program risk in both commercial and DoD software projects. Refinement of the ability to accurately estimate software cost and schedule will not only benefit Naval Aviation, but also commercial software development organizations. The automated software tools developed as a result of this research program would be readily marketable and usable by commercial organizations developing software for DoD, other Government agencies or commercial software development. Such a toolset would provide a valuable capability to produce an accurate justifiable estimate upon which to base the decision of whether or not to proceed with the software development effort.

REFERENCES:

1. Project Management Tools and Software Failures and Successes", Crosstalk July 98,
2. Jones, T. Capers"Software Engineering Economics", Prentice Hall PTR, 1981, Boehm, Barry W.
3. "Software Cost Estimation with COCOMO II", Prentice Hall, 2000 Boehm, Barry W.; Abts, Chris; Chulani, Sunita; Clark, Bradford K.; Brown, A. Winsor; Horowitz, Ellis; Steece, Bert; Madachy, Ray; Reifer, Donald
4. "Estimating Software Costs", McGraw-Hill, 1998, Jones, T. Capers
5. "Does Calibration Improve Predictive Accuracy?", Crosstalk April 2000, Ferens, David V.; Christensen, David S.
6. "Future Trends, Implications in Cost Estimation Models", Crosstalk April 2000, Boehm, Barry W.; Horowitz, Ellis; Madachy, Raymond; Abts, Chris

KEYWORDS: Software Cost; Schedule; Estimation; Resource Allocation; Decision Making; Cost Analysis

N01-021 TITLE: <u>Low-Drag Aircraft Slip Resistant Surface Treatment</u>

TECHNOLOGY AREAS: Air Platform

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO (A): PMA-273, PMA-275

OBJECTIVE: Develop an innovative non-slip surface treatment for aircraft applications that does not degrade aerodynamic performance while providing sufficient wet and dry traction for maintenance personnel to perform their duties.

DESCRIPTION: Military and many commercial airlines presently use non-slip treatments on upper areas of aircraft to provide a safer walking surface for maintenance personnel who must access these areas for routine service and repair operations. Historically, techniques for providing slip resistant surfaces have involved making the surface coarser, i.e. increasing the peak-to-valley height difference. This has provided marginally effective slip resistance but increased weight and aerodynamic drag. This in turn degrades aircraft performance in such areas as range, maneuver, and payload. In addition, the rough surfaces themselves can contribute to severity of injuries through lacerations. Military aircraft, especially when forward deployed and particularly when operating from ships, require rapid service and maintenance between missions. Many times this occurs in foul weather, making adequate foot traction problematic with increased risk of accidents and injury. There is a need for an effective slip resistant surface treatment that does not degrade aerodynamic performance nor incur significant weight penalty on military aircraft. The treatment should also meet the adhesion, flexibility, wear and chemical resistance specified in A-A-59166.

PHASE I: Provide an initial development effort that demonstrates scientific merit and the feasibility of providing an aerodynamically neutral non-slip surface treatment for use on military aircraft. The treatment should provide static and sliding friction coefficients equal to or superior to that provided by 80 grit sandpaper under both dry and wet conditions, as measured by ASTM D 4518, Method B.

PHASE II: Develop, test, and field demonstrate the surface treatment developed under the Phase I effort.

PHASE III: Produce the system demonstrated in the Phase II effort. The treatment will be transitioned to the Fleet through specification modifications and revisions. If further field evaluation is required, aircraft programs funds or other funds will be pursued.

COMMERCIAL POTENTIAL: Successful surface treatment can be used on commercial aircraft as well as on DOD aircraft and can transition to any other activity needing non-slip surfaces.

REFERENCES:
1. A-A-59166
2. ASTM D 4518

KEYWORDS: Non-Slip; Surface; Slip; Aerodynamic; Low Drag; Traction

N01-022 TITLE: Fasteners/Rivets for Watertight Integrity and Corrosion Prevention in Permanent Application

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO (A)

OBJECTIVE: To develop a material or coating that is applied during the manufacturing process of the fasteners/rivets. The material or coating shall be non-chromate, non-hazardous air pollutant (HAP) and meet current environmental laws/regulations. These fasteners/rivets are for permanent application on aircraft and helicopters. These fasteners/rivets shall provide watertight integrity and corrosion prevention without wet installation with sealant. In addition, these fasteners/rivets shall not require additional lubricant for installation in an aluminum/titanium structure.

DESCRIPTION: During aircraft and helicopter production, fasteners are currently wet installed with a two-component polysulfide-sealant. Applying the two-component sealant is both time consuming and labor intensive. The access sealant can be classified as hazardous waste. MIL-STD-7179 requires that fasteners be wet installed with sealant for watertight integrity and corrosion prevention.

PHASE I: Develop a material or coating for fasteners/rivets where the material or coating is part of the fasteners/rivets. Conduct laboratory testing to demonstrate the feasibility of applying a material or coating onto the fastener/rivets during production, providing watertight integrity, and corrosion prevention that meets all local, state, and federal environmental laws/regulations. Other considerations include paint adhesion, flexibility/malleability, -65oF and 350oF capability, ambient temperature storage, minimum of one year shelf life, minimum impact on torque-tension requirements, and no impact on retention of self locking nuts/collars. The non-hazardous material or coating shall consider the fastener vendor requirements to implement the new technology.

PHASE II: Phase II will consist of further development of these new materials or coatings for fasteners/rivets in order to meet the objectives of Phase I. Complete laboratory testing of improved formulations of materials or coatings will be conducted. The above tests shall demonstrate that the new material or coating meets all the stated performance requirements and environmental laws/regulations for permanent application on aircraft and helicopter systems.

PHASE III: Produce the fasteners/rivets with the new material or coating demonstrated in the Phase II effort for both the aircraft and helicopter manufacturing market. If further development and/or field-testing are required, aircraft program funding or Aviation Pollution Prevention Technology Programming funds will be pursued.

COMMERCIAL POTENTIAL: The new fasteners/rivets can be used on commercial aircraft, as well as non-aerospace applications, for both the government and private sector. Therefore, this technology is directly transferable.

REFERENCES:
1. MIL-STD-7179

KEYWORDS: Fasteners; Rivets; Watertight; Corrosion Protection; Materials; Coatings

N01-023 TITLE: Low-Cost Missile Environment Monitor

TECHNOLOGY AREAS: Materials/Processes, Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO (CU)

DESCRIPTION: The Tomahawk missile is placed inside a canister or capsule before leaving the manufacturer or depot. The current certification period for these missiles in the All-Up-Round (AUR) configuration is five years. Little or no maintenance is done to the AUR during this time period. Although the logistics cycle of the AUR is documented, environmental extremes are not always noted. These extremes can affect the reliability, availability, and safety of the missile. This device must be capable of being powered from available energy (i.e. heat, or dynamic motion) that can be constantly sustained for a minimum of five years. The system should enclose a charge monitor that measures internal environmental flux information and a charge detector. Charging flux information from these detectors should allow for the evaluation and monitoring of the effects of internal changes in the capsule that will lead to the development of a low-cost, reliable, low-weight device to detect impacting environmental changes. This low-cost self-contained device is to be designed for monitoring and recording environmental data within the missile capsule is needed to aid in the missile recertification process. The use of a battery-powered device is not desired. The environmental parameters of interest include temperature, shock, fluid intrusion (salt water and fuel) monitoring, and humidity.

PHASE I: Provide an in-depth study characterizing the problem and proposed system solutions identifying key attributes and applicable technologies. Provide a detailed design study of potential system designs to include hardware as well as software algorithms necessary for full system integration.

PHASE II: Demonstrate a system that can accurately record environmental extremes of temperature, shock, fluid intrusion (salt water and fuel) monitoring, and humidity while mounted inside a missile capsule.

PHASE III: Provide a production system ready and available for potential integration into all production and recertified missiles.

COMMERCIAL POTENTIAL: Success through Phase III will yield a low-cost device that provides a means of monitoring long term storage and shipping of fragile items exposed to the extreme environmental conditions aboard ships. Both air and sea commercial shippers can use this system in shipping containers that contains delicate items (sensitive electronic components) that are sensitive to environmental extremes. Vessels moving sealed containers across the oceans would realize the greatest benefit.

KEYWORDS: Environmental Monitor; Tomahawk Missile; Missile; Missile Maintenance; Environmental Data; All-Up-Round

N01-024 TITLE: Innovative Gas Turbine Engine Propulsion

TECHNOLOGY AREAS: Air Platform

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: Air 1.0

OBJECTIVE: Develop and demonstrate innovative gas turbine engine component technologies that have application to Navy engines with goals of increased power-to-weight, reduced fuel consumption, increased life, improved maintainability, and improved affordability.

DESCRIPTION: The Integrated High Performance Turbine Engine Technology (IHPTET) initiative is an integrated DOD/NASA/ARPA/industry program structured to meet current and emerging propulsion needs by doubling propulsion system capability around the turn of the century for a wide variety of aircraft, unmanned air vehicle (UAV), and tactical missile applications. Its three-phased approach will continually provide technology that ensures U.S. military and commercial turbopropulsion superiority. The IHPTET program will end in FY05. DOD and industry are starting a new follow-on effort in FY 01 called Versatile Affordable Advanced Turbine Engine (VAATE), which is in the definition phase. VAATE will have more progressive goals than IHPTET and will focus on ultra intelligent engines, versatile cores, and high impact (revolutionary) concepts that will result in a relative engine affordability goal of 10X (-25% fuel conservation and –60% cost) by 2015. VAATE will also focus on new methods and technologies to enhance the durability and readiness of legacy engines. Early VAATE demonstration efforts (from FY01 to FY04) will concentrate on configuration definition and will culminate in an early engine demonstration (4X capability/cost) by FY06. Phase II efforts will demonstrate a versatile, robust, intelligent core (6X capability/cost) by FY10. Phase III efforts will demonstrate innovative engine architecture, compact, cloakable infrared/radar cross-section (IR/RCS) design and maintenance free core/damage adaptable engines by FY15. A durability/readiness effort for legacy systems will run in parallel and be part of the VAATE program. The durability/readiness effort will focus on technologies that reduce the total ownership costs of weapon systems, with a focus on acquisition, operations, and support issues.

The general path to revolutionary propulsion system capability is well known. Higher temperatures at combustion initiation are required to increase efficiency (or decrease specific fuel consumption) and expand the flight envelope; higher maximum temperatures are required to increase the output per unit airflow; less weight per unit airflow is required to increase the output per unit weight (thrust/weight or power/weight ratio); and all of the preceding advances must be accomplished while maintaining or increasing internal component efficiency, durability, and life and maintaining or decreasing cost. Specific technology development areas include increased aerothermodynamic design capability for improved component efficiency levels and control of heat transfer; higher temperature and lower density materials; innovative structural concepts; and compatibility of these developments with affordable manufacturing processes. All of these developments must be accomplished in an integrated manner for each of the major component areas and for engine configurations as a whole. The ATPP delineates the technology transition path, payback, criticality and timelines associated with the proposed technology.

PHASE I: Define a viable innovative concept that has application to future Navy gas turbine engines and/or components and has potential for integration into the IHPTET/VAATE engine ATPP. Define the approach and substantiate the feasibility of the concept in the application. Define the benefits associated with the concept.

PHASE II: Refine and develop the concept/component through analysis and testing to validate the technology for its intended environment. Determine the requirements for and integrate the concept/component into and advanced Navy gas turbine engine system for demonstration (This may be demonstrated by the inclusion of the technology into the IHPTET/VAATE engine ATPP). Design and fabricate concept/component for demonstration in an IHPTET/VAATE engine. Validate the benefits associated with the concept.

PHASE III: Integrate, the concept/component into a military application. Once the design space, potential and operating constraints have been quantified in Phase II, the concept/component may readily be integrated into legacy and pipeline systems.

COMMERCIAL POTENTIAL: Aircraft gas turbine technology is vital to the U.S. industrial base. Because aircraft gas turbine technology is generally applicable to both military and civilian engines, achieving the IHPTET/VAATE goals can ensure continued U.S. preeminence in the increasingly competitive international turbine engine marketplace well into the 21st century.

KEYWORDS: Propulsion; Gas Turbines; UAV Engines; UCAV Engines; Advanced Turbine Materials; IHPTET

N01-025 TITLE: Fiber Optic / High Voltage Cables and Connectors

TECHNOLOGY AREAS: Materials/Processes, Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO (T): PMA 272

PRIMARY OBJECTIVE: To develop materials for a compact high strength and high durability cable, capable of withstanding extreme external environments experienced during high altitude airborne military and commercial applications. There are two separate and distinct parts to this single cable application, namely a fiber-optic cable for signal transmission and a high-voltage cable required to handle an 8KV potential. The effort is specifically focused on solving the high failure rate of a present connector/cable experienced by the Integrated Defense Electronics Countermeasures (IDECM) ALE-55 Fiber Optic Towed Decoy (FOTD) program aboard the F/A-18E/F aircraft. It may also be developed toward a commercial application, such as long-wire low-frequency transmissions used in transports and passenger aircraft.

OBJECTIVE (A): Develop a compact fiber-optic cable/connector capable of operating under extreme environmental conditions experienced in airborne and shipboard military and commercial applications. The fiber optic cable and connectors must be capable of operating within the harsh operational environment of the ALE-55 FOTD system as installed on the F/A-18E/F aircraft. The cable and connectors must be capable of maintaining high signal integrity (i.e., minimal electrical signal transmission loss) over the useful life cycle of the ALE-55 system while requiring minimal maintenance support. The connector/cable system's airborne operating environmental requirements include a high number of maintenance cycles, extreme hot and cold temperatures at high altitude with intense vibration levels and harsh contaminates (i.e.,jet fuel,engine exhaust, hydralic fluid). This cable must be able to be extended (deployed) at sub- and supersonic speeds and be lightweight.

OBJECTIVE (B): Develop a compact high-voltage cable and connectors rated to 8 kV capable of withstanding extreme environmental abuse experienced in airborne and shipboard military and commercial applications. The high voltage cable and connectors must be capable of operating within the harsh operational environment of the ALE-55 FOTD system as installed on the F/A-18E/F aircraft. The high voltage cable and connectors must be capable of maintaining high signal integrity (i.e. minimal electrical signal transmission loss) over the useful life cycle of the ALE-55 system while requiring minimal maintenance support. The connector/cable assembly must be able to withstand a sustained 8 KV potential.

The specific design criteria (i.e., temperature, vibration, strength & operating environment) will be provided per PMA-272 upon acceptance of this topic. The design criteria may be considered sensitive material.

For both objectives (A) and (B) of this effort, recommend the following phase approach methodology.

PHASE I: Perform a feasibility study to re-establish the design criteria for a connector/cable combination which will provide a high mean time between failure (MTBF) while operating under extreme environmental conditions. Recommend a solution that encompasses the critical material and design criteria. Recommend an innovative design that outlines the connector/cable material and structural design requirements. Provide a design concept that is capable of being demonstrated in Phase II, and that provides the performance necessary to be considered for application into the ALE-55 FOTD program as a solution to current connector/cable performance shortfalls.

PHASE II: Assemble and test a connector/cable engineering design model in order to demonstrate the system's ability to meet above stated performance requirements (i.e. details of which will be fully developed as part of Phase I). Expand the connector/cable design to include F/A-18E/F ALE-55 FOTD temperature/vibration/pressure environmental requirements.

PHASE III: Develop a prototype and demonstrate the connector's ability to satisfy the requirement established in Phase II. Solicit government/commercial agencies and users to invest in developing a prototype that will be compliant with ALE-55 FOTD System as a precursor to government funded flight tests.

COMMERCIAL POTENTIAL: Commercial miniature fiber optic and high-voltage cable and connectors for use in limited space/harsh environments.

KEYWORDS: Fiber Optic; Connectors; Miniature Towline Cable; ALE-55; FOTD; IDECM; High Voltage; Electronic Warfare

N01-026 TITLE: Nondestructive Evaluation (NDE) of Composite Parts Prior to Cure

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO (A): PMA-273, PMA-275, PMA-276

OBJECTIVE: Develop NDE technology for composite parts during lay-up in order to detect foreign materials, entrapped gases, wrinkles, or contaminants.

DESCRIPTION: Detection of foreign materials, entrapped gases, wrinkles, and contaminants during lay-up, when conditions may be easily corrected, can lead to a substantially reduced anomaly population in the cured part. This results in less time in the inspection unit and material review and less scrap, rework, and repair. The developed technology should be capable of covering a relatively large area at once and be simple to operate. It will be used after a minimal number of plies have been laid (i.e., during debulk) so that deplying can be minimized.

PHASE I: Demonstrate the feasibility of using existing NDE technology to meet the objective. Design a system using a selected NDE technology. The system should be simple enough to operate so that test personnel who are not familiar with NDE can use it. If possible, integrate the system into an existing manufacturing step/process.

PHASE II: Build a demonstration system and successfully use it on a V-22 component. Determine the cost savings potential.

PHASE III: Implement the system in a production environment. Obtain feedback from production personnel. Make necessary revisions to the system. Demonstrate its generic application to other composite components.

COMMERCIAL POTENTIAL: This technology has the potential to reduce part inspection, evaluation time, and R3 cost associated with composite manufacturing. If properly refined and made simple to use, this technology would have commercial potential in industries that manufacture composite parts.

REFERENCES:

1. Composites Manual Handbook, MIL-HDBK 17 of 13 April 2000
2. General Composite Repair, NAVAIR 01-1A-21 of 15 December 1993

KEYWORDS: NDE; Composites; Nondestructive Testing; Shearography; Electromagnetic Acoustic Transducers (EMATs); Green

Naval Facilities Engineering Services Command (NAVFAC)

N01-027 TITLE: <u>Sprayable Polysulfide Elastomeric Development</u>

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT IV

OBJECTIVE: Develop a high solids, environmentally compliant, elastomeric, sprayable, polysulfide-based barrier coating for use in overcoating marginally sound coating systems previously applied to exterior steel surfaces of Naval structures.

DESCRIPTION: Neither the Government nor Industry has a viable barrier coating for use in overcoating marginally sound coating systems previously applied to exterior steel. To prevent overcoat failures, this barrier coating must display low residual cure stress, low hygrothermal stress, sustainable flexibility, high corrosion resistance (hydrolytic stability), resistance to weathering, moderate tensile strength, sound adhesion, and be chemically compatible with industrial coatings. Once developed and employed as a maintenance overcoat on Naval structures, this coating will extend the life of marginally sound coating systems and prevent costly overcoat failures. In addition to developing the above coating, all interested proposers must have the corporate (in-house or joint venture) capability of commercial marketing and production.

PHASE I: Develop a polysulfide-based coating meeting the following approximate requirements: A) ^{3} 95% volume solids, B) 140% to 450% elongation, C) Hydrolytic stability (pH 3 to pH 13.5, resistant to cathodic protection), D) 200 psi to 400 psi tensile strength, E) 45°F to 95°F application and curing temperature, F) Internally plasticized, G) < 70 psi combined residual cure stress and hygrothermal stress throughout service temperatures and humidity, H) < 1.0 x 10-8 cm/sec water permeability, I) 180 psi to 400 psi adhesion to previously applied coatings, J) Chemically compatible with vinyl, urethane, acrylic, epoxy, and alkyd coatings, K) Topcoatable, L) Sprayable, and M) Environmentally compliant. Physical properties shall be determined using industry standards where applicable.

PHASE II: Refine, test and field demonstrate the coating developed under the Phase I effort. The field demonstration will consist of a one-coat application (3 – 7 mils dry) direct to a weathered exterior fuel tank coating followed by a suitable topcoat. The selected small business (or joint venture) will have an established history of formulating marking products and introducing them into the marketplace. For this coating, assign a manufacturer's product number and develop a new Product Data Sheet (PDS) detailing formulation and material performance properties.

PHASE III: Produce and market the coating demonstrated in the Phase II effort. Coating manufacturer will include this coating and the recently developed PDS in their current list and/or catalogue of commercial products and further commercialize the coating by advertising in a reputable paint/coating trade journal. The coating will be procured by Naval activities through either a performance-based consensus standard or a Commercial Item Description (CID). The Navy will assist in the development of the standard. Intended users are Navy, Army, Air Force, Marines, Bureau of Reclamation, Department of Transportations (DOTs), and private industry.

COMMERCIAL POTENTIAL: The coating is directly transferable to maintenance overcoating of marginally sound coating systems previously applied to bridges, fuel tanks, water tanks, offshore structures, structural steel, antenna towers, and concrete structures.

KEYWORDS: Coating; Paint; Polysulfide; Elastomeric; Maintenance; Overcoating

N01-028 TITLE: Flexible Marking Paint for Asphaltic Airfield Pavements

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT IV

OBJECTIVE: Develop a low stress (residual cure stress, moisture induced stress, and thermal stress), flexible, abrasion resistant, environmentally compliant, waterborne acrylic marking paint for use on asphaltic airfield pavements.

DESCRIPTION: Neither the Government nor Industry has a low stress (residual cure stress, moisture induced stress, and thermal stress), flexible, waterborne acrylic marking paint for use in marking asphaltic airfield pavements. Commercially available marking paints, including TT-P-1952D, promote cracking within and surrounding coated asphaltic pavements. These paints generate high levels of the above combined stresses that can exceed the asphaltic pavement's cohesive strength (surface tensile strength). As such, these paints display poor performance, increase airfield pavement debris, and initiate pavement distress. The development of a low stress, flexible marking paint formulated for asphaltic pavements will enhance airfield marking paint performance and mitigate pavement distress. In addition to developing the above coating, all interested proposers must have the corporate (in-house or joint venture) capability of commercial marketing and production.

PHASE I: Develop a single component, waterborne acrylic marking paint meeting the following approximate requirements: A) ³ 58% volume solids, B) 70% to 200% elongation, C) 250 psi to 350 psi tensile strength, D) 45°F to 95°F application temperature, E) Internally plasticized (0% plasticizers), F) < 50 psi combined residual cure stress/hygrothermal stress throughout service temperatures/various relative humidity and when applied at 10 mils dry, G) < 7.0% weight increase from water absorption at 48 hours immersion, H) 225 psi to 350 psi adhesion to asphaltic concrete at 65°F, I) Environmentally compliant, J) Abrasion resistant, K) High retention of glass road beads, L) 20 mils dry single coat application, M) Tack free at 30 minutes cure, 55°F, 75% R/H, N) No discoloration when applied to either new asphalt or iron sulfide based aggregate, and O) Sprayable. Physical properties shall be determined using industry standards where applicable.

PHASE II: Refine, test and field demonstrate the coating developed under the Phase I effort. The field demonstration will consist of direct application to a recently overlaid asphaltic concrete runway located in a warm climatic region. The selected small business (or joint venture) will have an established history of formulating marking paints for various markets. For this coating, assign a manufacturer's product number and develop a new Product Data Sheet (PDS) detailing formulation and material performance properties.

PHASE III: Produce and market the coating demonstrated in the Phase II effort. Coating manufacturer will include this coating and the recently developed PDS in their current list and/or catalogue of commercial products and further commercialize the coating by advertising in a reputable paint/coating trade journal. The coating will be procured by Naval Air Stations through either a performance-based consensus standard or a Commercial Item Description (CID). The Navy will assist in the development of the standard. Intended users are Navy, Air Force, Marine Corps, and the Federal Aviation Administration (FAA).

COMMERCIAL POTENTIAL: The paint is directly transferable to all airfields with asphaltic pavements. This paint may also be used to mark municipal roads and parking structures.

REFERENCES:
1. TT-P-1952D
2. TM-2328-SHR, "Investigation into Acrylic Paint Cracking (APC) on Asphaltic Pavements"

KEYWORDS: Coating; Paint; Marking; Airfield; Flexible Pavement; Asphalt

N01-029 TITLE: <u>Marking Paint for Portland Cement Concrete (PCC) Airfield Pavements with High Adhesion</u>

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT IV

OBJECTIVE: Develop an environmentally compliant, waterborne acrylic marking paint which promotes sound adhesion when applied to marginally prepared Portland Cement Concrete (PCC) airfield pavements.

DESCRIPTION: Neither the Government nor Industry has a waterborne acrylic marking paint that promotes sound adhesion when applied to marginally prepared PCC airfield pavements. The high Volatile Organic Compound (VOC) solvent-based marking paints, which exhibited sound adhesion to concrete pavements, are now prohibited for use as "Traffic Marking Coatings." Commercially available marking paints, including TT-P-1952D, exhibit low adhesion (< 90 psi) when applied directly to water-washed and dry PCC. Consequently, prematurely failures generally occur through lifting at the paint/PCC interface and subsequently increase airfield pavement debris. By increasing the ability of a marking paint to adhere to marginally prepared PCC, airfield marking paint performance is enhanced and premature coating failures are reduced. In addition to developing the above coating, all interested proposers must have the corporate (in-house or joint venture) capability of commercial marketing and production.

PHASE I: Develop a single component, waterborne acrylic marking paint meeting the following approximate requirements: A) ^{3} 58% volume solids, B) 10% to 70% elongation at 32°F, C) > 250 psi tensile strength, D) 45°F to 95°F application temperature, E) Internally plasticized (0% plasticizers), F) < 7.0% weight increase from water absorption at 48 hours immersion, G) > 180 psi adhesion to water-washed and dry concrete, H) Environmentally compliant, I) Abrasion resistant, J) High retention of glass road beads, K) 20 mils dry single coat application, L) Tack free at 30 minutes cure, 55°F, 75% R/H, M) No softening when applied to concrete with surface pH 13, N) No softening when applied to concrete with a moisture vapor emission rate of < 5.0 lbs/24 hours, 1000 ft2, and O) Sprayable. Physical properties shall be determined using industry standards where applicable.

PHASE II: Refine, test and field demonstrate the coating developed under the Phase I effort. The field demonstration will consist of direct application to a PCC runway approach end. . The selected small business (or joint venture) will have an established history of formulating marking paints for various markets. For this coating, assign a manufacturer's product number and develop a new Product Data Sheet (PDS) detailing formulation and material performance.

PHASE III: Produce and market the coating demonstrated in the Phase II effort. Coating manufacturer will include this coating and the recently developed PDS in their current list and/or catalogue of commercial products and further commercialize the coating by advertising in a reputable paint/coating trade journal. The coating will be procured by Naval Air Stations through either a performance-based consensus standard or a Commercial Item Description (CID). The Navy will assist in the development of the standard. Intended users are Navy, Air Force, Marine Corps, and the Federal Aviation Administration (FAA).

COMMERCIAL POTENTIAL: The paint is directly transferable to all airfields with PCC pavements. This paint may also be used to mark municipal roads and parking structures.

REFERENCES:
1. TT-P-1952D

KEYWORDS: Coating; Paint; Pavement; Marking Paint; Airfield Portland Cement Concrete

Office of Naval Rsearch (ONR)

N01-030 TITLE: Breaking the 1 Joule/cm3 Barrier for High Power Capacitors

TECHNOLOGY AREAS: Ground/Sea Vehicles, Electronics

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: Future Aircraft Carriers; PMS-378

OBJECTIVE: Design, Develop, Fabricate and Demonstrate Input (DC) Bus Capacitors for High Current, High Voltage, and High Frequency Navy Inverters

DESCRIPTION: A new generation of passive components, especially capacitors, are required for medium power (100-300KW) navy applications such as motor controllers, inverters, zonal power conversion systems and Aircraft Electrical Servicing Stations and very high power (1-10MW) navy applications such as the Advance Linear Motor (ALM). All existing technologies are deficient for these and future applications. Existing passive components have not kept pace with the rapid advance in solid state switching devices leading to a lowering of system efficiency while adding significant volume and weight to power electronics systems. Innovations are being sought in dielectric materials, capacitor packaging and manufacturing technology to meet the projected requirements for advanced naval electrical power systems. Capacitors must provide energy densities significantly greater than 1 J/cc in capacitors capable of operating at voltages at 500 Volts and above, with RMS currents in excess of 20 Amp for > 20KHz operation and possessing low and stable ESR (Equivalent Series Resistance). Energy per volume and/or weight, and energy density per cost constitute the principal figures of merit. Other desired properties are:
- Voltage operation higher than 500V.
- No significant degradation in performance for operation at temperatures ~100C
- Low Electrical Series Resistance, Dissipation factor
- Graceful Failure, fail open if possible
- Long service life and shelf life
- Variable size/shape to facilitate integration with other devices.
- Cost consistent with other high power circuit devices

Examples of materials innovation include materials with increased dielectric constant, or reduced dependence of dielectric constant on voltage, or reduced dissipation. Examples of properties that may be achieved by improvements in device packaging include schemes to insure open circuit failure, reduction of resistance produced by leads, longer life, innovative form, etc.

PHASE I: Develop and design innovative materials, fabrication and capacitor manufacturing approaches, which meet the objectives, described above.

PHASE II: Develop, refine, optimize, demonstrate and test prototype capacitors using existing high power inverters developed by the Navy. Demonstrate applicability for specified Navy system applications.

PHASE III: Demonstrate high volume manufacturing. Develop a family of capacitor products addressing applications in high and low voltage and power regimes. Benchmark reliability and lifetime.

COMMERCIAL POTENTIAL: Applicable to motor controllers in Hybrid Electric motor drives in automobiles and in industrial applications such as mining and factory automation.

REFERENCES:

1. PEBB Passive Components WEB site. http://Pebb.onr.navy.mil

KEYWORDS: Capacitors; High power; Inverters; Energy storage; Dielectrics; Power Electronics

N01-031 TITLE: Digital Compensation for Distortion

TECHNOLOGY AREAS: Materials/Processes, Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: DD-21; Cruiser Conversion

OBJECTIVE: Develop versatile techniques to be used within Direct Digital Synthesizers to pre-distort the microwave analog signals fed to high power solid state or vacuum tube amplifiers in such a manner as to reduce the harmonic, cross modulation, and intermodulation distortion contained in the amplified output signal to a point lower than -40 dBc.

DESCRIPTION: Future Naval E/M systems will increasingly be required to amplify and process multiple simultaneous signals. Direct Digital Synthesizers (DDS) will be increasingly used in the synthesis of the complex signals. A unique opportunity exists to digitally pre-distort (within the DDS) the signal fed to high power amplifiers in such a manner that the high power amplified output of those amplifiers contains distortion components (harmonics, intermodulation and cross modulation products) that are at least 40 dB below the signal peak at rated power.

PHASE I: Design the circuit architecture necessary to digitally generate two or more simultaneous signals and to pre-compensate those signals in such a manner that the amplified output of the power amplifiers to which the signal is fed will have reduced distortion as per the paragraph above. No hardware is envisioned in phase I.

PHASE II: Design DDS with integral pre-distortion compensation circuitry capable of operating over 300 MHz of instantaneous bandwidth and at center frequencies up to 1 GHz. Develop and demonstrate the critical componentry of such a DDS.

PHASE III: Demonstrate such a DDS capable of synthesizing pre-distorted signals up to 5 GHz with at least 1 GHz of instantaneous bandwidth.

COMMERCIAL POTENTIAL: The wireless communications industry is the predominant target market in the commercial sector. This market is large and growing rapidly.

REFERENCES:

1. M. Roden, Analog and Digital Communications Systems, Prentice
2. Hall, New York, 1985.
3. A. Katz, SSPA Linearization, "Microwave Journal," page 22, April, 1999.

KEYWORDS: frequency selectivity; signal synthesis; multiple signals; wide band; low distortion

N01-032 TITLE: Simulating Data for the Development of Decision-Making Systems

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: To develop novel algorithms and tools that will accurately model and simulate sensor data that can be used in the analysis and development of decision-making aids.

DESCRIPTION: Decision aids provide commanders with the tools necessary to successfully operate in an environment flooded with massive amounts of data obtained from multiple sensor sources. This effort seeks to explore new and creative technologies, algorithms, and computational methods to model and simulate sensor data for use in the analysis, development and benchmarking of decision-making tools and information integration algorithms. These should include accurate modeling of applicable uncertainties associated with the collection and processing of the data. Some of the sources of uncertainty that are of interest include processing error, sensor error, information pedigree or source, algorithm assumptions and environmental conditions (e.g., wind, multi-path, temperature, etc.). The simulated sensor data sources include, but are not limited to video, moving target imaging, radar, acoustic, Global Positioning System output, synthetic aperture radar, human intelligence, satellite imagery, terrain elevation information, hyper-spectral imaging, and ground/foliage penetrating radar.

PHASE I: Describe and develop innovative methodologies and a high-level system design for algorithms and tools that will model and simulate multi-source sensor data and associated uncertainties.

PHASE II: Develop and implement a prototype system that generates multi-source sensor information and incorporates the tools, algorithms and models developed in Phase I. Perform rigorous algorithm and model testing using real data from applicable sensor sources. Sensor data will be provided at no cost to facilitate the execution of Phase II.

PHASE III: Implement the models and algorithms in a comprehensive package that would include an intuitive graphical user interface (GUI) where the user can specify the type of sensor and appropriate uncertainty sources and levels. The ability to visualize the resulting sensor information, where applicable, would enhance the package. DoD transition possibilities include the Testing Evaluation Assessment Modeling & Simulation facility at NSWCDD, DD21, Single Integrated Air Picture and the DARPA Dynamic Databases program.

COMMERCIAL POTENTIAL: These tools and models would be valuable for generating data used in the development of decision aids and control systems. Some examples of where these systems are used in industry include production, manufacturing and national security intelligence analysis. These systems must be able to satisfactorily integrate a broad range of uncertain sensor data and information. The ability to simulate the data that are required for evaluating and validating such systems would save time and money in many industrial and military applications.

REFERENCES:

1. Modeling and Simulation of Dynamic Systems, Robert Woods and Kent Lawrence, Prentice Hall, 1997.
2. Information Technology for Command and Control: Methods and Tools for System Development, Stephen J. Andriole and Stanley M. Halpin (eds.), IEEE Press, 1991.

KEYWORDS: Modeling and Simulation; Decision-making; Sensors; Information Uncertainty; Physics-Based Modeling; Multi-Source Information

N01-033 TITLE: Innovative Sensor Technologies for In-Situ Air and Ocean Sampling under Extreme Conditions

TECHNOLOGY AREAS: Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: SPAWAR PMW-185

OBJECTIVE: Improve cost, survivability, and accuracy of in-situ meteorological and oceanographic sensors to enable accurate, cost-effective, measurements of environmental parameters under extreme (very high and very low) wind conditions. Of particular importance is the development of sensors that can directly measure the momentum, heat, and moisture fluxes under these conditions.

DESCRIPTION: This technology supports the acquisition of new sensors through better characterization of the operating environment.

High Wind Conditions: Under high winds (20 to 60 m/s), environmental conditions within the wave boundary layer prevent use of conventional in situ instrumentation. In the atmosphere, these extremes include stress and bending of instrumentation from wind and wave action, heavy salt deposition, heavy precipitation and/or sea spray. In the ocean, under high winds, current platform, buoy and autonomous vehicle technologies and sensors are inadequate for the highly turbulent environment. Equipment is also generally inaccessible during high wind events making direct monitoring and maintenance of sensors problematic. Innovative technologies are required for highly robust, reliable sensors able to accurately measure critical flux parameters under high wind conditions. Acceptable solutions include ruggedized versions of proven instrumentation, self-cleaning instrumentation or 'peeking' technologies such as mechanical shutters, local (non-space) remote sensors using lidar or acoustic technologies, or entirely new technologies.

Low Wind Conditions: Under very low wind conditions (less than 5 m/s), air-sea fluxes are dominated by processes in the layers just above and below the air-sea interface, and area of a few mm to a few cm, and are generally not horizontally homogenous. Precise measurements of momentum, temperature, moisture (both water vapor and precipitation), and radiative fluxes are required in the atmosphere. Within the ocean, measurements of processes within a few millimeters to a few meters of the surface are required to evaluate, e.g., surface renewal models. Instrumentation to address these near surface processes include sensors to measure the skin temperature, near surface profiles of temperature and salinity, surfactants, and direct measurement of the oceanic fluxes including novel approaches to horizontal inhomogeneity. Acceptable solutions include lidar or other optical sensors, acoustic sensors, or other miniaturized probing technologies.

PHASE I: The contractor will convincingly demonstrate the feasibility of the proposed sensor technology through design and/or proof-of-concept demonstrations. The contractor will interact with ONR in defining specific applications.

PHASE II: The contractor will design, construct, test, demonstrate and document a prototype of the new technology, including performance specifications and estimated production cost. The contractor will interact with ONR in identifying specific applications for tests and demonstrations.

PHASE III: Sensors are expected to transition to international ocean observing systems to support research, routine monitoring of severe storms, and improve operational environmental prediction.

COMMERCIAL POTENTIAL: There is a large international research community supported by international government agencies, the insurance industry and the petroleum industry interested in understanding, measuring and monitoring extreme weather and ocean events for climate change, accurate weather and ocean prediction and other commercial activities.

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1. The Air-Sea Interface Radio and Acoustic Sensing, Turbulence and Wave Dynamics. Ed. M. A. Donelan, W. H. Hui and W. J. Plant, 1993, University of Toronto Press, Inc., Toronto.
2. The Wind-Driven Air-Sea Interface Electromagnetic and Acoustic Sensing, Wave Dynamics and Turbulent Fluxes. Ed. M. L. Banner, 1999, ADFA Document Production Centre, Canberra.

KEYWORDS: atmospheric flux measurements; oceanic flux measurements; environmental sensing; extreme environments

N01-034 TITLE: <u>Compact High-Power Electronic Components</u>

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PMS-500 & PMA-264

OBJECTIVE: The objective of this work is to develop technology that will lead to smaller, lighter, more efficient high power electronic components and amplifiers for driving the highly reactive loads presented by underwater acoustic sources used in active sonar sensor systems.

DESCRIPTION: High power acoustic source systems typically consist of three fundamental components, the power source (the electric company), the power electronics (the power amp) and the transducer (the loud speaker). Typically the signal drive power is supplied to the transducer in the form of electrical energy, which the transducer converts into acoustic energy in the medium (typically water or air). The role of the power electronics is to condition the electrical energy from the power source such that it can be efficiently accepted by the transducer, a highly reactive load. Water, being more dense than air, presents a different problem for the driver transducer. Amplifiers designed to drive loud speakers are not directly suitable for driving underwater transducers without proper impedance matching components. Ship board and off board acoustic sources are all required to be efficiently packaged and to maximize power efficiency. Sonar transducers are currently driven by large amplifiers capable of supplying many kilowatts. Several of these may be required for a single sonar transducer. Often, an entire shipboard compartment is dedicated to housing these amplifiers. For underwater transducers not mounted on the vessel's hull (towed or deployed sources), it is very often desirable to position the impedance matching components in proximity to the transducer. In some small transducer array designs, the amplifier, as well, has been positioned in proximity to the impedance matching components and the transducer. Reducing the overall size and weight of the transducer array while retaining power efficiency and power driving capability is highly desirable. Accordingly, it is the goal of this topic to generate technology that will lead to smaller, lighter electronic components and systems to improve the volumetric and weight efficiency of underwater acoustic source power electronics.

PHASE I: Examine the limitations of existing power electronics components and generate hypotheses for improved volume and weight efficiency for driving highly reactive loads over broad frequency bands. Examine materials and innovative circuitry to accomplish the improvement. Produce analyses that demonstrates the proposed solution/approach, possibly supported by preliminary laboratory measurements.

PHASE II: Based on the successful results of Phase I, design and fabricate an experimental system to demonstrate the volume/weight efficiency improvement. Results should be related to specific transducer technologies. Improvements that are dependent on specific transducer technologies are valid. The systems approach is encouraged.

PHASE III: The successful outcomes of Phase II will be eligible to be incorporated into autonomous off-board acoustic sources such as the Long Endurance Low Frequency Source (LELFAS) and the Air Deployed Low Frequency Projector (ADLFP); ship powered systems such as Low Frequency Broadband Variable Depth Sonar (LBVDS); or ship or submarine hull mounted systems.

COMMERCIAL POTENTIAL: Any industry that uses high power electrical signals will benefit, particularly acoustic amplifier technology for air acoustics and ocean survey systems.

KEYWORDS: Power Electronics; Capacitors; Inductors; Amplifiers; Acoustics; Transformers; Transduction

N01-035 TITLE: <u>Four-Dimensional (4-D) Atmospheric and Oceanographic Instrumentation</u>

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: TESS, NITES, MORIAH - PMW 185.

OBJECTIVE: Develop low-weight, low-power, and low-volume instruments/sensors/techniques to autonomously measure atmospheric and/or oceanographic parameters.

DESCRIPTION: Innovative sensors and measurement techniques are solicited to obtain meteorological and oceanographic (METOC) variables (e.g., physical, chemical, optical, acoustic, geophysical or biological) in 3-D space and time. Emphasis should be placed on (1) novel approaches and concepts for measuring a particular parameter coherently in 4-D, (2) observations which can be conducted as autonomously as possible (i.e. for independent operation on Remotely Piloted Aircraft (RPA), Autonomous Underwater Vehicles (AUV's), buoys or with expendable instruments), (3) providing a significant reduction in instrument weight and volume without reducing fidelity or resolution as compared to current state-of-the-art devices, and (4) developing the next generation of low cost, potentially expendable instrumentation usable in both navy operational scenarios as well as in S & T environmental data collection.

Examples of some of the types of instruments solicited include: instruments to measure aerosol properties, in situ ocean wave directional spectral instruments, the next generation of low cost METOC expendable instrumentation, and ultra wideband conformal acoustic projector arrays. The term Expendable Instrumentation includes both one time usage as well as long time in situ usage, and the sensors should be affordable if expendability is required but reusable if not. Included are instrumentation development efforts that would result in significant improvements and costs savings for existing expendable instrumentation, or would develop new expendable capabilities for measurements currently obtainable by other means (such as aerosol properties, scattering absorption and phase function, visibility, IR extinction, etc.). Broadband acoustic projector transducer arrays involve reciprocal, high powered (> 10 watts/cm2) projectors encompassing the nominal frequency band from 10-85 kHz and exhibiting high efficiencies, stability, and integral power amplifiers for application to UUVs and submarine platforms. All platform deployment scenarios (shipboard, submarine, and aircraft) are included. Priority is given to devices that can lead to substantial improvements in anti-submarine warfare (ASW), mine warfare (MIW), ship self-defense, airstrike targeting and special operations, through improved battle space environmental knowledge.

PHASE I: Provide both an exact description of the parameter to be measured including accuracy and sensitivity along with the instrument design concept for achieving the measurement.

PHASE II: Produce a viable prototype system and demonstrate its ability to support field measurements from an operating autonomous research platform.

PHASE III: Transition the technology to scientific use in the atmospheric, oceanographic or environmental monitoring research communities, and operational DOD systems.

COMMERCIAL POTENTIAL: New instruments can be used in a wide variety of commercial environmental monitoring systems.

KEYWORDS: meteorology; oceanography; instruments; automation; expendable; acoustic transducer arrays

N01-036 TITLE: Remote Data Link for Integrated Ocean Observing System

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: TESS, NITES, MORIAH - PMW 185.

OBJECTIVE: Significantly reduce the per byte transmittal cost for data from in-situ ocean/atmosphere sensor platforms to shore-based collectors via an innovative, low-cost, modular communications system using extant or projected communication technologies. This is a unique opportunity to concurrently develop a matched communications and observation system by closely connecting with the interagency National Oceanographic Partnership Program [NOPP] Integrated Ocean Observing System [IOOS] recently approved [May 2000] by the National Ocean Research Leadership Council [Navy, NOAA, NSF, NASA and seven other federal agencies].

DESCRIPTION: There is a need for an innovative, inexpensive, relatively high bandwidth communications system to forward remotely sensed unclassified ocean/atmosphere parameters from in-situ platforms to the user in real time. A modular, expandable system initially capitalizing on inexpensive extant facilities [rf, cell phone, satellite] with growth potential to embrace projected cutting edge communications technology is the goal. The challenge is to develop a pioneering, affordable, yet expandable autonomous system, transparent to the user, linking data from a variety of platforms [buoy, mooring, AUV, float, etc] in parallel with the developing NOPP Integrated Ocean Observing System. Fundamental progress will require a strongly coordinated effort between the contractor and the interagency NOPP IOOS Program Office [OCEAN.US]. The goal is inexpensively deliver reliable and accurate environmental parameters from remote in-situ sensors to the public and private sector. These data are central to safety at sea and severe weather warning preparation, and are key drivers employed by defense mission planners/tactical action officers selecting weapons systems and fleet/unit defensive postures.

PHASE I: Develop a detailed design, in parallel with the NOPP OCEAN.US office, for an innovative, stand alone, modular communications system with relatively high bandwidth to inexpensively deliver ocean/atmosphere data from a variety of sensor platforms. Determine the feasibility and costs associated with currently available technologies as well as with projected next-generation communication capabilities. Prepare a risk or cost-benefit analysis comparing the proposed designs with systems currently in use.

PHASE II: Fabricate a prototype communications system using enhanced in-place systems with a growth potential capable of exploiting projected advances in communications technology. Determine scale-up costs at varying bandwidths.

PHASE III: Develop a production and implementation plan for the next-generation ocean/atmosphere in-situ data communications systems. Clearly articulate the transition potential and probable users within the ocean/atmosphere science and operational users, e.g., government [Navy, NOAA], industry [oil patch, pollution monitoring], and the science and education communities.

COMMERCIAL POTENTIAL: There is a significant commercial application for this system. The public and private sector would likely employ such a system for a wide variety of autonomous remote monitoring applications involving safety and warning systems at sea and ashore. Commercial fisheries, cruise ship operators and educators from K-12 through graduate level, et al would benefit from remote environmental sensor data. However, the fundamental user remains the warfighter at sea; efficient employment of precise weapons systems depends on accurate, real time environmental indices.

REFERENCES:

1. National Oceanographic Partnership Program Report "Toward a U.S. Plan for an Integrated, Sustained Ocean Observing System, April 1999
2. National Oceanographic Partnership Program Ocean Research Advisory Panel Report "An Integrated Ocean Observing System: A Strategy for Implementing the First Steps of a U.S. Plan", December 1999

KEYWORDS: Data; Communication; Sensors; Ocean; Atmosphere; Data Distribution

N01-037 TITLE: Technology for Shipbuilding Affordability

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

OBJECTIVE: The objective of the project is to develop and implement innovative technologies that will reduce the cost to construct ships and thereby improve the competitiveness of the domestic shipbuilding industrial base and reduce the cost of military ships. Four Phase I and 2 Phase II awards are planned.

DESCRIPTION: US shipyards along with suppliers, owners, operators, and government personnel have developed the MARITECH Advanced Shipbuilding Enterprise (ASE) Strategic Investment Plan (SIP). This plan contains an industry led strategy to promote commercial competitiveness and reduce the cost of military ships. It identifies Major Initiatives and Sub-Initiatives that are the R&D requirements for this industry. This entire plan is available for review on the World Wide Web at http://www.nsrp.org/. Coordinating with U.S. shipbuilders to adapt and implement "World Class" commercial best practices is encouraged. The application of best practices can cover areas such as production methods, production planning and control, accuracy control, supplier relations and design for Producability. Proposals under this topic must address one of the following 3 research areas related to the SIP:

1. Advanced Product Designs and Materials sub-initiative, Product Design and Materials Technology Major Initiative area: In particular development of innovative designs for improved shipboard maintenance and reduced life cycle cost, improved tools to evaluate the life cycle cost implications of design alternatives, and tools to aid in life cycle planning for new ship designs.

2. Three sub-initiatives (a, b, and c below) from the Shipyard Production Processes Major Initiative area:

a. Process Control
Develop, pilot, and provide to the industry process control programs that address and/or employ standardized production processes, accuracy control techniques, and improved cost/schedule/quality management methodologies. These efforts may include focus on:
- Distortion control technology
- Advanced measurement techniques
- Electronic transfer of data
- Automated data analysis
- Statistical process control expansion
- Methods for mistake-proofing processes
- Visual control methods

b. Production Control
Define, pilot and provide to the industry, production control methodologies that support improvements to the detail planning and management of material, labor, production information, facilities and tooling. This sub-initiative may involve the review of cost saving methodologies/technologies being exploited by other industries in addition to exploration of:
- Standardized piece/parts
- Inventory policy
- Computerized control and tracking of interim parts and products
- Automated part markings
- Just-In-Time practices

c. Surface Preparation and Coatings
Develop, pilot and provide to the industry, surface preparation and coatings process and/or material improvements that would result in measurable labor, cycle time and/or material savings. Focus areas to be considered include:
- Edge preparation technologies for removing sharp corners on profiles and plates
- Steel and outfitting process integration
- Increased use of weld coat primer
- Coating automation
- Portable/flexible containment systems

3. Human Resources sub-initiative, Crosscut Initiatives area: This sub-initiative targets the definition of approaches, and demonstration of methods for providing innovative human resource partnership programs that assist in leading the change in technology and processes in the shipbuilding industry. It also addresses innovative processes or practices that could improve workplace environments for shipbuilding industry employees. Interest areas include development and implementation of tools to educate and train human resources professionals in change management, diversity issues, business processes and practices in world class organizations; benchmarking, development, and implementation plans to address comprehensive wage

and salary administration, innovative and new recruitment strategies; innovative approaches to addressing the critical skill shortage in a changing shipbuilding environment; and implementation plans and methods to develop employee potential to bridge the skill gap caused by the evolving technology changes in the shipbuilding industry.

Proposals should specifically describe the technology that will be applied to solve the problem, how it will be developed, what the estimated benefits will be and how it will be transitioned into the shipbuilding industry. Teaming with the shipbuilding industry to form integrated project execution and implementation team will improve transition potential and is strongly encouraged. Shipbuilding industry contacts for each Major Initiative are available on the web site [Carney, John U.] . While proposals should support one of the three MARITECH ASE initiative areas defined above, they should not request funding to support or augment currently contracted tasks within the MARITECH ASE program.

PHASE I: Prove feasibility for improvements being developed and detail where and why they will impact shipbuilding affordability. Include a Return-On-Investment (ROI) analysis for industry implementation.

PHASE II: Develop a working prototype production system or prototype product to demonstrate its performance characteristics. Develop a demonstration/implementation (Phase III) plan including descriptions of specific tests, evaluations and implementations to be performed (including sites and points of contact).

PHASE III: Implement the Phase III plan developed in Phase II.

COMMERCIAL POTENTIAL: The technology developed under this topic shall be applicable to both military and commercial shipbuilding practices and marketable to the shipbuilding industry.

REFERENCES:
1. MARITECH ASE Strategic Investment Plan, available on line at http://www.nsrp.org/

KEYWORDS: shipbuilding; affordability; production; manufacturing; processes; maintainability

N01-038 TITLE: Wireless Sensors System for Aircraft Health Management

TECHNOLOGY AREAS: Air Platform, Sensors

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: H-53, H-60, V-22, Joint Strike Fighter Program Office

OBJECTIVE: Demonstrate the ability of dual-use wireless transducers to reduce cost and complexity of aircraft systems operation and maintenance.

DESCRIPTION: Aircraft diagnostic and prognostic systems can enhance aircraft safety, reduce total costs of ownership, and increase asset availability. However, they require a great deal of integration with the platform. Wiring such a system into the aircraft makes up a large percentage of overall system complexity, cost, and weight. Wireless transducers have enormous potential to simplify new and retrofitted diagnostic/prognostic systems by eliminating currently required cabling and interconnects, enhancing robustness via redundancy, easing sensor placement, and reducing system weights. A wireless system also allows for flexibility in sensor placement to meet changing system needs and to aid in identifying, troubleshooting, and monitoring emerging fleet problems.

PHASE I: Develop a wireless sensors system concept for monitoring aircraft propulsion systems, to include engines, gearboxes, lift fans, shafts, and/or couplings. Develop a prototype design and conduct limited component or subsystem testing to indicate system characteristics and capabilities.

PHASE II: Based on the results of Phase I, develop and demonstrate wireless transducer system measurement capabilities that can be incorporated into an overall aircraft level prognostic/diagnostic health management system, as currently found on both commercial and military aircraft. The wireless system shall be able to monitor aircraft propulsion and power systems in real time, and provide synchronized data at the system level, comparable to current 'hard-wired' systems.

PHASE III: Demonstrate the system design at the aircraft level to validate performance in a military aviation application. Transition wireless sensor capability into new aircraft, including Joint Strike Fighter, and into related retrofit applications.

COMMERCIAL POTENTIAL: Wireless transducers are directly applicable to commercial aviation and industrial gas turbine operations, and will yield similar benefits to the civil market, as they will for the military market. Breakthroughs in this area will increase safety and operational availability, while reducing system weight, complexity, and operating costs.

KEYWORDS: Wireless; Diagnostics; Prognostics; Health Management

N01-039 TITLE: Integrated Simulation-Based Design Environment

TECHNOLOGY AREAS: Information Systems, Ground/Sea Vehicles, Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: EO-SUBS, PMS-404, & Undersea Weapons

OBJECTIVE: Develop a simulation-based design capability that allows existing design tools and codes to be integrated into a common design environment for undersea weapons and vehicles. Specifically, to provide an open architecture, system independent environment where computational tools can be used to design and modify a weapon or vehicle geometry to meet specified performance goals. Also, incorporate advanced visualization and analysis tools into the design environment to allow complex computational data sets to be evaluated in a more efficient fashion.

DESCRIPTION: Current design methodologies use numerous computer-based design tools to determine the performance of a particular concept. There is also considerable effort underway to increase the role of computational codes in the design of marine vehicles and weapons systems. However, there are separate codes for different performance areas (e.g., hydrodynamics, hydroacoustics, propulsion, maneuvering, etc.) and these codes frequently run on different computers under dissimilar operating systems. There is a need to develop an open architecture, system independent design environment that will allow all the different computer-based design tools to be integrated into one common design environment. Operation in a common environment would allow data to be shared between tools and could substantially decrease the time necessary to develop a new concept. A common environment would also facilitate Multidisciplinary Design Optimization (MDO) techniques. This design environment must incorporate advanced visualization and analysis techniques to allow accurate and efficient evaluation of the computational data being generated. This design environment also needs to be operational in the near-term (2-3 years) to be suitable for the design of the next generation of undersea weapons.

PHASE I: Demonstrate the feasibility of a technique for the integration of design tools into an open architecture, system independent environment.

PHASE II: Design and develop an integrated design environment with specific attention to hydrodynamic issues and performance areas appropriate for advanced marine vehicles and new weapons systems. Integrate a set of design tools for at least one particular performance area, i.e., hydrodynamics, hydroacoustics, propulsion, and maneuvering. Incorporate advanced visualization and analysis tools into the design environment. Demonstrate the application of the integrated design process and verify its results by performing numerical experiments.

PHASE III: Extend the Phase II effort to include design tools for each of the other performance areas and apply the Integrated Simulation-Based Design Environment.

COMMERCIAL POTENTIAL: The development of this computational method will provide a design capability that does not presently exist, and will permit design studies to be conducted more efficiently (faster) and affordably than current design practices. This is a capability that can be applied to a variety of large and small marine applications including surface ships, submarines, unmanned undersea vehicles, and undersea weapons. It could also be extended to other applications such as aircraft design.

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3. "Current State of the Art on Multidisciplinary Design Optimization (MDO)," An AIAA White Paper, ISBN 1-56347-021-7, September 1991.

KEYWORDS: Hydrodynamics; Simulation-Based Design; Integrated Design Tools; Visualization; Undersea Weapons; Marine Vehicles

N01-040 TITLE: Modeling of Composite Solid Propellant Combustion

TECHNOLOGY AREAS: Information Systems, Materials/Processes, Space Platforms, Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO(TSC) - various tactical missiles

OBJECTIVE: Develop and validate a computational design tool capable of accurately predicting/describing the steady state combustion characteristics of multicomponent solid propellants.

DESCRIPTION: The US Navy has the mission to develop and deploy the next generation of tactical missile propellants with superior performance and acceptable hazards characteristics. There have been important advances recently in the fundamental understanding of the decomposition mechanisms, flame structure, and combustion dynamics of solid rocket motor propellant ingredients and mixtures. The development of a modeling capability which exploits these advances to provide the capability to describe the combustion characteristics of composite solid propellant using scientific parameters will provide a very important design tool in the development of the next generation of solid propellants and the capability to tailor their performance to the desired application. This capability would significantly reduce both time and expense in solid propellant development and decrease the risk of unanticipated events.

PHASE I: Develop a model capable of describing the steady state combustion of a composite solid propellant which accounts for condensed phase reactions, (temperature sensitivity), gas phase decomposition, diffusion, mixing, pressure sensitivity, temperature sensitivity and other combustion dynamics. Demonstrate feasibility and validate on a two component (binder and monopropellant) system.

PHASE II: Extend model to other multicomponent systems: (i) binder, other monopropellant ingredients, (ii) binder, monopropellant, ammonium perchlorate (AP), (iii) binder, monopropellant, AP, metal fuel. Collect experimental data required to calibrate model coefficients and verify model. Validate model using IHPRPT (Navy lab and/or commercial) propellant formulation performance data. Provide documented computer code for PC platform.

PHASE III: Transition technology into the National IHPRPT (Integrated High Payoff Rocket Propulsion Technology) program and apply in the design of a tactical rocket motor propellant formulation.

COMMERCIAL POTENTIAL The technology developed under this effort can be used in the design and evaluation of commercial rocket motors, pyrotechnics, and air bag formulations. The ability to model the combustion processes of these products has significant repercussions in terms of time to development, cost of development, tailoring the formulation to the specific application, and safety.

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3. Liau, Y. C. Yang V. and Thynell S. T., "Analysis of RDX/GAP Psuedo-Propellant Combustion with Detailed Chemistry", 35th JANNAF Combustion Mtg., Vol. I, CPIA No. 680, 1998,
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KEYWORDS: solid propellant; combustion; modeling

N01-041 TITLE: Prediction of Hyperbaric Oxygen Seizures with Neural Networks

TECHNOLOGY AREAS: Biomedical

OBJECTIVE: The objective of this research program is to apply neural network methodology to the prediction of seizures that are induced by exposure to hyperbaric oxygen (HBO). Recent evidence indicates that changes in several cardiovascular parameters occur prior to the onset of HBO-induced seizures in animal models. In addition, it is well established that there is considerable individual variability in the susceptibility to HBO poisoning. A neural network methodology, accounting for individual differences in HBO susceptibility, will provide an "early warning system" for the increased probability of HBO seizures.

DESCRIPTION: Research has demonstrated that cardiovascular measures such as heart rate variability display different responses during different brain states. Recently published research indicates that changes in mean arterial occur several minutes prior to the onset of tonic-clonic seizures in several animal model systems.

PHASE I: Apply neural network methodology to the measurement of multiple cardiovascular measures during exposure to HBO in animal model systems where seizure is induced. Determine predictive cardiovascular parameters of HBO-induced seizure.

PHASE II: Assess predictive validity of neural network in animal models and in human subjects exposed to sub-seizure levels of HBO.

PHASE III: Demonstrate application/integration of the predictive model system in the LAR 5 Oxygen Breathing Device used by Special Operations Forces breathing pure oxygen.

COMMERCIAL POTENTIAL: HBO therapy is widely used for the medical treatment of several medical conditions and for decompression sickness (the "bends"). Improved prediction of HBO toxicity will have a large impact in HBO treatment.

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KEYWORDS: oxygen toxicity; neural networks; cardiovascular; prediction; hyperbaric oxygen

N01-042 TITLE: Needleless Topical Administration of Dengue DNA Vaccine

TECHNOLOGY AREAS: Biomedical

OBJECTIVE: Develop and demonstrate cholera toxin as an adjuvant to allow topical administration of a DNA vaccine for dengue virus allowing needleless and safe administration. The cholera toxin will enhance the effectiveness of the dengue DNA vaccine by providing an adjuvant effect.

DESCRIPTION: Dengue Viruses cause over 100 million infections a year and are one of the leading threats to military operations in the tropics. Dengue causes epidemics in military encampments and renders units unable to fight effectively. There is no safe, effective and licensed vaccine for dengue. The Naval Medical Research Center has developed a DNA vaccine for dengue that has shown promise in animal trials. A form of topical administration using cholera toxin appears to enhance the effectiveness of conventional vaccines and leads to safe, needleless delivery. Cholera toxin may prove a successful vehicle to deliver DNA vaccines to military members and has great advantages for safe administration of vaccines in tropical areas where a licensed vaccine would be marketed.

Cholera toxin (Ctx) is well known as an adjuvant following intravenous administration of vaccines and following oral administration of vaccines. Ctx was shown to stimulate both antibody production and T cells with Th2 cytokines predominating, especially when purified Cholera toxin B subunit (CtxB) was added. Antibody responses are long lived. The related Escherichia coli heat-labile enterotoxin B subunit (EtxB) was shown to bind strongly to GM1 gangliocide resulting in polyclonal activation of B cells without significant proliferation and results in the upregulation of MHC class II molecules, B7, CD40, ICAM-1 and IL-2 receptor alpha (CD25). Thus B cell function and Th2 mediated cell functions are enhanced. This lead to suggestion that Ctx might work as a topical adjuvant.

Recent work by Glenn, et al demonstrated that topical Ctx induces a systemic antibody response against both cholera toxin itself and co-administered antigens such as tetanus and diphtheria toxins. The effects of Ctx in stimulating B cell and Th2 mediated responses may create an ideal environment for dendritic cell recruitment, recognition of DNA vaccines, and subsequent establishment of B cell memory. We propose to test Ctx with topical administration of dengue DNA vaccines.

PHASE I: Test cholera toxin topical administration with the NMRC dengue DNA vaccine for test of concept in mice. Success is development of neutralizing antibodies at levels higher than naked DNA alone. Perform a dose response study.

PHASE II: Perform primate testing on all four serotype dengue DNA vaccines delivered by cholera toxin adjuvanted topical administration. Success is development of neutralizing antibodies and protection of monkeys from viremia after challenge with live dengue virus.

PHASE III: Perform a human safety and immunogenicity trial of the dengue DNA vaccine delivered by cholera toxin adjuvanted topical administration. Success is development of neutralizing antibodies to dengue.

COMMERCIAL POTENTIAL: In addition to the military application of this vaccine delivery system, this method of delivery would be used to deliver commercial dengue DNA vaccines and also other commercial DNA vaccines and traditional vaccines because it does not require a needle and therefore reduces risk of transmission of HIV/AIDS, hepatitis B/C and other infections that are passed in the developing world by re-used needles.

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KEYWORDS: Vaccine; Adjuvant; Needleless Administration; DNA; Dengue; Force Maintainability

N01-043 TITLE: Underwater Sampling and Chemical Analysis System as Payload for an Unmanned Autonomous Vehicle

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO-MUW (Mine & Undersea Warfare), PMS-EOD

OBJECTIVE: Design, engineer, fabricate and test a rugged underwater sampling and chemical analysis system which can be integrated into a small autonomous underwater vehicle (AUV) useful for detection and identification of unexploded ordnance in the marine environment.

DESCRIPTION: There is a plethora of current research in the area of analytical method development for detection of explosives in air. A smaller number of reports describe detection of low levels of TNT in water using biocentric-based methods as well as more conventional analyses, supported in part by the ONR Chemical Sensing in the Marine Environment (CSME) program. Almost no R&D efforts have been aimed at developing a water sampling and analyte pre-concentration system. A major unsolved issue is how best to couple a water sampling system to the sensor system and how best to develop a small, integrated, lightweight system suitable for a payload in the new class of small, modular, AUVs currently under development. Major chemical analytes of interest are trinitrotoluene (TNT) and one or more isomers of dinitrotoluene (DNT). The system will be employed in marine waters at depths of 3 to 30 meters, and must be capable of providing chemical analyte concentrations with a time response and lower limit of detection appropriate for effective detection and tracking to source of underwater chemical plumes. The underwater sampling subsystem must be coupled to a suitable chemical analysis subsystem, and the integrated chemical analysis system must meet specified operable temperature range, weight, size, and power requirements, making it suitable for use in an AUV. The lower detection limit and time response for TNT and DNT expected from an integrated system must be predicted relative to those of currently available compatible chemical sensors.

PHASE I: Design an underwater subsystem to sample and pre-concentrate explosive chemical analytes from marine waters. Determine what constraints the sampling system design puts on the type of chemical analysis system selected. Demonstrate the feasibility of the sampling subsystem design using a bench top breadboard system. Conclude Phase I by producing a design, a cost benefit analysis of production, and a test and evaluation plan of a prototype integrated chemical analysis system AUV payload.

PHASE II: Fabricate a prototype integrated underwater sampling and chemical analysis system . Conduct laboratory-based tests of the prototype system to measure the lower detection limits and time response for TNT and DNT in marine water. Down-select from among available chemical sensor systems. Down-select from currently available AUV platforms, and integrate a prototype payload within the mass, volume, and power constraints for the selected system. Participate in CSME field tests with the prototype system in an AUV to demonstrate the ability to effectively sample and quantify TNT and DNT signatures from an artificially generated chemical plume in very shallow waters. Participate in Chemical Plume Tracing field tests to demonstrate the ability to detect TNT during chemical plume tracing trials. Modify design of systems based upon field test results, and design a follow-on integrated TNT sampling and chemical analysis payload for a selected AUV.

PHASE III: Produce a turnkey integrated AUV payload for underwater sampling and chemical analysis of explosives (TNT and DNT) for transition to Navy's PEO MUW (PM VSW MCM). Provide working system, personnel training, and test and evaluation support for testing this system in Joint Exercises in FY 04-07.

COMMERCIAL POTENTIAL: There are numerous private-sector applications for an underwater sampling and chemical analyses systems in such areas as environmental sampling of industrial and municipal waste streams for compliance, as part of an in-line quality assurance system in chemical and pharmaceutical processing plants, and for commercial aviation search and find missions. In addition there are potential opportunities for commercial sensor systems to support Defense Treat Reduction Agency programs aimed at locating weapons of mass destruction as part of counter-terrorism efforts.

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9. Autonomous Underwater Vehicles at WHOI , URL: http://deeptow.whoi.edu/auvs.html, and links therein as of 5/30/2000.

KEYWORDS: detection of explosives; autonomous underwater vehicles; remote operation; unexploded ordnance; expanded littoral battlespace; autonomous chemical sensingS

N01-044 TITLE: <u>Device Independent Voice-To-Voice Language Translation Software</u>

TECHNOLOGY AREAS: Electronics, Human Systems

OBJECTIVE: Develop and demonstrate a pocketable voice-to-voice language translator with capabilities similar to the full PC systems currently being developed. To maximize their usefulness, these pocketable systems should have some stand alone capability, such as performing word-for-word translations, and also be capable of connecting remote servers to perform complete context based translation.

DESCRIPTION: Emerging technologies in speech software, language translation and computing platforms are enabling the development of voice-to-voice language translation systems. These systems are beginning to be speaker independent and are capable of translating continuous speech. With the emerging capabilities of hand held platforms (e.g., PDAs and Smartphones) and device independent languages (e.g., Java), there is potential for creating a pocketable language translator capable of connection to remote servers.

For stand-alone usage, where connections to a remote server is not possible, word-for-word translation will allow a limited, but still very useful, language translation capability. For areas where remote connection is possible (e.g., anywhere cellular phone coverage is available) then the device independent software should make it possible to go through the remote server to connect to and/or call someone on a separate handheld platform and have the translation occur in near real-time. For example, one person could use a cellular Smartphone/PDA to connect to another person's smartphone/PDA. The first individual might speak Spanish and have the English translation displayed and spoken on the other PDA.

In the same manner, the translation could be sent back to the originating handheld device. In this mode the user would speak and have the translation displayed and spoken on the same platform. This would be useful for situations where only one PDA is available and/or as a tool for learning foreign languages. Note that the use of remote servers will allow the speech and translation software to be continuously updated.

PHASE I: Develop remote language translation software for a pocket-size translation system.

PHASE II: Deliver a prototype pocketable, cellular PDA capable of voice-to-voice language translation under remote conditions and procedures for its use by military forces.

PHASE III: Eliminate or reduce technological risks of implementing the technology for expeditionary ground forces and/or joint Fleet/MARCORPS operations.

COMMERCIAL POTENTIAL: Business applications exist in global marketing (retail and wholesale), finance, tourism, and training.

REFERENCES:

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2. Large Scale Dictionary Construction for Foreign Language Tutoring and Interlingual Machine Translation, B. Dorr. Journal of Machine Translation, # 12, 1997.

KEYWORDS: Voice-to-Voice; language translation; speech software; remote translation network servers

N01-045 TITLE: Blue Optoelectronics

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT III AAR-47 Missile Warning Systems

OBJECTIVE: To develop blue and near UV light integrated optoelectronics technology for modulation, switching, and distribution of blue and near-UV light. This technology will include integrated optical waveguides, splitters, and electrooptical modulators integrated with LEDs and photodetectors.

DESCRIPTION: Blue and UV optoelectronics should allow one to achieve drastic reduction in size and cost of missile detection systems and biological and chemical hazard detection. Current signal detection and processing systems employ hybrid circuits consisting of discrete component systems. In contrast, if electronic and optoelectronic components are integrated monolithically in a single chip, the detection and signal processing systems will provide compactness, low cost, better reliability and high functionality because of inherent advantages of reduced parts count, size and weight of integrated circuits. Commercial applications include data storage, medical equipment, DVD players, video disk recorders. While progress has been made in the development of III-Nitride based electronic and optoelectronic devices new design

and fabrication approaches are needed for practical applications of these devises. The program should focus on
enhancing performance and powerful spectral tailoring, such as required for rejection of solar radiation residues and spectroscopic hazardous biomolecules. For emitters the structures augur the entry of new LEDs and lasers, e.g. for compact display and lighting applications.

PHASE I: Modeling and experimental demonstration of waveguiding in GaN and AlGaN thin films on low cost, lattice matched substrates. Assessment of technology and design of integrated blue and UV optoelectronic circuits.

PHASE II: Development of integrated blue and UV optoelectronic circuits and demonstration of integrated optoelectronic sensors. Demonstration advanced LEDs and photodetectors operating in the ultraviolet(UV)-blue wavelength range between 365 and 450 nm.

PHASE III: Development of subsystems and systems for biological and chemical substance detection and identification. Operating characteristics, such as sensitivity, of integrated circuits will be determined for gas sensing applications.

COMMERCIAL POTENTIAL: Biological and chemical substance detection and identification is very important for medical, biological applications, as well as for chemical and automotive industry. Integrated blue optoelectronics sensors have promise for the development of cheap and reliable GaN-based sensor systems drastically reducing cost, improving reliability, and safety.

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1. D. Ciplys, R. Rimeika, M. Asif Khan, J. W. Yang, R. Gaska, and M. S. Shur. Characterization of thick GaN layers using guided optical waves, ISCRCM-99 proceedings, ISCRSM-99 Proceedings, to be published

KEYWORDS: GaN; integrated optoelectronics; biological hazard; chemical agents; blue light; near UV FET

N01-046 TITLE: <u>Sonar Stimulation for Virtual Targets in Netted, Tactical ASW Training on Legacy Submarines</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles

OBJECTIVE: Develop and demonstrate the capability of running "virtual ORANGE" (that is, "enemy") submarines on an instrumented range, coordinated among several platforms.

DESCRIPTION: This capability requires two-way transfer of submarine exercise data between a shore facility and a submarine. The 688 Class Submarine will be the predominant platform well into the future, and the Fleet has shown an intense interest in acquiring an external interface for simulated ("virtual") targets for Anti-Submarine Warfare (ASW) training. Also, this capability will allow 688's to engage in coordinated ASW training with surface ships, equipped with the SQQ-89 On Board Trainer (OBT) Trainer Control Device, and to do so without the need for live target services. The result will be an increased training capability with a significant reduction in operational costs.

Currently, the Battle Force Tactical Training (BFTT) Program is the most widely recognized Navy program for in port netted training. The Program will populate the Fleet with BFTT configured platforms within a few years. The Submarine Force to date has had minimal participation in this netted training technology. The submarine sonar community has, however, embarked on a program to introduce Commercial off the Shelf COTS) technology into the submarine sonar suite. The Acoustic Rapid COTS Insertion (ARCI) Program, also known as the AN/BQQ-10, will back-fit legacy submarine platforms (688, 688I) with COTS based tactical hardware and software. The ARCI development plans include introduction of an On-Board Trainer (OBT) during Phase III. The OBT, embedded in the tactical sonar system, will inject simulated

("virtual") threat contacts into the tactical system's pre-beamformer. The simulated contact will be displayed on the tactical hardware as if it were a
real target.

The ARCI OBT will be controlled only from on-board the submarine in the sonar room. A Baseline Change Request (BCR) has been submitted to provide remote operator control capability from on board the submarine. This BCR will allow remote control of the OBT so the sonar operators will be unaware when a training scenario has been initiated. The submarine training (NAVSEA 92L1) and legacy sonar (PEO (SUB) PMS425) program offices both support approval of this BCR.

The goal of this SBIR is an external, off-board, and bi-directional data interface capability with the OBT. The simulated contact data to be provided to the submarine would be Time Space Position Information (TSPI), target type, and event data. The externally transmitted contact data would be received on-board by a simulation controller device and sent to the OBT's remote control port. The OBT would create a high-fidelity acoustic signature and inject this signature into the sonar's sensor electronics to stimulate sonar. This will create a "virtual target" representative of a threat signature to be displayed by the Sonar. The SBIR effort requires development of the software components necessary at either end of a secure link, to select and package the data to be transferred to the other end. A computer on-board the submarine, to interface between the simulation controller device and the shipboard OBT, will also be required. At the host range site, development will focus on the implementation of the following: OBT Proxy Controller module, modifications to the Acoustic Modem Interface, and modifications to the High Level Architecture (HLA) Data Interface.

PHASE I: Provide a feasibility study to identify data compression techniques and Time Space Position Information (TSPI) dead reckoning algorithms that will support the development of a submarine OBT controller device. Demonstrate the selected compression techniques and algorithms. Document applicable trade-off analysis of the various schemes.

PHASE II: Expand the feasibility study to integrate the selected data compression techniques and dead reckoning algorithms with the acoustic communications system. Prototype appropriate software applications and demonstrate that the required exercise data and controller commands can be transferred across the acoustic comms system.

PHASE III: Expand the prototype demonstration and integrate and test the software applications into operational systems installed at both range sites and onboard a submarine. Develop detailed specifications, system test, and test planning documents. Demonstrate netted/integrated training coordinated across multiple platforms on an instrumented range.

COMMERCIAL POTENTIAL: The transmission technology developed will have commercial applicability to the Gaming community for distributed game play applications. Also, the use of acoustic telemetry for low latency data transfer has commercial applications in the areas of ocean exploration and mining, training for search and rescue missions, salvage rescue missions, vessel traffic, etc.

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3. Military Training Technology, MT2 Volume 4, Issue 6 1999; "New Dimensions in Simulation - Getting Out of the School House".
4. Synthetic Environment Tactical Integration (SETI) brief for COMSUBPAC, dated 1999
5. Undersea Warfare Magazine, Winter 98/99 publication, "Virtual Reality Under the Sea".
6. ITEA Journal of Test and Evaluation (International Test and Evaluation Association), Sep/Oct 99, "Synthetic Environment Tactical Integration".

KEYWORDS: ARCI; BFTT; OBT; SETI; ASW Training; Acoustic Telemetry

N01-047 TITLE: Optical Particle Size Spectrometer For Monitoring Particle Size And Concentration In Aircraft Sampling Inlets And Ducts

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

OBJECTIVE: To determine particle losses as a function of particle diameter in airborne aerosol sampling inlets and ducts by comparison with similar measurements in the free air stream.

DESCRIPTION: Measurements of various aerosol particle properties require sampling through inlets and ducts. Often however particles are lost during sampling and transport to the measuring equipment, which causes unknown uncertainties in the measurements. The losses are usually due to particle inertia and thus are directly related to particle size and speed. Aerosol particle size spectra are typically obtained from measurements in the free air stream by optical particle size spectrometers designed for external mounting on aircraft. A probe that may be internally mounted on or in a sampling duct, or plumbed to a sampling duct, and is based on principles similar to the externally mounted probes, with similar size resolution and range, would facilitate a full characterization of particle losses in the sampling system.

PHASE I: Design a versatile optical aerosol size spectrometer for measurements of particle size spectra in airborne aerosol sampling systems. Should cover sizes from 0.5 to 50 mm in diameter, and be compatible with available free-air-stream probes. Should also be adaptable to different sampling systems, and work in flows varying in speed from approximately 1 to over 100 m/s.

PHASE II: Develop, build, and test the instrument. Assess its compatibility with existing probes in the laboratory, and test its performance on an aircraft.

PHASE III: Transition the prototype to a commercial product.

COMMERCIAL POTENTIAL: The system would directly support many Navy and DoD aerosol sampling devices, especially in Chem/Bio warfare and pollution control. Navy and DoD applications would also include use as a bench instrument for monitoring aerosol size spectra in ground or ship based sampling systems. This system could also be marketed to airborne research groups and civilian air quality monitoring facilities.

REFERENCES:
1. Huebert, B.J., G. Lee, and W.L. Warren, Airborne aerosol inlet passing efficiency measurement, J. Geophys. Res., 95, 16369-16381, 1990.
2. Baumgardner, D. and B. Huebert, The airborne aerosol inlet workshop: meeting report, J. Aerosol Sci., 24, 835-846, 1993.

KEYWORDS: Aerosol sampling; aerosol particle size spectra; aerosol particle optical properties; aerosol particle composition

Space & Naval Warfare Systems Command (SPAWAR)

N01-048 TITLE: Indications and Warning (I&W) Inference Engine for the Information Warfare (IW) Picture

TECHNOLOGY AREAS: Information Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT IV:Ships Signal Exploitation Equipment (SSEE)

OBJECTIVE: To greatly enhance I&W by utilizing a rule/case based reasoning inference engine, which uses a knowledge base provided by sensors and analyst/operators.

DESCRIPTION: In today's warfighting environment, Information Warfare (IW) warriors are faced with monitoring dense, unfamiliar signal environments, frequently generated by new communication technologies. From these RF environments, they must build Indications and Warnings (I&W) of both future signal environments and operational intentions of hostile, neutral, own and friendly forces. I&Ws are generally derived from a collection of operationally significant information within the signal environment and then predicting important transmissions or actions based on sets of prior observations.

This prediction process may be greatly enhanced by the development of "inference engine" software. This software will automate I&W and provide additional insight for visualization, will clarify uncertainty, identify intent to deceive, and provide increased situational awareness through visualization and collaboration. Additionally, the inference software should predict the degree of confidence or quality factor associated with the prediction. Rules and cases will define signal transmission profiles that are time and operational event related, consider sensor attributes, consider target topologies, consider patterns and identify ambiguous targeting solutions. As an example, communications usage is operationally dependent. When significant events occur that are relevant to a nodes mission, the number, periodicity, length of communications to and from that node increase. Correlation of these factors to the operational event may be established as an intelligent search agent. This intelligent search agent will then match node operational characteristics to its various sets of event-based tables. When a match is made, the operator can be cued with the set of events to which these characteristics were previously related.

PHASE I: Validate the concept and identify the rule based (or alternative knowledge based) predictive software. Develop a system design. This design should identify the general methodology, computer aided training, the internal software functions, the input and output requirements and interfaces, software development areas, operator interfaces, inference effectiveness and updating, concept of operation example.

PHASE II: Develop and test the engine including inferences in a simulated environment. Quantify effectiveness of operators. Test in a battle group exercise and reach-back environment to determine its value added and effectiveness.

PHASE III: Prepare Global Command and Control System-Maritime (GCCS-M) compatible inference packages for use within the fleet. Develop packages for other DoD components with similar I&W requirements.

COMMERCIAL POTENTIAL: This system has numerous commercial applications where inference of future events is desired. For example, communication companies concerned about network loading; market analysts predicting trends; weather services predicting future events; highway commissions predicting future traffic flow and etc.

KEYWORDS: Collaboration; inference; prediction; rule based; visualization

N01-049 TITLE: <u>Enhanced Data Rate Performance for VLF/LF</u>

TECHNOLOGY AREAS: Information Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACT IV: PMW-173-3A

OBJECTIVE: To develop an approach for increasing the data capacity of a very limited-bandwidth VLF/LF channel significantly closer to the Shannon Limit using the hardware design of current transmitters and SLVR submarine receivers.

DESCRIPTION: The frequency bandwidth available for VLF/LF communication signals is limited. Due to the electrical constraints imposed by this uniquely low radio frequency range, it is impractical to employ sophisticated modulation techniques using the complex hardware modulation techniques employed in many current wireless and wired communications mediums. However, recent upgrades of the VLF/LF transmitters allow new waveform modulation techniques to be implemented within software; conversely, the SLVR submarine receiver can employ sophisticated digital signal processing for symbol recovery. The goal of this effort is to identify the best method to utilize VLF/LF communication channels using a combination of digital signal processing techniques including: signal pre-distortion, constant magnitude continuous phase modulation, channel equalization, message compression, and forward error correction.

PHASE I: Perform an analysis of the options and identify promising approaches. Develop models and/or simulations to provide analysis of how these approaches increase data capacity. Identify best approach describing software/hardware development required for system.

PHASE II: Develop software modules to implement the recommended approach and use the modules in an end-to-end simulation. The simulation will include scenarios such as the following: transmission of the chosen waveform through an antenna with limited bandwidth; transmission through an impulsive noise channel; reception by an underwater antenna; and processing of the waveform by the receiver.

PHASE III: The software modules will be reused to a maximum extent in the development of a real-time system hosted in the SSC San Diego Integrated Test Facility (ITF). This software product will be transitioned to the VLF/LF transmitters and SLVR submarine receivers.

COMMERCIAL POTENTIAL: The technology could be applied to any bandwidth-limited channel in a noisy, fading, and waveform-distorting RF environment. Examples include: wireless network communication via very low-power transmitters; High-Frequency (HF) radio communication; and acoustic or light-based data communication systems.

REFERENCES:

1. "Advances in Constant Envelope Coded Modulation," IEEE Communications Magazine, December 1991.
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KEYWORDS: communications; narrowband; pre-distortion; message compression; FEC; VLF; continuous phase modulation

N01-050 TITLE: <u>Bandwidth Efficient Remote Manipulation and Fusion of Huge Data Sets</u>

TECHNOLOGY AREAS: Battlespace

OBJECTIVE: Allow military (and other) users with severely constrained communications bandwidth, like navy ships at sea or forward deployed ground forces in the field, to have real-time, simultaneous access to multiple potentially invaluable, but heretofore unmanageable large, data sets, especially satellite imagery and numerical computer model data sets.

DESCRIPTION: Deployed military forces at sea and in the field have far less robust communications capability than permanently established, non-deployable organizations within the U.S. Nevertheless, these deployed forces must act independently with short lead-times in making decisions that involve force personnel survivability. To enable better decisions under these circumstances, in a network-centric fashion, we must allow remote units to access and to visualize the best and most current information available anywhere in the "network". That information often takes the form of huge imagery data sets physically stored in disparate locations. The aim of this project is to develop client-server and neuro-cognitive technologies that will allow these huge data files to be located, virtually overlain and/or fused, analyzed, and manipulated on the fly, via small communications channels, without physically moving data. A family of commercial products is being developed that include data processing engines that allow access to any SQL server. These products have not been applied to data types and/or databases that would be of Navy interest. Accordingly, implementation risks are considered low.

PHASE I: Develop a methodology to establish a client-server pair between the data source and data user. The system should allow an operator to remotely manipulate imagery or other data types, manage its distribution, and virtually fuse it with models.

PHASE II: Test the technology on ships at sea with expanded data network.

PHASE III: Package the client system for “plug and play” on ships and at field locations. Permanently establish server systems at every DoD and relevant government data source. (E.g., NASA, Naval Oceanographic Office, National Imagery and Mapping Agency, Fleet Numerical Meteorology and Oceanography Center, National Weather Service, National Reconnaissance Office)

COMMERCIAL POTENTIAL: Every academic institution, research and development organization, and government agency in the U.S. could have instant, practical, access to invaluable data sets. Government contractors could be granted access, making myriad analysis tasks much more efficient and cost-effective.

KEYWORDS: data sets; data manipulation; data fusion; client-server; imagery; numerical model; meteorology; oceanography

N01-051 TITLE: Optical Powering Of Systems

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT II, Advanced Deployable System (ADS)

OBJECTIVE: The objective of this topic is to develop the technology and design for optical powering of undersea, fiber-optic, cable systems.

DESCRIPTION: Undersea, fiber optic, cable systems are currently either battery powered or powered form shore via a conductor that is part of the cable. For the former, large battery packs need to be deployed wherever electronics are located along the system. For the latter, the conductor in the cable dominates system size and controls system cost. An alternative concept is to power the fiber optic cable system by sending laser power from the shore side of the cable that is tapped off at locations where electronics are located and converted to electrical power for powering the electronics (the power laser will operate at a different optical wavelength than the telemetry lasers bringing data ashore). Highly efficient optical wavelength de-multiplexers, highly efficient optical to electrical converters, and high intensity lasers are required for this powering approach.

PHASE I: Develop the optical characteristics that would provide power of several watts at each location where electronics are located along the undersea cable. Determine where optical and electrical components need to be developed that are beyond current commercial technology. Generate a coordinated plan for development of all necessary components.

PHASE II: Fabricate and procure all necessary optical and electrical components for a multi-node laboratory demonstration. Conduct a laboratory demonstration where each node has a dummy lode of several watts. Generate system schedule and cost estimated for a P3I addition to the ADS system.

PHASE III: Develop production capability for the optical and electrical components to power and ADS system. Work in conjunction with the ADS development contractor for identification of environmental, shock, vibration, and packing constraints that must be met for deployment. Provide low level production and integration of the subsystem components for optical powering.

COMMERCIAL POTENTIAL: Optical powering of electronics attached to a fiber optic system will potentially have commercial application to large, distributed networks where power is not always available and every location.

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KEYWORDS: optical; power; fiber-optic; undersea; wavelength; converters

N01-052 TITLE: Compressed Internet Protocol (IP) Data Via Geosynchronous Earth Orbit (GEO) Satellite Circuits

TECHNOLOGY AREAS: Information Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT III: Submarine High Data Rate

OBJECTIVE: Investigate and define the characteristics of an optimal protocol for the reliable transmission of digital data over a Geosynchronous Earth Orbit (GEO) satellite with limited data bandwidth; inconsistent Bit Error Rate (BER) performance; intermittent operation; and a Local Area Network (LAN) interface on each end of the communication link.

DESCRIPTION: One of the goals for the next generation of shipboard communication systems is "transparent" network connectivity: Users wish to send or receive data in a manner that is independent from the operation of the radio room or the utilization of specific communications circuits. Current plans for the future submarine computer network systems include the usage of Transmission Control Protocol/Internet Protocol (TCP/IP), Asynchronous Transfer Mode (ATM), and Local Area Network Emulation (LANE) protocols.

The execution of these Commercial Off-The-Shelf (COTS) methodologies is beset with unique difficulties in the submarine operational environment.

Satellite communications links are intermittent and short-term due to the stealth nature of submarine operations: It is frequently desirable to minimize the length of time at which the submarine is at periscope depth, which is currently essential for submarine satellite communication. Consequently, “transparent” network connectivity requires a sophisticated system for queuing data and the execution of a complex array of Quality of Service (QoS) parameters.

In many operational situations, a submarine is unwilling to transmit a radio signal unless it has a Low Probability of Detection (LPI) characteristic; many times, complete radio silence is required. In these situations, it is impossible for the submarine to return the packet reception acknowledgement data that is required for COTS TCP/IP operation.

The data rate and Bit Error Rate (BER) of submarine-based satellite communications links is frequently inferior to the typical performance of the same types of links in surface-ship applications. Consequently, the optimal utilization of data compression and error correction techniques is essential in order to achieve Fleet requirements for data rates and availability.

COTS TCP/IP and ATM protocols have not been designed to perform well within the above constraints. Therefore, enhancements to these commercial protocols are essential for the optimal implementation of IP and ATM protocols within submarine satellite communication systems.

PHASE I: Develop enhancements to COTS IP and ATM protocols; these may be “original” or based upon published literature. With guidance from the user community, end-to-end simulation scenarios will be developed and executed. The deliverable will be a report providing a detailed description of the proposed protocols, simulations, results, and conclusions.

PHASE II: Implement the best approach (or approaches) into hardware and software that represents a close approximation of actual submarine satellite communication systems. The performance of the enhanced protocols will be tested under realistic SATCOM link conditions.

PHASE III: The successful protocol enhancements from Phase II will be integrated into actual Navy-owned submarine communication system hardware. Field-testing will be performed to characterize the performance of these protocols in comparison with those that are currently in use by the Fleet.

COMMERCIAL POTENTIAL: The protocols developed during this program may be useful in commercial wireless applications that employ TCP/IP in a low data rate/relatively high BER environment. For example: TCP/IP via mobile telephone.

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3. Allyn Romanov, Sally Floyd, "Dynamics of TCP Traffic Over ATM Networks, " IEEE Journal of Selected Areas in Telecommunications, May 1995.

KEYWORDS: TCP/IP; ATM; satellite; protocols; QoS; enhanced

N01-053 TITLE: <u>Simulation Runtime Prediction System</u>

TECHNOLOGY AREAS: Information Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT III: PMW-131 Naval Simulation System (NSS)

OBJECTIVE: To allow simulation developers and users to estimate a simulation's runtime prior to its actual employment. That is, to predict the elapse time of – or benchmark – a simulation run.

DESCRIPTION: Simulation has proven to be a very powerful tool in training and in course of action (COA) analysis. Yet, most training applications require real-time execution, and COA analysis strives for run times that are many times faster than real time. Thus, it is critical – as a simulation is designed, developed, hosted, and employed – that accurate predictions of its runtime are available. This effort will correlate software design, hardware hosting, and simulation implementation metrics with runtime performance, using specifically scaled displays, and will produce the associated software product.

PHASE I: Formulate an initial design of the Simulation Runtime Prediction System that defines a set of metrics and associated assessment concepts for predicting NSS runtime with varying scenario inputs, software objects, and hardware hosts. Estimate system implementation feasibility and payoff.

PHASE II: Develop the Simulation Runtime Prediction System, including an application program interface to the NSS object library and database; runtime prediction algorithms, confidence intervals, and baselines; and post-processing statistical index generation and displays.

PHASE III: Implement and employ system modules tailored to the growing aviation, communications, and industrial manufacturing simulation systems, with associated commercial software and database interfaces and documentation.

COMMERCIAL POTENTIAL: The use of large commercial simulations to support just-in-time analysis of aviation (route plans), communications (network analysis), and manufacturing is growing. This system will address the need that commercial users have to optimize their simulation use.

REFERENCES:
1. Thavikulwat, P., Activity-Driven Time in Computerized Simulations, SIMULATION & GAMING, Vol. 27, No. 1, March 1996
2. Pariseau R., et all, Use and Misuse of Data Types and Scales in Analysis, Acquisition Review Quarterly, Vol 1, No. 2, Spring 1994
3. Guckenberger, D.L. et all, Moving in Time, MILITARY SIMULATION & TRAINING, Issue 2, Feb 1995.

KEYWORDS: Simulation; runtime; prediction; real-time; metrics; benchmarking

N01-054 TITLE: Precise Time and Frequency for Navy Applications

TECHNOLOGY AREAS: Information Systems, Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: Link-16 and NAVSSI

OBJECTIVE: Develop a prototype hardware low cost solution for providing an accurate time and frequency standard suitable for Government and commercial applications.

DESCRIPTION: Most military systems (communications, sensors, targeting, information distribution) require a high performance frequency standard for proper operation. The traditional approach for the design of these systems has resulted in the proliferation of atomic frequency standards, whereby each system contains an independent time and frequency source. This causes two major problems. First, extra space and weight is taken up by essentially the same piece of equipment. Second, these time and frequency sources may not be steered to a common reference; in order to exchange meaningful information regarding situational awareness between users, a common time reference frame must be established.

The Navy's Navigation System Senor Interface, NAVSSI, collects and distributes precise navigation data to users, eliminating the need for each system to contain a standalone GPS receiver. NAVSSI, however, does not have the ability to meet the demand for a precise time and frequency standard. There are no time and frequency standards available on the open market that may be integrated into NAVSSI to meet the stringent requirements of multiple users. Likewise, precise knowledge of time is required by Link-16 terminals in order to support the time synchronous operation and high accuracy Time of Arrival (TOA) measurement capability of the Link-16 terminals. The goal of this program is for the development of a small stable atomic oscillator that may be hosted on both a VME card for insertion into NAVSSI, and integrated in a Link-16 terminal.

NAVSSI and Link-16 terminals use a 10 MHz Oven Controlled Crystal Oscillator. While considered a "good" grade of oscillator, the drift characteristics are not sufficient to meet the requirements of many other users. The oscillator in NAVSSI is disciplined to a GPS timing signal, so it actually provides much better performance, but the vulnerability of GPS results in a requirement that a backup time and frequency standard must be present. For Link-16, the Relative Navigation (RelNav) function can provide munitions-quality accuracy but its performance is highly dependent upon the ability to maintain a precise knowledge of system time. This requires very low time drift characteristics during clock and position measurement intervals. Minimizing the frequency drift error characteristic of this source within the Link-16 terminals will allow the RelNav capability to be used in ICBM applications where long flight times are a critical mission requirement. In both application areas, a high quality oscillator source with very low drift rate is needed. Advancements in clock technology are required to provide a smaller, low-cost, highly accurate time and frequency standard that may be hosted on a VME card for NAVSSI and integrated into Link-16 terminals. The purpose of this SBIR is to identify, design and develop prototype hardware that will provide improved time stability characteristics that show the most promise in achieving the desired oscillator accuracy for both military and commercial applications.

PHASE I: Identify and develop architecture options and tradeoff performance parameters that show the most promise for developing an oscillator that provides an accuracy of 1x10-12 seconds or better over at least 30 minutes. Demonstrate the viability of the development, integration, and production yields.

PHASE II: Develop, test, and demonstrate under realistic conditions the most promising techniques. Carry out further validation, including certified laboratory and field-testing of the developed hardware. A cost estimate for future follow-on production units should be provided. Where it can be done economically, with non-SBIR funding, comparisons of the SBIR-developed technique with other available developments shall be performed.

PHASE III: Apply the hardware solution to the NAVSSI and Link-16 terminals. Demonstrate the developed hardware capability through operational tests.

COMMERCIAL POTENTIAL: From the outset this development must be keyed to multi-use applications – this imperative is driven by the need for interoperability and time coherency across military battlespaces, and is comparable to wide-area and metropolitan networks, regional and national enterprises such as FAA traffic control, and surveillance by FBI Coast Guard or Customs. This is needed wherever accurate and coordinated knowledge of time is required. Reduced size, weight and cost Link-16 terminals are presently being studied which would further open up an innovative application to industry in commercial air, transportation or any other system which presently requires knowledge of time. The potential capability and flexibility of the developed solution would allow its use for other commercial applications including cellular telephone base stations and timing systems for computer networks.

KEYWORDS: JTIDS; Link-16; NAVSSI; Time; Frequency; Oscillator; Relative Navigation; Distribution

N01-055 TITLE: IW (Information Warfare) Sensor and Wireless Network for Recovery of Wide-band Data

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: VTUAV, ONR35 Autonomous Operations FNC Platform

OBJECTIVE: To provide a low cost, data acquisition and wide-band wireless network for transmitting data between (airborne, ground, or sea) wide-band sensors, relays, and remote processing sites.

DESCRIPTION: Access to hostile areas, whether military or civilian, for collecting data has always been dangerous for manned sensor platforms. Remote expendable vehicles (airborne, mobile and static ground, and sea based) currently under development will alleviate this danger. When deployed in numbers, these expendable remote sensor platforms exhibit greater survivability and thus higher probability of detecting significant events in the hostile environment. These sensors are assumed to be within a mile of each other. A significant component of the remote sensor system is the data recovery component. Because the sensors must be expendable (inexpensive), the processing of data from the field of sensors will most likely be performed outside the hostile area. This implies a data link from the field of sensors (via a remote relay) to the shipboard or ground-station processing center. The remote relay is assumed to be 5 miles from the sensor field and up to 100 miles from the processing center.

The IW sensor field will: (1) detect, identify, and locate the target signal and (2), transfer data to the relay and subsequently to the shipboard processing system. In operation, the system is envisioned to operate in two modes: (1) multi-sensor snapshot and (2) single sensor high-speed streaming. It is desired that the data link between the relay and processing center be compatible with the common data link (CDL) presently in use by DoD elements.

Whereas the ultimate goal is to produce systems with the capabilities described above, this effort will focus on developing the sensor and the asymmetric network between the sensor and the relay.

PHASE I: Complete a conceptual/feasibility analysis for the complete system including the remote sensor field, relay and processing center. Perform a preliminary system analysis and design for a field of three sensors. Identify high risk areas in the recommended system design.

PHASE II: Design, develop and test UHF sensor with a 50 MHz in the asymmetric network between the sensor and the relay. Complete the design of the relay and identify development risk areas.

PHASE III: Design and build an IW) Sensor and Wireless Network for Recovery of Wide-band Data that can be mass-produced. Test and demonstrate it.

COMMERCIAL POTENTIAL: The need to communicate wide-band information from remote, mobile sensors via a network is a continuing requirement from commercial and DOD perspectives. This capability will be useful by organizations that transmit television pictures, wide-band RF signals, EO/IR images, video and etc.

KEYWORDS: wireless; data acquisition; remote sensors; intercept; exploitation; information warfare

N01-056 TITLE: Characterizing the Shallow Water Environment and Ambient Noise using In Situ and Remotely Sensed Information

TECHNOLOGY AREAS: Information Systems, Sensors, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ADS/Dynamic Ambient Noise Prediction System

OBJECTIVE: To estimate the ambient noise, geoacoustic parameters and vertical sound speed profiles impacting low frequency (< 300 Hz) acoustic propagation in the shallow water environment by using dynamic surface ship tracks obtained from remotely sensed data as acoustic sources.

DESCRIPTION: Shallow water ambient noise depends critically on two factors: the highly variable (in time and space) acoustic propagation paths and the dynamic tracks of nearby surface ships. Innovative methods to accurately estimate the propagation environment (sound speed and geoacoustic parameters) and ambient noise in shallow water areas are sought using passive fixed and towed array sonar systems in conjunction with remotely sensed information.

PHASE I: Develop a concept of multi-sensor (acoustic and non-acoustic) data fusion to dynamically estimate tracks of nearby surface ships in the shallow water area. Using these tracks as acoustic sources of opportunity, develop an integrated methodology to ascertain the spatial variability of the ocean bottom (i.e., geoacoustic variability obtained through innovative Inversion Techniques) and the spatial and temporal variability of the vertical sound speed. Finally, use the measured ambient noise to statistically characterize the shallow water environment. Passive fixed and towed arrays, in conjunction with remote sensing assets, are to be used.

PHASE II: Evaluate the propagation environment and ambient noise shallow water environment characterization concept developed during Phase I by developing a prototype software suite that will demonstrate its dual use applications. This prototype will demonstrate a measured improvement in Navy signal processing systems, such as APB(A) and STDA, as well as in commercial remotely sensed fusion systems, using benchmark data provided by the government.

PHASE III: Develop software that can be integrated into existing ADS or APB(A) signal processing systems and that runs in real-time. Evaluate in real-time during an ADS or submarine towed array at-sea exercise.

COMMERCIAL POTENTIAL: There is great interest in fusing acoustic data with commercial remote sensing assets like RADARSAT II and several other synthetic aperture radars (SARs) scheduled for launch in the near future. Combining such satellite data with the shallow water acoustic data increases the probability of detecting, identifying and tracking ships of high interest in crowded coastal environments. In fact, commercial news agencies intend to launch satellites in the near future to monitor coastal shipping events.

Naval Sea Systems Command (NAVSEA)

N01-057 TITLE: Effectiveness of Doubler Plates as a Permanent Repair Under Cyclic Loads in a Highly Corrosive Environment

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Provide quantitative technical rationale (criteria) for limitations on the application of doubler plates as a repair fix for surface ships.

DESCRIPTION: The use of doubler plates, or lapped plating has become extensive and is a cheap method of repairing corroded plating. While this method of repair has economic advantages, its use has never been accepted as a permanent repair but only as a temporary one until the ship is either in dry-dock or in restricted availability and permanent repairs can be made to the original corroded structure. What we have been witnessing in some instances are reports that not only the base structure is corroded, but that the doubler plates, used to cover the corroded plating are experiencing corrosion themselves. Doubler plates have never been considered to restore structural strength, only maintain local water tightness. In addition to the questionable structural performance that doubler plates provide, there is also concern about crack-initiation in the base metal resulting from the peripheral fillet-welding of these plates.

PHASE I: Collect and compile historical documentation and survey data of the uses (successful & unsuccessful) of doubler plates for ships in-service. Develop and provide limitations and/or restrictions on their use based on compiled case data.

PHASE II: Develop a load application matrix which combines the effects of in-plane primary hull girder stresses and lateral localized pressures with the basic plate panel strength characteristics (bending, fatigue , buckling, etc) taking into account various reductions in plating thickness due to corrosion. Identify the reduction in both continuous & intermittent fillet weld strength of doubler plates treating both primary and local lateral loads as cyclic.

PHASE III: Develop design guidelines for the limits of applicability for use of doubler plates based on the outputs of Phases I & II.

COMMERCIAL POTENTIAL: Commercial structural design standards such as those contained in the classification societies would benefit as new performance data of doubler plates is incorporated . This would lead to better monitoring & inspection procedures for these repairs as well as provide a more cost-effective strategy for decisions to permanently repair doubler plates.

REFERENCES:

1. NAVSEA S9086-DA-STM-000: Naval Ship's Technical Manual (NSTM) Chapter 100 (Hull Structures)
2. NAVSEA T9074-AS-GIB-010/271: Requirements for Nondestructive Testing Methods.
3. ABS Hull Thickness Measurement Bulletin (Gauging Surveys) October 1998.
4. Navigation and Vessel Inspection Circular (NVIC) No. 7-68
5. Commercial Ship Design for Corrosion Control - Ship Structure Committee (SSC) Report SSC-397, 1997.
6. Optimal Strategies for Inspection of Ships for Fatigue and Corrosion Damage - Ship Structures Committee (SSC) Report SSC-407, 1999.
7. Strength Assessment of Pitted Plate Panels - Ship Structure Committee (SSC) Report SSC-394, 1997.

KEYWORDS: Corrosion; Temporary Repair; Inspection; Maintenance; Fatigue Strength; Inaccessible Areas

N01-058 TITLE: Wireless Interface to Programmable Logic Controllers (PLC)

TECHNOLOGY AREAS: Information Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: CG 47 class, DDG51 class, Carriers

OBJECTIVE: Develop wireless connection capability for the shipboard Programmable Logic Controllers.

DESCRIPTION: The installation of Programmable Logic Controllers is a major cost driver for the shipboard controls and monitoring systems. By far the most popular method of communicating with external devices is by using the RS-232 method. As the Programmable Logic Controller is populated, the use of the RS-232 communications method increases the cost of the installation. To reduce the costs of Programmable Logic Controller installations and to take advantage of wireless sensors, the following is proposed:

PHASE I: Determine the best suited wireless technology for shipboard application (audio, radio, infra-red, etc), and develop a suitable wireless communications concept for shipboard data transfer to provide a cost effective approach to eliminating reliance on the RS-232 communications method currently utilized by PLCs. Communications will be via wireless interface card that is based on COTs and IEEE 802.11 (including 802.11b) and Bluetooth standards. The standard for the RS-232 is EIA RS-232.

PHASE II: Develop a wireless interface to a Programmable Logic Controller and fabricate suitable prototype equipment to demonstrate the utilization of wireless sensors within the network.

PHASE III: Implement the integration of the wireless sensors and Programmable Logic Controller at the NAVSEA Philadelphia Land-Based Test Site. Upon successful validation and verification, install the system aboard a ship for demonstration and further validation.

COMMERCIAL POTENTIAL: Programmable Logic Controllers are used in many commercial applications. If there is industry present, there is usually a Programmable Logic Controller near-by. For this reason, the solution of a wireless input capability has a large commercial application. The capability will enable further expansion of controls and monitoring without a substantial increase in cost.

KEYWORDS: Wireless; Wireless Sensors; Programmable Logic Controllers

N01-059 TITLE: Portable, wireless transmitting accelerometer for measuring vibration

TECHNOLOGY AREAS: Electronics

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: Assessment of Equipment Condition (AEC) Program

OBJECTIVE: Develop a self or battery powered accelerometer for measuring vibration and transmitting the data in a wireless fashion with price and performance comparable to standard accelerometers.

DESCRIPTION: The field of machinery maintenance can be significantly enhanced by the development of a portable and wireless transmitting accelerometer with price and performance comparable to currently available cabled models. The accelerometer should be self or battery powered, and sized to be used with current portable vibration data acquisition equipment using magnetic mount accelerometers and robust enough to be used in a harsh shipboard environment. The accelerometers should be constructed such that many can be used simultaneously to enhance data acquisition speed, convenience and eliminate safety concerns with respect to extensive cabling. Data communications will need to take place in a fashion that can readily take place between the accelerometers and a portable/laptop style device.

PHASE I: Develop concepts and methods, and preliminary design, including technical and physical drawings, for an accelerometer that will acquire and transmit vibration data. Current hurdles that this technology will need to overcome include packaging all of the electronics (sensor, power supply and transmitter) on an extremely small footprint, not much larger than current accelerometers attached by cabling. The unspecified power supply must be reliable and fairly long lasting. The electronics will need to "turn on" the accelerometer on some type of cue, and transmit the data along with identifying information on itself. The need to allow up to 6 of these to operate simultaneously may also cause data transmission problems. The most difficult issues to overcome will be the size, and to do it in a cost effective manner. We look forward to innovative solutions that will take some facets of MEMS technology to the main stream in a unified package.

PHASE II: Develop, fabricate and test a prototype accelerometer conforming to the Phase I preliminary design, and procedures necessary to demonstrate wireless accelerometer performance and production potential to the Navy community.

PHASE III: Develop a production version of an operational wireless accelerometer. Furnish production quality versions for testing and evaluation such that multiple units can be tested simultaneously for full evaluation.

KEYWORDS: maintenance; vibration; accelerometer; data acquisition; wireless

N01-060 TITLE: <u>Damage Tolerant Composite Scuttles and Hatches</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: DDG 51

OBJECTIVE: Develop cost-effective composite hatches and scuttles that provide superior damage tolerance relative to current sandwich construction.

DESCRIPTION: The DDG 51 surface combatant has approximately 150 hatches and scuttles. The majority of these scuttles and hatches are heavy and difficult to operate. In addition, significant resources are spent over the service life of the ship to maintain these components. Composite materials offer solutions to both of these technical challenges, as composite materials are inherent lighter than conventional engineering materials and do not rust. Additional requirements for the composite scuttles and hatches are EMI shielding and fire protection.

PHASE I: Develop a conceptual design and preliminary sketches for a damage tolerant scuttle or hatch. Develop engineering data and materials to support fabrication of a prototype damage tolerant hatch/scuttles. Identify low-cost manufacturing method. Develop conceptual design for scuttle or hatch.

PHASE II: Develop, fabricate, and test two hatches or scuttles for EMI, fire, and damage tolerance. Develop and apply analytical methods for structural analysis. Prepare installation and repair processes. Provide cost estimates for prototypes and for large-scale production runs and a preliminary design disclosure package.

PHASE III: Prepare a manufacturing plan to produce the scuttles/hatches in quantity. Market the product to the military and commercial shipbuilding industries.

COMMERCIAL POTENTIAL:
Cruise Industry
High quality appearance (Built in color available)
Reduced maintenance
Conformable shapes
Cargo
Reduces weight
Reduced maintenance
Potential to transition this technology directly into door applications for commercial markets

REFERENCES:
1. MIL-STD-2031, "Fire and Toxicity Test Methods and Qualification Procedure for Composite Material Systems Used in Hull, Machinery, and Structural Applications inside Naval Submarines", 1991.
2. Sorathia, U., et al, "Fire Safety of Marine Composites", MACM 2000 Conference Proceedings, Section T, 2000.

KEYWORDS: Composite materials; Lightweight; Cost effective; Damage tolerant; Hatches; Scuttles

N01-061 TITLE: <u>Development of Probabilistic Design Primary Loads (Vertical & Lateral Bending) for use in a Weight-Optimized Structural Design of CVNX</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT I, CVNX

OBJECTIVE: Develop realistic, extreme primary hull girder loads necessary to facilitate the application of reliability-based methods for investigating the possibility of weight savings.

DESCRIPTION: Current structural design practices for aircraft carriers employ historical or traditional approaches regarding the design bending moment. These design primary loads have been statistically shown to have a significant chance of being exceeded during the ship's service life. In addition, methods for determining carrier strength are based on the use of factors of safety which are believed to provide inherent margins against all possible failure modes. Without the use of a more exact assessment methodology to explicitly calculate "real" loads imparted to a carrier and explicitly assess all possible failure modes for the carrier structure, it will be virtually impossible to achieve any potential weight savings in the hull structure. In addition, the CVN(X) ORD makes direct reference to achieving a specified level of reliability consistent with an existing carrier.

PHASE I: Develop an operational profile for the ship consistent with the service life requirement specified for the CVN(X) and calculate ship motions for all possible environmental scenarios. Determine statistical distribution of both vertical & lateral primary bending moments including the lifetime-extreme values for each .

PHASE II: Determine the appropriate limit-state equations for the primary hull girder and at all the structural sub-system/components. Determine the limitations in strength prediction models that consider distortions in structure resulting from fabrication. Develop limiting slenderness parameters for all structural members (plates, webs, flanges, plate-stiffener, etc) to preclude buckling failures at all levels (except global).

PHASE III: Apply new statistically-derived, extreme primary loads obtained in Phase I and the limit-state models from Phase II and perform a weight-optimized midship section design. Calculate Group I weight and compare with Group I weight of existing carriers.

COMMERCIAL POTENTIAL: The commercial industry (offshore, building) already has in existence, reliability-based structural design methods. Because the nature, and magnitude of these loads, their design standards may or may not be applicable. Commercial ship classification societies appear eager to either develop this technology or capitalize on existing efforts made in the Navy R&D community. As knowledge in the area of risk & structural reliability transition from the Navy to the commercial sector, a broader range of application of these methods are anticipated, resulting, ultimately in an improved method for structural design for both naval & commercial ships. There is also a relationship between the advancement of structural reliability for naval ship design and the current partnership initiative underway between the Navy & ABS in developing a Naval Vessel Rules.

REFERENCES:
1. MIL-STD 1689 - Hull Plating Fairness Limitations.

2. Ship Structural Design by Owen Hughes.
3. LRFD Rules for Naval Surface Ship Structures (in preparation) NSWC/CD Code 65 Report

KEYWORDS: Lifetime Extreme Load; Structural Reliability; Probability; Bending Moment; Combined Loads; Optimize

N01-062 TITLE: Relay Replacement

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: CVN, CVNX

OBJECTIVE: Develop solid state relays (SSR) to replace the problematic electromechanical relays in the automatic bus transfer (ABT) control circuitry of the in-plant load centers onboard CVN 68 class ships.

DESCRIPTION: The electromechanical relays presently installed in the automatic bus transfer control circuitry of the in-plant load centers onboard the CVN 68 class ships have chronically malfunctioned, have been failing at a rate of 25 per year, and are a maintenance burden to adjust properly. Repair parts for these relays are no longer available and as a result whenever a relay malfunctions, the entire relay must be replaced. The cost of a replacement relay is approximately $1,800. This results in increased system down time and repair cost. Solid state relays are smaller, offer long operating life, will be COSAL supported, and offer increased reliability over electromechanical relays since they incorporate no moving parts and have no contact bounce. Solid state relay technology has been available since the early 1970's but the Navy has yet to incorporate this technology for this application. Solid state relays with identical performance characteristics to the electromechanical relays, which need replacement, are currently unavailable. The Navy desires to develop solid state relays, which would closely match the performance characteristics of the currently installed electromechanical relays (in this application, the N-130 relay). The solid state relays must be capable of operating in a shipboard environment and withstand shock and vibration requirements. The new relays should fit in place of the old relays, and be adjustable/programmable to mimic the 6 different configurations currently installed aboard the CVN-68 class carriers. Since solid state relays are typically smaller than equivalent electromechanical relays it may be necessary to design an adapter device such as an intermediate plate to fit the new relays in place of the old.

PHASE I: Design/Develop solid state relays that closely match the performance characteristics of and may interchange with the current Navy relays. Focus should be on the feasibility of the design to approach the interchangeable and performance requirements.

PHASE II: Refine Phase I design to meet all performance characteristics of current design requirements. Produce and test prototypes, including shock & vibration qualification. Demonstrate installation of solid state relay into ABT control circuitry and perform tests.

PHASE III: After successfully qualifying relays to meet Navy requirements, demonstrate the capability to produce the needed relays in quantities the Navy needs. Provide the engineering and development design, manufacturing and test reports.

COMMERCIAL POTENTIAL: A reliable non-mechanical solid state relay will be marketable to electrical/electronic device manufactures, to the power generation industry, and to the commercial shipbuilding industry. Product derivatives may offer reliable and affordable alternatives to the electromechanical relays used to protect various other types of electric devices.

REFERENCES:
1. MIL-DTL-2212H

KEYWORDS: Relay; Solid State Relay; SSR; Electromechanical; EMR; Automatic Bus Transfer; ABT

N01-063 TITLE: Data-fusion for Advanced Cathodic Protection Monitoring and Control for Marine Structures

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT I, CVNX

OBJECTIVE: Develop and demonstrate data-fusion technology/software system to fully integrate cathodic protection system data (existing and additional) and to demonstrate its use in determining coating/dielectric status, corrosion activity and electrolytic current status on both external hull-type structures, and interior tank type structures. In addition, and where applicable, to use such fused data to better control ICCP systems.

DESCRIPTION: Corrosion control of ship's hulls and tanks is a major cost driver for the Navy. Investments in advanced paints, their proper application, and the implementation of improved cathodic protection systems have greatly increased the corrosion life of ships' hulls and tanks, and have the potential for greatly lowering their life-cycle maintenance costs. In order to fully realize this reduced maintenance benefit, it is necessary that emphasis be shifted toward actually reducing maintenance performed. In order to achieve gains in this area without risk, some reliable predictive measures are necessary. Presently this is a process of conservative prediction based on previous ships' experience and various inspections including diver-based inspections. Cathodic protection data, while available for the hull ICCP systems, is generally not an absolute indicator of hull condition except in the crudest sense, e.g., hulls which require increasing amounts of ICCP current are generally in worse condition from the anti-corrosion/dielectric paint layer standpoint. ICCP data is rarely used or even considered in assessing hull condition for maintenance planning purposes. It is possible however that existing cathodic protection data, has the potential to be used to make better assessment of hull conditions in real-time if properly analyzed. The possible outcome of such use could include:

1. Improved performance and reliability of ICCP systems for CVNX and ships Fleet-wide.

2. Better predictive ability that can be used for planning of hull maintenance so that maximum paint life can be realized. This could result in achievement of longer periods of service between dry-docking a ship for painting

3. Better reference electrode accuracy through use of multiple data fused electrodes at each location.

4. Possible development of a compact electrolytic current vector array design, leveraged on better reference-electrode data-assessment. Such arrays can be used for signature related R&D for real-time alternate closed loop control of ICCP systems.

5. Software would be easily integrated into integrated control and condition based maintenance systems.

PHASE I: Develop and provide test arrangement to demonstrate feasibility and benefit of using of data-fusion technique in conjunction with an ICCP system on a steel structure in seawater. Data could include anode current and voltage, reference cell voltages, shaft grounding voltages, ship's speed, water temperature, salinity, pH, etc. Demonstrate feasibility and benefit of data-fusion for a three-dimensional reference electrode array intended for measuring electrolytic current vectors in seawater.

PHASE II: Refine data-fusion software and develop portable test unit that can be used on larger-scale application test such as on a cathodically protected pier or Naval vessel. Demonstrate the use of such equipment on the structure. Using a portable but grounded bare steel or other appropriate test electrode of sufficient size, demonstrate system response while the electrode is moved to various locations around the test structure. Refine data-fusion reference electrode array design to optimize the size and number of reference electrodes necessary to achieve meaningful and repeatable data for determination of electrolytic current vectors. Demonstrate this on a cathodically protected structure.

PHASE III: Develop, fabricate and demonstrate an optimized data-fusion software/data acquisition package that can be easily applied to a wide variety of cathodic protection equipment. Design and fabricate optimized electrolytic current vector probe for use in seawater. Optimization factors should include accuracy, durability, size, weight, and cost.

COMMERCIAL POTENTIAL: Cathodic protection systems are utilized world-wide for the protection of ships' hulls and tanks, off-shore oil platforms, piers, seawalls, tunnels, underground and above ground tanks, pipelines, bridge footings, and many more. Cathodic protection data types are very similar among these applications; however, actual cathodic protection parameters and data trends vary widely. A portable data system using appropriate data fusion software and multi-sensor approach could be valuable for use in all of these applications. The electrolytic current vector sensor is especially valuable in highly conductive electrolytes where voltage drops may be very small compared to the normal inaccuracies of single point reference electrodes.

REFERENCES:
1. Lucas, K. E., Thomas, E. D., Kazinoff, A. I., and Hogan, E. A., “Design of Impressed Current Cathodic Protection (ICCP) Systems for U. S. Navy Hulls” Designing Cathodic Protection Systems for Marine Structures and Vehicles, STP 1370, H. P. Hack Ed., American Society for Testing and Materials, West Conshohocken, PA., 1999, ISBN: 0-80312-623-9
2. J. Morgan, Cathodic Protection (Houston, National Association of Corrosion Engineers, NACE, 1987) ISBN: 0-91556-728-8
3. C. Munger, L. Vincent, Corrosion Prevention by Protective Coatings, Revised Edition, (Houston, NACE, 1999), ISBN: 1-57590-088-2

KEYWORDS: Data-fusion; cathodic protection; electrochemistry; corrosion; reference electrode; software

N01-064 TITLE: <u>Aircraft Carrier Oxygen Producer Lower Cost Alternative</u>

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT I; CVN-77, CVNX

OBJECTIVE: To Develop a Lower Total-Ownership-Cost Oxygen Producer for Use on Aircraft Carriers. Current producers are expensive to operate and maintain. Demand for oxygen from the air wing is decreasing, but will not approach zero for 10+ years.

DESCRIPTION: Aircraft require a system to supply the aircrew with oxygen for respiration. Current technology uses shipboard cryogenic oxygen-nitrogen plant to produce liquid oxygen, which is loaded onto each aircraft. Aircraft Carriers are equipped with two cryogenic producers, each capable of about 20 gallons per hour of liquid oxygen. Naval aircraft are being converted to an On-Board Oxygen Generating System (OBOGS), which eliminates the need for stowage of liquid oxygen on the aircraft. Therefore, at some point in time the large, expensive, current producers can be replaced with smaller, cheaper technology capable of producing the small quantities of oxygen needed to recharge the aircraft gaseous emergency supply and provide ship-service oxygen.

PHASE I: The contractor will design, on paper, a shipboard system to produce 5 gallons per hour of liquid oxygen, or 575 standard cubic feet per hour of gaseous oxygen. Purity requirement should be 95% oxygen with the remaining product mainly nitrogen, while meeting the Aviator's Breathing Oxygen Spec (MIL-O-27210) for all trace contaminants. Adaptations of existing commercial technology are encouraged, as is the use of automated operation. Development of small commercial cryogenic plants, research into the use of membrane technology for oxygen production, and development of pressure swing absorption (PSA) technology will all be considered, as will any technology not previously known to the Navy technical community.

PHASE II: Based on the phase 1 theoretical design, the contractor will develop a prototype oxygen producer meeting the requirements specified in Phase 1 and demonstrate that the producer will produce oxygen in the required quantity and purity.

PHASE III: Any aircraft carrier is a candidate for the lower cost oxygen producer. Aircraft Carriers CVN-70, CVN-71, CVN-72, CVN-73 are CVN-74 are especially likely candidates for back fit of the newly developed system in that they are equipped with older, more costly to maintain cryogenic producers. The lower cost oxygen producer is also potentially appropriate for CVN-77 and CVNX. This oxygen producer could become the Navy standard for aircraft carrier use for the foreseeable future.

COMMERCIAL POTENTIAL: Current membrane technology for oxygen production is in its infancy. Membrane technology for production of nitrogen is highly developed, but additional research and development is needed to permit the production of oxygen from air using membranes, since the percentage of oxygen in air is much lower. The potential for commercial application of the knowledge acquired while developing membrane technology for shipboard use extends across the commercial oxygen industry.

REFERENCES:

1. TECHNICAL MANUAL NAVAIR A6-332AO-GYD-000
2. MILITARY SPECIFICATION FOR AVIATORS BREATHING OXYGEN MIL-O-27210

KEYWORDS: oxygen generator; membrane; pressure swing absorption; cryogenics; On-Board; Oxygen Generating System (OBOGS); nitrogen

N01-065 TITLE: <u>High Temperature Pipe and Equipment Insulation</u>

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT I, CVNX

OBJECTIVE: Develop and demonstrate an easily applied and maintainable, high-temperature (600F) pipe and equipment insulation for military ship application. The insulation must be durable, repairable, and must meet all current and anticipated environmental regulations.

DESCRIPTION: The high-temperature insulation material currently used on naval ships and submarines involve a labor-intensive process for initial installation. The material is also thick and takes up large volume of space aboard the ships. The insulation is used for personnel safety. A new high-temperature insulation is needed that can be easily sprayed or applied by brush to various shapes and size components and/or pipe configurations, as well as not induce/promote corrosion of these components. The materials should require less thickness than the current product to obtain the same insulation factor. The new insulation must be tough and be able to survive mechanical hits and not chip off. Reparability of the insulation is also important. Ship's force should be able to make repairs to the insulation while deployed. The material should environmentally friendly, not burn or off-gas hazardous fumes when exposed to flames. The possible outcome of such use could include:
* Reduced maintenance for ship's force
* Longer service life than the currently utilized insulation materials
* Improved reliability and performance
* Improved sailor quality of life and safety
* Ease of installation and maintenance of product
* Improved geometries and configurations of machinery spaces and engine rooms due to reduction of thicknesses
* Due to reduction in thickness, may lend itself to use of NDE techniques to determine under insulation corrosion of components.

PHASE I: Develop and demonstrate feasibility in accomplishing preliminary testing of insulation as a prove concept. Feasibility shall include, but not limited to time and ease of installation, ease of repair, ease of removal, cost of material(s) and labor, need for specialty tools, need for specialty training for installation, and anticipated service life expectancy.

PHASE II: Fabricate insulation and install on land-based large scale piping for testing physical properties, insulation characteristics, and installation concepts. Further testing will be accomplished to determine resistance to damage and reparability. For submarine use, off-gas testing is imperative. Develop more specific cost data of material, labor, and installation procedures.

PHASE III: Full scale demonstration and develop transition plan from research project to full-scale production.

COMMERCIAL POTENTIAL: The potential users of this material include all Navy ships, including submarines, with potential commercial application to power stations and high temperature chemical facilities.

REFERENCES:
1. Naval Ships Technical Manual Chapter 635, "Thermal, Fire, and Acoustic Insulation", Rev. 2, 28 July 1998, S9086-VH-STM-010/Chpt 635.

KEYWORDS: Insulation; High-temperature; Pipes; Military Ship Application; Personnel Safety

N01-066 TITLE: Fully Automated Cargo Handling System

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT 1, CVNX

OBJECTIVE: To design and test an advanced, low maintenance, survivable, highly dexterous fully automated cargo handling system for ship material handling and inventorying.

DESCRIPTION: Conventional handling of cargo/stores aboard ship requires major manpower and time. Pallets of cargo are brought on board and must be moved by forklift trucks to the respective conveyor for strikedown. The majority of existing conveyors are package conveyors capable of handling 85, 100, or 175-pound packages. Pallets must be broken down and the cargo/stores are placed on conveyor trays one box at a time. This requires large working parties (upwards of 400 personnel) and consumes a considerable amount of time and is a detriment to quality of life. Due to excessive number of personnel used for extended hours to support the existing shipboard on-load efforts to manually transport the cargo received, risk of serious injuries greatly increases. The automation of this system will enhance the quality of life on board ships by increasing safety to the operators and decreasing time and amount of manual labor by at least 70%. The system will be required to have the feature to automatically catalog inventory, (i.e. use a bar scanner to control inventory). This is intended to decreasing the time for the supply division to maintain inventory records and ordering supplies and food.

The CVNX Operational Requirement Document (ORD) specifies the following replenishment objectives:
- Replenish underway (combined connected and vertical) sufficient to resupply all goods, fluids, and return retrograde within 3.1 hours after 5 days at 310 aircraft sorties per day with 90% of aircraft being rearmed between sorties.
- Strike-down and strike-up of all goods without encumbering essential warfighting processes and shall equal the rate of receipt of material aboard the ship.
- Material stowage and handling rate will be at least 290 lifts per hour.

This requirement is currently unachievable. The system will allow for continuous movement of cargo/stores to avoid moving the bottleneck from one location to another. The horizontal conveyance will have independent paths that will be capable of moving in either direction. This will increase strikedown capability and also provide redundancy in the event of a failure. It is critical to realize this concept should not only move cargo but store or retrieval of the stores and control inventory. For example this system will have to originate from several central stations that all cargo/stores will have to go through. It is envisioned that pallets will be scanned and will then be transported on horizontal conveyance to the appropriate vertical conveyance to the appropriate storeroom. Scanning will also occur in the storeroom, and this scan will be compared to the first to ensure accuracy of scanning. Upon a satisfactory check between the two scans, the item will be entered into the inventory. The pallet will then be stored and its location will be recorded. This system will also be required to retrieve a full or a partial pallet of cargo.

PHASE I: Conduct design studies of developmental technology and concepts of moving cargo with a fully automated cargo handling system. Detail reporting of selection of concepts, materials, and components will be required.

PHASE II: Develop a working model, scaled in size to facilitate mounting on a ship motion simulator. The model will demonstrate the fully automated movement of cargo/stores from delivery on ship to store room. The model will show how inventory control and ordering will be controlled.

PHASE III: Construct a full-scale system to be used as a land based test site through support of the Advanced Technology Demonstration. Or other DoD sponsored program.

COMMERCIAL POTENTIAL: This technology could be utilized in a very wide range of applications in the commercial sector.

KEYWORDS: Conveyors; automation; bar scanners; vertical; horizontal; safety

N01-067 TITLE: Reverse Osmosis (RO) for use in Polluted Waters

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT III: Landing Craft Utility (LCU (X))

OBJECTIVE: Design and demonstrate a Reverse Osmosis (RO) distilling unit that can be used in Littoral Waters to provide safe drinking water for Navy personnel. The RO membrane, filtration, and/or treatment technology must be capable of satisfying the unique requirement of operating in harbors and coastal waters that may be polluted. The RO unit shall included as part of the system a unit to test and verify ('real time') the quality of the effluent.

DESCRIPTION: The Naval Health community, cognizant of water purity afloat, is most concerned about potable water contamination during the desalination process from pesticides, arsenic and other chemicals that may be found in littoral waters. Water in harbors, rivers, inlets, bays, landlocked waters, and the open sea within 12 nautical miles from the entrance of these waterways can be considered polluted. Under present policy, the desalting of polluted water for human consumption shall be avoided except in emergencies. The need RO units to produce drinking water in these areas is mainly on Navy small craft such as the 135' Landing Craft, Utility that routinely operate in polluted sources. The Navy needs a small capacity (e.g.800 gpd) RO unit capable of satisfying its needs and verify the quality of the water produced. The water produced will have to meet the National Primary Drinking Water Standards and the EPA National Drinking Water Standards.

PHASE I: Develop/design a Reverse Osmosis unit that has the capability to operate in Littoral waters and remove the pollutants commonly found in these waters. The RO unit shall be capable of producing 800 gallons per day of potable water from littoral waters and verify the quality of that potable drinking water.

PHASE II: Fabricate and test the RO unit on polluted water, such as that found in several of the operating areas of the potential platform (135' Landing Craft) to produce, test and verify the quality of the water meets drinking water standards. Verify that the system produced will be of such size that it will fit on the smaller platforms the Navy uses in the Littoral Waters, such as a 135' Landing Craft. Test and evaluate the unit and the test/verification device to prove it can produce the quality of water required for drinking water onboard the U. S. Navy small craft.

PHASE III: After verifying that the RO developed in Phase I can produce quality drinking water from harbors and coastal waters, this unit can be presented to other services that have coastal patrol craft. The RO unit will be applicable to Army, Marine Corps, Special Warfare, Air Force and Coast Guard boats and crafts for the production of quality drinking water from coastal waters and harbors.

COMMERCIAL POTENTIAL: This technology will be applicable to larger private boats, sailboats and motorized boats. The RO developed will become available for sale to Marinas for production of drinking water from the harbor waters where the Marina is located. This technology is applicable for the production of clean fresh water from harbors and coastal waters.

REFERENCES:

1. The major reference document for this technology is the EPA Drinking Water Standards.

KEYWORDS: Reverse Osmosis; drinking water; distilling plant; purification

N01-068 TITLE: Chaos Techniques to Predict Ship Motion for Amphibious Operations

TECHNOLOGY AREAS: Ground/Sea Vehicles

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PMS-317: LPD-17 Amphibious Transport Dock Ship Program

OBJECTIVE: Develop and demonstrate deck motion prediction models for amphibious warfare ships using chaos theory and non-linear dynamics. Incorporate and demonstrate prediction models into LPD-17 control systems and visual landing/embarkation aids as appropriate.

DESCRIPTION: The operation of aircraft and UAVs from the flight decks and the operation of landing craft and amphibious assault vehicles from the well decks of LPD class ships is fraught with risk, which is exacerbated under high sea state conditions. Current limitations posed by deck motion effects the safety of not only ships force assigned to tasks associated with aircraft and landing craft recovery, but the aircrews and landing craft crews as well. These same limitations also effect combat operations, causing aircraft and landing craft operations to be postponed or cancelled, to be executed incrementally and to delay recovery.

The basic problem is one of predicting the location of the deck a short period into the future. Ocean waves are chaotic, but are relatively low dimensional and have a significant event prediction horizon, and can potentially be modeled. Once a model exists, incorporation into a control system or visual aid will increase operational capability and safety.

PHASE I: Demonstrate the feasibility of using chaos theory to predict wave motion by determining the inherent limits of prediction for hull-motion data and optimization of nonlinear predictors. Software must be developed that uses nonlinear dynamical equations to form a chaos-based "model" enabling motion prediction. A proxy multivariate state space is created that describes the dynamical system using time series data and its time delays. The orbit of the system in the reconstructed state space produces a nonlinearly distorted version of the system attractor, capturing the system's multivariate behavior. Analysis can then be done in a space that unfolds the geometrical object (the attractor), enabling prediction. The attractor must be formed using an appropriate time delay and the minimum embedding dimension determined through data analysis. The Lyapunov exponents must then be calculated to determine how far into the future prediction will be reliable. These equations, in the form of a software package must be delivered to Phase II. By using nonlinear dynamics, reliable prediction into the future of the deck's motion is achievable in real time, which is a capability impossible to achieve with existing linear models. Discussions with Naval aviators have indicated that a ten second prediction horizon may be more than enough to significantly improve flight operation safety, and should be a performance goal of the developed system. If the system can predict ten second periods, where the deck motions are no greater than the deck motions resultant from one meter wave height, amphibious operations can be improved.

PHASE II: The deck motion prediction models will be validated by comparing predicted motions with actual motion data collected during system demonstrations. The models should work under all sea state conditions. Demonstrations will occur both in a controlled, test site or laboratory environment and while deployed on an operational amphibious ship. The ship selected for the demonstration while underway should take into account the desire for encountering high sea state (above sea state 5) conditions. Validation must occur at both the flight deck and well deck areas. Once validated, the software must be integrated into the flight control and well deck control information systems for control officer demonstration and usage. The deck motion prediction information may also be integrated into the visual landing and docking aids, if the concept of operations support this usage.

PHASE III: Develop a commercialization plan and marketing strategy for the developed software, demonstrate producibility of the software addressing multiple applications and enter into acquisition agreements.

COMMERCIAL POTENTIAL: In addition to its military uses, motion prediction models and their input to control systems will generate commercial interest in the commercial shipping, general aviation and ground transportation industries. A mission critical commercial use such as marine search and rescue by federal state and local law enforcement entities may drive the market initially for this technology. Being able to predict the motions of objects in the water will enable the safest and most efficient extractions and allow warnings prior to events, enabling proactive mitigation procedures. A mission critical Navy application is the ability of this technology to enable amphibious combat operations to commence or continue under conditions that currently halt these types of operations.

REFERENCES:

1. Analysis of Observed Chaotic Data, Abaranel, H., Springer-Verlag, NY, 1996.
2. "Time Domain Analysis of Signals from Nonlinear Sources", Arbaranel H., IEEE Signal Processing Magazine, May 1998.
3. "Detecting Strange Attractors in Turbulence", Takens, F., in Dynamical Systems and Turbulence, Warwick 1980, ed D. Rand and L. Young, Springer-Verlag, Berlin, 1981.

KEYWORDS: chaos; non-linear dynamics; amphibious operations; wave motion; prediction models; prediction horizon

N01-069 TITLE: <u>Shipboard Bio-mechanical Oil Water Separator</u>

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO-Carriers, PEO EXW (LPD-17 & PMS-377), PEO SUB,

OBJECTIVE: Design and demonstrate a Biomechanical Oil/Water Separator for use onboard US Navy ships and submarines. The system should be scalable to handle the generation rates of all the US Navy platforms.

DESCRIPTION: Presently the US Navy utilizes strictly mechanical Oil/Water Separators and ceramic membranes for polishing the effluent to below 5 PPM of oil or gravity separation systems. The Oil/Water Separator has proven to be unreliable and both have high maintenance requirements. The Navy needs equipment that can be operated with very little maintenance, is highly reliable and can process influent that has detergent and/or emulsified wastes. We are looking for a system that can operate 24 hours a day, 7 days a week in an automatic mode with little or no crew interface required. The required processing rate would need to be 10 gallons per minute and be scalable up or down for various generation rates on various Navy platforms. Lower flow rates would be for our submarines, smaller Combatants, and Mine Sweepers and Hunters. Larger capacities will be needed for the Large Deck Amphibious and Auxiliary ships, and Aircraft Carriers.

PHASE I: Design/Develop a biomechanical oil/water system to process the bilge waste generated onboard various US Navy platforms. Develop a system that is scalable up and down for processing a median flow rate of 10 GPM.

PHASE II: Produce and install a prototype biomechanical system that can process bilge waste and produce an effluent of less than 5 PPM oil concentration at a rate of 10 GPM. This unit should be automatic in operation as to require little or no crew interface or maintenance. The prototype unit should be operated from a mobile trailer type platform so that it can be moved from one ship to another for pierside test and evaluation. This type of operational scenario will allow the Navy to provide real ship developed waste stream. Second step of this phase is to provide a shipboard prototype that can be installed onboard a Navy platform for shipboard test and evaluation when the ship is underway. Test of the shipboard prototype will determine the system's compatibility with ship-required interfaces and identify suitability and effectiveness issues impacting operational capability, including determination of sensitivity to ship motion and vibration.

PHASE III: After verifying that the unit can operate ship board and produce a quality effluent that will meet and exceed the present standards, the company will produce other test systems that will be operated at varying flow rates from 1 GPM up to 20 GPM. The larger capacity unit will be tested pierside and then installed onboard a larger ship for shipboard test and evaluation. The system can be utilized shoreside in the higher flow rates and potentially be scaled up for even higher flow rates that would handle multiple ships waste streams at a shore facility.

COMMERCIAL POTENTIAL: This technology will be applicable to large commercial shipping companies, as today no reliable, fully automatic oil pollution abatement system exists. This system would have International commercialization possibilities with Foreign Navies. There would even exist a need for this system in the shoreside arena. Commercial facilities that have ships docking and unloading for periods of time in excess of a day or two would, with this equipment, be able to offer the ability to process any bilge waste generated by the unloading ship.

REFERENCES:

1. OPNAVINST. 5090.1B
2. MARPOL Requirement Documents

KEYWORDS: Pollution Abatement; Oil/Water Separator; Effluent Quality

N01-070 TITLE: <u>High Volume Underway Replenishment Circulating Ropeway</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO Carriers, PEO EXW (LPD-17 & PMS 377)

OBJECTIVE: Develop and demonstrate a high volume Underway Replenishment Circulating Ropeway. The circulating ropeway must sustain a "continuous throughput" transfer rate of 150 3-ton loads per hour, every hour, between two ships steaming 300 feet apart. The ropeway must be adapted to the challenges of an at sea environment: it must be quickly rigged between two ships at sea with minimal manning; it must provide a safe and quick means of emergency breakaway; it must provide compensation for the motion between two ships at sea state 5.

DESCRIPTION: Current Underway Replenishment systems use linear technology (one load over, one load back) to transfer an average of 18 2-ton loads per hour between two ships steaming 200 feet apart. Up to three of these systems are used simultaneously to transfer stores and ordnance to aircraft carriers. This technology will require an unacceptable amount of time (over 8 hours) and people (400 - 500) to meet the Underway Replenishment needs of future aircraft carriers. In order to meet the needs of future aircraft carriers, our goal is to transfer as many as 150 3-ton loads per hour using a single system. Additionally, there have been 13 collisions during Underway Replenishment operations over the past 10 years, resulting in millions of dollars in ship damages. An increase in Underway Replenishment ship separation (from 200 feet to 300 feet) will increase operational safety by reducing collision risks.

Circulating ropeway technology is currently employed most commonly in the ski lift industry. As many as 4000 people are transported to the top of the slope each hour. Groups of people board gondolas suspended from the circulating ropeway. Gondolas are detached and reattached to the ropeway momentarily to facilitate passenger boarding and unloading. While these commercial load sizes and transfer rates are within the range of future Underway Replenishment requirements, adaptive technology will need to be developed to enable use of this technology at sea. At sea use will require that the system be quickly and safely rigged between two ships steaming 300 feet apart; it must be quickly and safely "broken away" in the case of emergency; and it must compensate for a tremendous amount of relative motion (two ships pitching, rolling and heaving at sea state 5). These characteristics exceed the capabilities of any commercial or Navy systems developed thus far. However, should the effort to develop adaptive technologies prove successful, there is a high potential to revolutionize at sea transfer rates; to reduce personnel requirements; and to increase operational safety of Naval Underway Replenishment.

PHASE I: Develop and exploit circulating ropeway concepts for at-sea underway replenishment, and confirm suitability of circulating ropeways to future Underway Replenishment needs. Describe and address each challenge presented by circulating ropeways when used in an Underway Replenishment environment and describe resolution of each challenge.

PHASE II: Design and develop an adaptive prototype circulating ropeway (possibly in scale) that conducts safe and effective operations between ships at sea, and design a full-scale prototype system. Provide cost estimates for the full-scale prototype fabrication, shipboard installation, at sea test, and shipboard removal.

PHASE III: Conduct at sea test and refine the prototype design as necessary. Demonstrate producibility and develop an implementation plan for new construction ships and, potentially, for in service retrofit.

COMMERCIAL POTENTIAL: Adaptive technology has the potential to increase the range of commercial applications for circulating ropeways (for example, transferring loads and people directly from ships to tops of mountains and cliffs).

REFERENCES:
1. ANSI B77.1-1999, "American National Standard for Passenger Ropeways - Aerial Tramways, Aerial Lifts, Surface Lifts, Tow and Conveyors - Safety Requirements"
2. "Conceptual Inputs for Optimizing the Functional Efficiency of Circulating Monocable Ropeways; Project Engineering, Design and Operation in a Safety Management Control Loop Based on Incident Analysis," September 1997, by Artur Doppelmayr. Available online at: http://www.doppelmayr.com/DasBuch/Pages_e/HUELLE.HTML

N01-071 TITLE: Water-Wet Pelletized Nitrocellulose Dehydration

TECHNOLOGY AREAS: Materials/Processes, Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT III; SABRE System

OBJECTIVE: Develop and demonstrate a safe and economical separation method to continuously dehydrate water-wet pelletized nitrocellulose (PNC) and furnish the PNC wet with an inert diluent such as heptane. The new process must not require modification to the existing water-wet PNC manufacturing facility.

DESCRIPTION: Pelletized nitrocellulose (PNC) is a special form of nitrocellulose that was transformed from the fibrous material to spherical material (pelletized). PNC is produced semi-continuously through a two step process consisting of the material transformation in water followed by some form of dehydration. PNC is used in slurry cast composite modified double base explosives. An explosive mixed and cured with PNC rather than normal fibrous nitrocellulose will have a higher bulk density and better cohesive bonding characteristics. When PNC is used in an explosive mix, water cannot be present because it interferes with the plasticization process. When supplied in an inert diluent such as heptane, PNC has free flowing characteristics that greatly improve both its mechanical handling and mixing properties.

Previously, a continuous dehydration process that removed water from PNC by reduced pressure azeotropic evaporation with heptane was used. However, an incident forced the process to be shut down for re-design. Since that time, heptane-wet PNC has been supplied through a time-consuming and labor-intensive process of oven drying followed by mixing in heptane. Because this uneconomical dehydration method involves personnel handling Class 1.1 explosives, and can not be expanded to keep pace with increasing PNC requirements, a new separation method to continuously dehydrate water-wet PNC and furnish the PNC wet with an inert diluent must be developed.

No potential separation method should be ruled out. However, the following general guidelines are provided. The process must be feasible technically and economically at a manufacturing scale. The process must not require modification to the existing water-wet PNC manufacturing facility. There must be no possibility for long-term exposure of PNC to high temperatures. Any inert diluent substituted for heptane must not dissolve or sensitize nitrocellulose.

In addition, any potential separation method must take into account that within certain moisture ranges water-wet PNC is a non-Newtonian fluid with rheological properties that are defined as dilatant. Under normal conditions water-wet PNC has the consistency of a very viscous fluid, but when subject to shear force it acts as a solid. The exact water content required for PNC to exhibit these properties varies with the particle size distribution. However, it is generally in the range of 30% to 40% by weight. At lower water contents it is a rheologically stable damp powder. At much higher water contents (i.e. ~90%) it is essentially a Newtonian fluid. Heptane-wet PNC at concentrations up to 60% by weight also behaves as a Newtonian fluid. When water-wet PNC is suspended in heptane it exhibits the dilatant character at much lower water contents. Although the exact water content varies inversely with the concentration of PNC in heptane, it generally occurs when the water content exceeds 5% on a heptane free basis, or 1% of the entire heptane/water/PNC system.

PHASE I: Research separation technology and develop a separation method to dehydrate water-wet PNC and furnish the PNC wet with an inert diluent such as heptane. Where theoretical models and established data are not currently available experimentally determine molecular properties. Demonstrate the technical merit and feasibility of the separation method in the laboratory.

PHASE II: Design and execute pilot plant scale demonstrations of the selected continuous water-wet PNC dehydration process. Fully establish the technical and economic feasibility of the separation technology being developed. Collect pertinent process development and scale-up data for a detailed facility design.

PHASE III: Transition the demonstrated continuous water-wet PNC dehydration process to manufacturing scale. Integrate design, fabrication, and installation into an existing water-wet PNC manufacturing facility to provide DoD with material made with the new process.

COMMERCIAL POTENTIAL: Continuously dehydrating water-wet PNC and furnishing the PNC wet with an inert diluent such as heptane is a challenging problem. Any novel method developed to reliably accomplish this separation would certainly have applications to other solid/liquid separations. The application of this technology would not be limited to the DoD or energetic materials community, but rather could be applied throughout the chemical process industry.

REFERENCES:

1. Doolittle, A.K. The Technology of Solvents and Plasticizers; John Wiley & Sons, Inc.: New York, NY.

2. Meyer, R. Explosives; Verlag Chemie: New York, NY; 1977.

KEYWORDS: Pelletized Nitrocellulose; Heptane; Dehydration; Azeotropic Evaporation; Separation; Continuous

N01-072 TITLE: Improved Magnetostrictive Materials

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: IUSW, DD21, LBVDS

OBJECTIVE: Develop magnetostrictive materials which, when compared to commercially available Terfenol-D, offer reduced hysteresis, a potential major increase in strain output or strength, and improved uniformity of electromechanical material parameters independent of manufacturing size. Materials to consider include both Terfenol-based or like alloys, magnetic shape memory alloys, and gallium-iron structural magnetostrictive alloys.

DESCRIPTION: Existing formulations for the giant magnetostrictive material Terfenol-D exhibit both hysteresis and twins in their crystal structure which limits obtainable strain and increases losses. New materials or improved or new formulations for Terfenol-D are needed to permit higher strain output of the material when used in actuators and underwater acoustic transducers. The material properties should facilitate the design of improved high power, broadband underwater transducer arrays for littoral ASW use and reduced volume, high authority actuators for a variety of shipboard, airborne, and manufacturing applications.

PHASE I: Develop derivatives of Terfenol-D, magnetic shape memory alloys, and structural Galfenol alloys which exhibit high strain and low hysteresis under high magnetic and physical stresses while developing strains in excess of that obtainable with existing Terfenol-D or exhibit magnetostrictive properties in structurally strong alloys with high permeability. Develop a series of candidate material compositions and determine the amount of hysteresis reduction, improved strain, or structurally strong properties obtainable with each as a function of achievable strain and manufactured material cost. Develop texturing procedures in b.c.c. Fe-based alloys which allows the utilization of the high magnetostrictive _100 constant. Develop metallurgical and manufacturing techniques and processes to permit the affordable manufacture of these improved alloys in a repeatable and predictable manner with minimal variation as a function of sample size.

PHASE II: The goals of the program include developing an improved low hysteresis material to permit very high power operation of magnetostrictive driver assemblies in actuators and underwater transducers (such as hybrid longitudinal vibrators and/or Class VII flextensional transducers), to separately develop revolutionary high strain materials which will permit a radical redesign of traditional actuators and underwater transducers as a means of increasing their output capabilities and/or reducing their volume and weight while maintaining high strain output. In order to achieve the proper balance (cost and timeliness) between these two closely-related technologies and resultant goals, assess the technical risk involved in the near-term realization of strain levels and blocking force in shape memory alloys which are at least an order of magnitude in excess of Terfenol-D strain levels in order to determine the Phase II resource allocation, and to assess the potential of gallium iron magnetostrictive alloys which are both strong physically, not brittle, and have high permeability. Develop and manufacture an improved Terfenol-D based material with reduced hysteresis and size-independent mechanical and magnetostrictive properties. The improved material shall be produced in sufficient quantity and sizes to demonstrate that the technological breakthrough is realizable in production for either defense or commercial applications. Separately develop and manufacture a prototype shape memory alloy material which demonstrates the predicted gigantic strain levels of this class of material. Refine and scale-up the fabrication and manufacturing aspects of these improved materials, manufacture samples for exhaustive testing, and deliver prototype driver assemblies of each technology for incorporation in high power transducers and actuators. Formulate and demonstrate the magnetostricitve strain capability of gallium iron type alloys with high strength and low brittleness.

Fabricate prototype transducer elements and demonstrate their performance in a sonar transducer under Class A explosive environments. The demonstration should include sufficient testing to provide confidence that these materials can provide adequate shock resistance.

PHASE III: Transition the improved, low hysteresis Terfenol type material technology into transducer and actuator designs both for backfit and for new systems under development. Possible transition applications include high powered lightweight acoustic projector arrays for towed sources as an upgrade opportunity, improvements to hybrid transducers and actuators to increase power capabilities of broadband conformal arrays and solid-state stepping motors respectively, and technology insertion into high power actuator applications in extreme temperature environments. Develop a collaboration between transducer/system developer(s) and the material developer to optimize utilization of the improved material's performance capabilities. Utilize manufacturing techniques to minimize the production cost of the material. Put the improved material into production and make it available for both Government and industry evaluation and use. Develop structurally strong magnetostrictive materials which can be used both in actuatots and sonar transducers. Develop prototype magnetic shape memory alloy driver assemblies and incorporate into candidate actuators and transducers for Government and industry evaluation.

COMMERCIAL POTENTIAL: The development of this technology will permit the design and fabrication of high power actuators and transducers for commercial applications in the aerospace, automotive, and control industries.

REFERENCES:

1. "Magnetization and Magnetostriction of Dendritic [112] TbxDyyHozFe1.95 (x + y + z = 1) Rods Under Compressive Stress," M. Wun-Fogle, J. B. Restorff, A. E. Clark, and J. F. Lindberg, Journal of Applied Physics, vol. 83 (11), pp. 7279 - 7281, 1 June 1998.
2. "Magnetic Properties of Giant Magnetostrictive TbxDyyHozFe1.95 (x + y + z = 1) Rods Under Compressive Stress," M. Wun-Fogle, J. B. Restorff, A. E. Clark, and J. F. Lindberg, to be published in the proceedings of the 6th International Conference on New Actuators (Actuator 98) Conference, June 17 19, 1998 in Bremen, Germany.
3. "Magnetostrictive Alfenol/Galfenol Alloys Under Large Compressive Stresses", A.E. Clark, M. Wun-Fogle, J.B. Restorff, and T.A. Lograsso, presented at the 2000 U.S. Navy Workshop on Acoustic Transduction Materials and Devices, 11-13 April 2000 in State College, PA.

KEYWORDS: magnetostriction; Terfenol-D; transducer; actuator; acoustics; rare-earths; shape memory alloys; galfenol; alfenol

N01-073 TITLE: Development of Low-Cost Manufacturing Process for 1, 2, 4-Butanetriol (BT)

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: Trident II, MSL

OBJECTIVE: Develop and demonstrate a manufacturing process for butanetiol that is both low-cost, and environmentally friendly.

DESCRIPTION: 1,2,4-Butanetrinitrate (BTTN) is ten times more thermally stable than nitroglycerine. However, preparation costs for BT, the starting material for BTTN, is $30 to $40 per pound versus about $0.50 per pound for glycerine, the starting material for nitroglycerine. The Navy and Army currently use BTTN as an energetic plasticizer in propellants and explosives. Atlantic Research Corporation is also looking at the use of BTTN as a possible ingredient in the Trident II Gas Generator. BTTN is used as a partial replacement for nitroglycerine in the Chaparral and Sidewinder missiles. If the cost of BT can be reduced, projected use of BTTN for the outyears would be about 180,000 pounds per year.

PHASE I: Design and develop a low-cost BT manufacturing process which could be used to prepare BTTN that meets current military specifications. Provide detailed design plans of the new process;

include analytical data schemes to show repeatability and reproducibility of the material resulting from the new process.

PHASE II: Demonstrate the low-cost aspects of the manufacturing process through detailed verification and analyses, so that the BTTN prepared using BT starting material from the new process meets military specifications.

PHASE III: Use the low-cost manufacturing process to manufacture pound quantities of Mil Spec BT for use in propellant and explosive manufacture.

COMMERCIAL POTENTIAL: Development of this process would make BTTN affordable for use in both military and commercial propellants, as a replacement for nitroglycerin with lower cost and higher thermal stability.

REFERENCES:

1. B. J. Alley, E. S. Hayes, W. H. Graham, J. W. Blanks, "Relationship of Impurities in Butanetriol Trinitrate (BTTN) and its Precursor Butanetriol (BT) to Propellant Thermal Stability", U.S. Army Missile Command, CPIA Publication 455, Vol. 3, pp 661-671,1986.

KEYWORDS: precursor; butanetriol; BTTN; ingredient; thermal stability

N01-074 TITLE: <u>Drag Reduction in Water</u>

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop and demonstrate novel methods of drag reduction in water which are not based on the supercavitation principle or addition of surfactants.

DESCRIPTION: The velocity of a moving underwater body has natural speed limits that are considered to be around 40m/s. This limit is given by the asymptotic values of friction-factor at high speeds. This limit puts serious restrictions on the speed of torpedoes or efficiency of air-to-water missiles. The offeror's proposal should describe or exhibit an understanding of the significant aspects of the technical challenge and the military application, and develop an innovative method of overcoming and reducing the high-speed friction factor.

PHASE I: Demonstrate drag reduction based upon novel application of fluid principles. The effort should be directed toward theoretically demonstrating a novel principle for lowering the friction-factor values. Literature data and/or preliminary experiments should demonstrate the feasibility of the new approach.

PHASE II: Develop the phase I innovative concept by implementing the reduced friction-factor at high values of the Reynolds number and collecting experimental data. Develop a detailed mathematical model of the phenomenon along with detailed experimental data taken at industrial scale testing during development.

PHASE III: Military applications that would benefit from this technology are a broad range of surface-to-water and air-to-water weapons. This technology should transition to Air and Surface Weaponry and Underwater Weaponry programs.

COMMERCIAL POTENTIAL: The shipbuilding industry can benefit by having available a method that provides a lower friction-factor because of higher speed and lower energy consumption.

REFERENCES:

1. Miller D. Int. Defense Review 12, 61 (1995)
2. May A: Jour. Appl. 23, 1362 (1952)
3. Bird R.B. Stewart W.E. and Lightfoot E.N.: Transport Phenomena (J. Wily, N.Y. 1960)
4. Birkhoff G. and Caywood T.E.; Jour. Appl. Phys. 20, 646 (1949)

KEYWORDS: Drag reduction; Non-cavitating; Friction-factor; Underwater velocity

N01-075 TITLE: Advanced, High Momentum Recoil System for Naval Guns

TECHNOLOGY AREAS: Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: EX 171 ERGM - Extended Range Guided Munition

OBJECTIVE: Provide a higher momentum recoil capability for the Mk 45 Mod 4 gun that will have a minimum impact on the existing gun system design in terms of space, weight, and ship structure. Designs will focus on means of raising the available recoil limit with novel new design approaches while reducing the maximum recoil force transmitted to the gun mounting ring at or below the limits currently planned for the Mod 4 gun.

DESCRIPTION: Next generation high energy guns for reasons of efficiency, range, and cost will fire projectiles, which are two to four times heavier than are currently associated with any specified caliber. Unfortunately, for the gun designer, this means more momentum, M*V product to react through the gun system load paths and into the ship structure. For new, special purpose guns, without train and elevation controls, which can be mounted vertically with a CG below the ship's CG, this does not pose so much of a problem. But the Mk-45 and AGS are existing designs with train, elevation, whose recoil loads must be reacted by upper deck structure high above the ship CG. Worse yet, a problem of premature fatigue of these gun's base ring bearing has been identified. This is a direct result of a load that is too close to the design limit of the bearing (the peak recoil load as a result of firing ERGM at zero elevation is at the limit). Further this gun system is capable of 25 MJ launches with new technology propelling charges, but must be limited to 8 to 10 MJ because of momentum constraints for certain high mass projectiles currently under development (Best Buy-165 pounds). An advanced, controlled force, recoil design offers the possibility of doubling the momentum capability of the upgraded Mk-45 Mod 4 gun, but a solution to the base ring fatigue problem is still needed. An alternative goal for such a design could also allow for a maximum force x stroke reaction in a more compact package than is currently possible.

PHASE I: Develop an engineering design of the advanced recoil system and apply this design to the MK-45 gun system, firing 100 to 165 pound projectiles at 18 MJ. Develop mathematical models that permit simulation of the recoil system effects on the firing MK-45. Calculate and simulate peak recoil forces at all bearing points of the recoil load path to include the base ring and gun system mounting structure.

PHASE II: Fabricate, test, and evaluate the design of the proposed recoil system on a gun system. Sub-scale testing is acceptable, full scale, 5-inch testing is preferred. Live firing shall simulate 110 to 165 pound slugs consistent with Extended Range Guided Munition (ERGM) and "Best Buy" projectiles at 18 MJ muzzle energy.

PHASE III: Fabricate, integrate, and test a prototype improved recoil system elements into an operational Mk 45 gun system. Test firings shall be conducted with slugs weighing 110 to 165 pounds, fired at muzzle energies of 18 MJ.

COMMERCIAL POTENTIAL: Advanced, active shock isolation systems for commercial building protection from earthquakes.

KEYWORDS: Shock Isolation; Dampers; Springs; Momentum; Active Shock Isolation; Bearing

N01-076 TITLE: Flexible, Low-Noise Air Management

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT I: DD-21

OBJECTIVE: Develop and demonstrate a low-noise, low-maintenance air management system to facilitate and enable increased flexibility and adaptability for shipboard ventilation systems.

DESCRIPTION: Shipboard air movement equipment is used to cool equipment and provide a safe and comfortable environment for personnel. Air-cooling is already the commercial "standard" for electronics systems and components. Advanced concepts for ship design stress upgradability and flexibility for architectures to encourage and enable technology upgrades. Air-cooling of rafted equipment by means such as underfloor plenums is an enabler of this flexibility. Currently, fans are used to accomplish this air movement for equipment cooling and air distribution. Fans are a source of noise in the operating environment. Fans are also energy inefficient, especially given the ducting often required by shipboard systems. Fans frequently require maintenance in the shipboard environment, maintenance that is incongruous with the reduced manning of future ships. A new, low-noise, low-maintenance system for air movement adaptable to a range of load requirements in flexible cooling concepts would greatly reduce ship design costs, as well as life cycle costs.

PHASE I: Develop/design/select an alternative air movement technology with low-noise, low-maintenance characteristics for ship/marine applications. Develop an advanced air movement prototype based on the technology. Conduct testing to assess performance and costs, verify noise reduction, demonstrate control techniques, and evaluate potential full-scale shipboard capacities and scalability. Examine airflow requirements for a range of shipboard applications from ship equipment cooling to space ventilation and assess system/component requirements for achieving these various capacity requirements.

PHASE II: Demonstrate an advanced air management system with medium capacity airflow in the Navy unique environment (e.i., exposed to shock, vibration, Electromagnetic Interference/Compatability [EMI/EMC], salt spray, etc.) either installed in a ship or in a representative land-based facility or mock-up. Assess performance, noise levels, acquisition and lifecycle costs, and demonstrate control techniques. Determine the scalability of the system and applicability for use in electronic consoles, equipment racks and ship ventilation zones.

PHASE III: Develop a commercially-viable system and implementation plan for Navy ship equipment and space ventilation.

COMMERCIAL POTENTIAL: A low-noise, low-maintenance air management system could be utilized in countless commercial applications where fans are currently used, especially such as in raised-floor computer laboratories, Information Technology work spaces, telecommunications spaces, hospitals, etc.

REFERENCES:

1. "Total Ship Open Systems Architecture (TOSA)," ASNE Day 2000, John Vasilakos, CSC Advanced Marine, Richard DeVries, DeVries Consulting, K. Todd Tompkins, NAVSEA Carderock

KEYWORDS: Noise Reduction; Flexibility; Low Maintenance; Air Movement; Fans

N01-077 TITLE: Projectile Inertial Navigator from COTS Instruments

TECHNOLOGY AREAS: Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT II; (ERGM) Extended Range Guided Munition

DOD ACQUISTION PROGRAM SUPPORTING THIS PROGRAM: Extended Range Guided Munition (ERGM) EX 171

OBJECTIVE: Develop an inertial navigator suitable for use in guidance and control of a projectile, using commercially available, low cost instruments such as micromachined silicon accelerometers.

DESCRIPTION: This topic seeks a gun-hardened inertial navigator made from low cost, commercially available instruments. Technology demonstrations have shown that micromachined silicon instruments can be used to construct a six-axis inertial navigator (three translation and three rotation axes) that can be used together with the Global Positioning System to guide a projectile. The inertial navigator provides navigation if GPS is jammed, it works in the autopilot's control loops to transform Earth-referenced navigation commands into body-referenced control commands, and it stabilizes the line of sight for a terminal seeker to provide proportional navigation.

Although the technology demonstration showed that silicon micromachined instruments could provide this inertial navigator, the market has not yet produced such instruments in large quantities. For other applications (for example, automotive air bags) there are instruments that almost provide the needed performance. Although a full-custom, purpose-designed silicon micromachined IMU is technically feasible, the up-front costs have prevented any manufacturer from producing it, given the limited number of EX-171 projectiles to be produced (compared to the million-unit quantities typical of commercial production.) Asked to develop a highly integrated IMU, produced in a custom process with up to 20 steps, for a market that may purchase only 10,000 units, industry sees too much risk and too little payoff. So, to have a viable, low cost source of instruments, with the possibility of multiple vendors, the NSFS program must look to non-custom, commercial off-the-shelf instruments. The purpose of this SBIR topic is to develop and demonstrate an approach that combines and integrates commercially available instruments to create a tactical navigator.

PHASE I: Design a tactical grade navigator suitable for Naval Surface Fire Support applications from commercial or non-developmental components. Upon loss of GPS the navigator should not drift more than 20 meters in 25 seconds during the airborne mission. (Before GPS was lost, the inertial instruments were calibrated and aligned to GPS). The design may use any commercially available instruments that will function in the tactical environment. That would include inertial instruments (accelerometers and gyros) and non-inertial instruments, such as a magnetic compass. However, a sun sensor would not be suitable, because the tactical environment includes night missions. The navigator must be able to withstand 20,000 g gun launch acceleration (where g = 9.8 m/sec^2), should use less than 5 watts, and fit in 10 cubic inches in its production configuration (excluding GPS and navigation computer).

PHASE II: Construct a prototype navigator and demonstrate its performance and gun-launch survivability. Except for the instruments and their mounting structure, the prototype need not be an exact form-and-fit replica of the production version, but must be traceable to such a design. That is, non-form-and-fit and non-gun-hardened support electronics (computer, power, and data acquisition, for example) may be used. But the instruments themselves must survive the gun launch acceleration and then be demonstrated to provide the specified performance of 20 meters in 25 seconds.

PHASE III: There are five transition opportunities within PMS 529 programs: (1) Product improvement to the EX 171 Extended Range Guided Munition to reduce its production cost, (2) Application to the Barrage Round demonstration (will require smaller form factor and higher g-rating), (3) Application to the Forward Air Support Munition (lower g-rating but lower drift desired), (4) Application to a guided variant of the M 172 5" Cargo Projectile, and (5) use in Forward Observer/Forward Air Controller equipment such as an improvement to the Target Detection, Location, and Handover System, and use in the Direct Sensor to Weapon Network demonstration (no g-rating, low power desired).

COMMERCIAL POTENTIAL: Inertial augmentation of GPS will expand the existing market in surveying, Geographic Information Systems, and self-documenting digital photography used in areas such as highway maintenance, crime scene documentation, insurance investigation. These area are developing into a multi-billion dollar market, but GPS-alone approaches suffer from information voids if the satellites are shadowed, for example in important areas such as under highway bridges, on city sidewalks ("urban canyons").

REFERENCES:

1. A Micromechanical INS/GPS System for Guided Projectiles, Dr. Donald Gustafson, Ralph Hopkins, Dr. Neil Barbour, and Dr. John Dowdle, in Proceedings of the 51st Annual Meeting, Institute of Navigation, Alexandria VA, June 1995.
2. "Test Results of the NAVSYS GPS/Inertial Mapping (GIM) System", Timothy Ash, Dr. Josef Coetsee, Randy Silva, and Dr. Alison Brown, in Proceedings of the 51st Annual Meeting, Institute of Navigation, Alexandria VA, June 1995.

KEYWORDS: inertial; navigation; accelerometer; gyroscope; projectile; MEMS

N01-078 TITLE: Improved Sonar Dome Window Materials that are Acoustically Transparent across a Wide Frequency Range

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT I: DD21

OBJECTIVE: Develop and demonstrate innovative sonar dome window materials that maximize acoustic transmission through the window, across a wide range of frequencies.

DESCRIPTION: Current sonar dome windows are "tuned" to a certain frequency range. There is a need for improved windows that can be used in applications where the sonar system may be transmitting signals of very wide bandwidth or two different frequencies completely. Due to the hydrodynamic forces imposed on the dome, the window must also be designed to maintain structural rigidity. This combination of acoustic properties and structural integrity poses a challenge that must be addressed.

PHASE I: Analyze alternative materials that are available to determine if they have the acoustic and mechanical properties that are desired. Design a prototype window that has the appropriate hydrodynamic shape in the flow field. Conduct laboratory tests of raw materials to measure the acoustic and mechanical properties of the proposed window materials.

PHASE II: Based on the acoustic test results and the mechanical design developed in Phase I, build test fixtures and a prototype sonar dome window. Investigate and model the sonar self-noise of the new sonar dome window to ensure that flow and structure-borne noise has been minimized. Conduct lake tests with the prototype window to measure the acoustic properties across a wide range of frequencies. The testing conducted in this Phase will provide valuable data on the performance of the new window without having to develop and install it on a Navy vessel. The results of the lake testing will then be used to optimize the design in preparation for ship installation in Phase III.

PHASE III: Install a prototype window on a Navy fleet ship and conduct sea tests to determine warfighting performance, reliability and maintainability. Prepare to manufacture the windows for installation on Navy ships.

COMMERCIAL POTENTIAL: This technology will benefit any industry that transmits acoustic signals through materials (e.g. medical industry, fishing industry, oil exploration industry).

KEYWORDS: sonar; domes; rubber windows; acoustics; transmission; rho-c

N01-079 TITLE: Run-Time Reallocation of Computing Resources in a Heterogeneous Networked Computing Environment

TECHNOLOGY AREAS: Information Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT I: DD21

OBJECTIVE: Traditionally, software applications are written and compiled for a single target processor. Executable software will only run on the target processor. To run the software on a different processor, the software has to be recompiled. The objective of this work is to develop an operating environment layer for tactical applications that will allow run-time executable files to run on multiple processor types. The rationale behind this topic is that the typical Navy ship has tactical systems developed using multiple processor types. Additionally, the research shall derive a method of fault tolerance so the applications can be re-hosted on a different processor type in a timely and graceful manner, i.e., with minimal loss of data and functionality.

DESCRIPTION: Develop an operating environment layer to allow run time executable real time tactical applications to run on multiple processor types, and develop operating environment and network system modifications to allow run-time reallocation of computing resources across heterogeneous computing resources.

PHASE I: Develop and describe an approach to creating multi-processor application executables and a run time processor reallocation feature.

PHASE II: Develop prototype multi-processor application executables and a run time processor reallocation features using typical Navy real time tactical applications. Demonstrate these multi-processor application executables and a run time processor reallocation features in a Navy lab.

PHASE III: Convert several Navy real time tactical applications using this new technology.

COMMERCIAL POTENTIAL: This research has potential in any networked server environment where real time and run time reallocation of computing resources is needed to prevent critical mission failure.

REFERENCES:

1. Configurable Computing: Technology and Applications, R. Vemuri and R. Harr, IEEE Computer, April 2000
2. Adaptive Computing Systems Program, DARPA Information Technology Office http://www.darpa.mil/ito/research/acs/index.html

KEYWORDS: middleware; real-time applications; Reallocation; multi-processor; tactical; software

N01-080 TITLE: Fault Location in an Intelligent Open Sensor Network

TECHNOLOGY AREAS: Sensors

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT I: DD21

OBJECTIVE: To develop and model techniques to determine the location of faults within a large distributed network of intelligent sensors that employs an open architecture and protocol.

DESCRIPTION: Distributed sensor networks for condition-based monitoring of the health of other systems and equipment have been developed. However, as more complex systems are developed, the need to monitor the health of these systems requires more complex sensors and more complex sensor networks. The reliability of the information being collected and disseminated throughout the network is only as good as the reliability of the sensor network itself. At issue, and what is being addressed in this SBIR topic, is the health of the complex sensor network itself. At the present time, the reliability of the sensor network is not being considered when systems are developed nor is it being addressed in various open standards. In order to be reliable and provide a high degree of confidence in the data transmitted over the network, a large network of intelligent sensors must be capable of autonomous self-monitoring in order to determine the existence of any faults and their location within the distributed network. Thus, the development of models for large sensor network fault determination and location is essential for the proper design and implementation of a large distributed sensor network for condition-based monitoring of different systems.

Based on the typical sensors used for condition-based maintenance, for example pressure sensors, accelerometers, and temperature transducers, and their failure modes, techniques and models need to be developed for various network topologies. These topologies can include, for example, the star, ring, and linear topologies. These models and techniques for determining faults and fault locations must take into account that the distributed network must consist of an open architecture and protocol that is in compliance with the current IEEE 1451 family of standards.

PHASE I: Conduct a study to examine the feasibility of developing techniques for monitoring the condition/health of a large distributed network of sensors that uses open architectures and protocols and is based on the IEEE 1451 family of standards. Determine the models required to design a large distributed sensor network of various topologies capable of self-monitoring for naval shipboard systems.

PHASE II: Build an intelligent open sensor network capable of monitoring its own health using the modeling techniques determined in Phase I to determine fault status and fault location within the network. In addition to monitoring its own health this network should properly monitor the health of a naval shipboard system. The particular shipboard system is at the discretion of the company.

PHASE III: Expand the proof of concept demonstrated in Phase II to other shipboard distributed networks and other larger shipboard systems.

COMMERCIAL POTENTIAL: Automobiles and industrial plants require more complex sensor networks to monitor the various systems. For example, in the automotive industry, reliable distributed sensor networks are required for the proper operation of antilock braking systems, diagnostics, and collision avoidance. The results of this research would have a direct impact on the automotive industry as well as other industries that rely on large complex distributed networks of sensors.

REFERENCES:

1. "Understanding Smart Sensors," Randy Frank, Artech House, 2000
2. "Condition-Based Maintenance and Machine Diagnostics," J. H. Williams, A. Davies, and P. R. Drake, Chapman & Hall, 1994
3. "Achieving Reliable Information from Extensive Sensor Cluster Networks on Ships," Richard A. Kant and Graham K. Hubler, NRL/MR/6670-98-8331, 1998
4. IEEE 1451.2 IEEE Standard for Smart Transducer Interface for Sensors and Actuators - Transducer to Microprocessor Communication Protocols and Transducer Electronic Data Sheet (TEDS) Format

KEYWORDS: smart sensors; distributed sensor networks; open systems architectures; fault tolerance; reliability

N01-081 TITLE: New Sabot and Pusher Plate Concepts for Barrage Round

TECHNOLOGY AREAS: Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT II: Extended Range Guided Munition (EX 171)

OBJECTIVE: Provide a low cost, high performance sabot and pusher plate for the Barrage Round projectile that minimizes parasitic mass through innovative new design approaches, high specific strength materials, and novel fabrication techniques.

DESCRIPTION: The Barrage Round is a technology demonstration of a high speed kinetic energy projectile with a flechette payload. Development of this projectile will encourage new high-pressure guns with large chambers to increase the range and lethality of such a projectile. Because the Barrage Round is a sub-caliber projectile with a fine conical shape, it requires a sabot and pusher plate for launch. Ordinarily, a high performance sabot and pusher plate for use in a high pressure, high energy gun would require high cost, exotic materials, difficult designs, and elaborate fabrication processes. This need not be the case, however. Current sabot/ pusher designs for the conical shaped projectile being considered here, launched at a 37 kgee peak acceleration, are expected to add 15% to the launch mass. Advanced designs, materials, and fabrication methods can be expected to reduce that value to only a few percent, but new issues arise: what does the optimum design look like, what materials should be used, do suitable manufacturing methods exist, and what are the production costs.

Currently, Barrage Round is being demonstrated with a sabot and pusher-plate design fabricated of high strength aluminum, fabricated by traditional methods. All the truly high payoff concepts can be expected to require a considerable investment in new material and manufacturing technologies. What is being sought here is the solution with the highest performance payoff but at a cost that is commensurate both with its lethality benefit to the round and the cost of the round itself. It is expected that through a host of unexplored design solutions such as geometry changes in petal sections, bore rider material choices and accompanying obturator designs, contact surface coatings, and separation strategies that support both low- cost and high performance procurement decisions that still provide 50% or greater reductions in sabot/ pusher plate mass.

PHASE I: Conduct a first-principals structural dynamics analysis of proposed new sabot and pusher designs and compare the mass and cost-to-manufacture of those results with traditional aluminum designs for the baseline launch conditions of 80 ksi peak pressure, 37 kgee peak acceleration, and 16 kg flight mass. Include at least one composite-based design alternative. The contractor may find it desirable to interface with the Navy Mantech Center for Composites Manufacturing in FY 01 and develop a quick response effort to obtain their assistance.

PHASE II: Iterate Phase I composite designs to improve manufacturability. Develop mass vs. cost trade off estimates for performance comparisons with traditional designs. Using manufacturable designs, produce composite sabot/ pusher plates for Phase III flight tests.

PHASE III: Integrate and test the Phase II prototype improved sabot and pusher plate in an operational Mk 45 Gun system. Test firings shall be conducted with slugs weighing 16 kg, fired at muzzle energies of 18 and 25 MJ with NSWC Indian Head propelling charge designs. A test series of at least 50 rounds shall be performed to allow evaluation of improved sabot/ pusher design.

COMMERCIAL POTENTIAL: Advanced 3-D structural modeling of high stress, high strain-rate, complex structural shapes is directly applicable to many types of dynamic impact problems that engineers deal with today. The higher operating stresses and loading rates of guns represent the range of operation that high speed and high efficiency transportation is already moving toward. Special structures and shapes such as are being explored here are directly applicable to next generation, space launch vehicles.

KEYWORDS: Metal Matrix Composite; Carbon Fiber; Sabot; Pusher Plate; Projectile; Bore Rider

N01-082 TITLE: Application of JINI Technology to Tactical System Integration

TECHNOLOGY AREAS: Information Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: NSSN

OBJECTIVE: Develop a new approach for creating a network infrastructure based on Jini technology to simplify their construction and adaptation, providing extensible integration to commercial, third party, custom and legacy interfaces.

DESCRIPTION: Integrating heterogeneous equipment to provide inter-subsystem communication and services continues to be a fundamental challenge for the technology refresh and insertion process. As the commercial world adopts easy instant connection technologies based upon Bluetooth and Jini, standards will prevail and become ubiquitous within network device industries providing a universal plug-and-play capability. The role of Jini in network is to develop a capability for spontaneously forming networks of heterogeneous equipment. Jini Lookup Service provides a central market for services around the network and making them accessible to client application programs. Java technology is the basis for this new Jini technology, making it possible to link various platform types into a common network.

A network infrastructure needs to be developed that leverages these commercial developments, but provides the framework for extensions that take into account the special real-time needs of the complete submarine system development roadmap. Inter-subsystem communication and a universal, spontaneous plug-and-play capability across diverse heterogeneous platforms should be the focus of the research. The goals of aligning with the commercial world's accepted technologies, and establishing a flexible, open-applications architecture across all subsystems must be maintained throughout the development process. Performance should be determined throughout, from conceptual estimation to benchmarking, to record differences between hard-solutions and open-standards with respect to real-time requirements. Attributes of security, scalability, adaptability, maintainability, supportability, COTS reuse, deployment costs, and life-cycle-costs should be addressed.

PHASE I: Research, develop and recommend alternative Jini-based network infrastructure concepts. Demonstrate applicable commercial technology feasibility.

PHASE II: Develop a Jini-based network architecture design. Develop candidate submarine sub-system network interfaces in accordance to the defined architecture. Demonstrate communication plug-and-play functionality and performance. Determine the security, scalability, adaptability, maintainability, supportability, COTS reuse, deployment costs, and life-cycle-costs attributes.

PHASE III: Deploy components of the Jini-based network infrastructure across the submarine system as part of the technology refresh and insertion plan.

COMMERCIAL POTENTIAL: The technologies researched and developed under this topic can be applied back into commercial mission-critical applications requiring scalability to thousands of devices needing security and flawless operation. The real-time extensions of the architecture can be applied to heterogeneous systems where human interactive devices such as a dispatcher's radio and electronic notepad need to access databases such as a cellular-phone company's logs or police databases.

KEYWORDS: Information Systems; Jini; Internet; Networks; Real-Time; Computers

N01-083 TITLE: Submarine Mast Detectability Reduction

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT IV: PEO for Submarines

OBJECTIVE: The objective of this program is to develop stealth technologies related to Infrared (IR) and Visual signature reduction of submarine masts. The program will address methods to reduce both hard body and hydrodynamic signatures.

DESCRIPTION: Submarine masts are vulnerable to detection by non-acoustic (radar, IR, EO) sensors when exposed above the ocean surface. To date, the Navy has focused its efforts on radar signature reduction. This project will investigate passive and active techniques for reduction of IR and EO signatures for both future mast and back-fit applications. Candidate technologies need to be compatible with existing and future radar treatments.

PHASE I: Investigate and formulate new materials and techniques for simultaneous reduction of radar, IR and EO mast signatures that are suitable for the submarine operational environment. Demonstrate potential effectiveness of candidate materials and techniques through modeling and analysis by showing that these signatures presented by the new materials are drastically improved over the current signatures. Demonstration shall be performed for existing mast applications or proposed for new mast designs.

PHASE II: Fabricate material samples in the form and shape ready for end use and develop new effective techniques to demonstrate electrical and mechanical performance of candidate technologies in a laboratory environment. Compatibility with existing radar treatments and ability to survive in the submarine environment shall be demonstrated if no single multi-spectral material can be developed and proven effective for simultaneous reduction of all three signatures.

PHASE III: Fabricate a submarine mast of choice by the government that is treated with a multi-spectral treatment for installation on a submarine and evaluation of its electrical (radar, IR and EO) and mechanical performance at an over-the-water test range and in a submarine environment.

COMMERCIAL POTENTIAL: The efficient heat dissipating materials produced by this research could be applied to electronics chassis.

REFERENCES:

1. Non-Acquisition Category Program Definition Document (NAPDD) #556-872E1
2. COMSUBLANT/PAC FY99 Command Capabilities Issues (CCI)

KEYWORDS: Submarine; Signature Reduction; Infrared; Visual Suppression

N01-084 TITLE: Technology for Torpedo Affordability

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes, Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT III: Surface Ship Torpedo Defense (SSTD)

OBJECTIVE: Develop and implement innovative technologies that will reduce the cost of constructing torpedoes while retaining required performance and thereby improve the competitiveness of the domestic torpedo -building industrial base and reduce the cost of military weapons.

DESCRIPTION: The Navy continually investigates various diverse technologies for weapons applications. As such, advanced technology demonstrations for affordability and advanced industrial practices, which improve manufacturing processes to increase productivity methods, are of interest. Along these lines, a group of shipyards, suppliers, owners, operators, and government personnel have developed during the last year the MARITECH Advanced Shipbuilding Enterprise Strategic Investment Plan to promote commercial competitiveness and reduce the cost of military ships. The Navy desires to begin a similar process with the 6.25" torpedo to develop low-cost future torpedo systems.

The Navy seeks to drastically lower unit cost of torpedo systems through technology development, adaptation and implementation of "World Class" commercial best practices, and process and technology implementation projects. Technology development projects should target development of new or improved production methods, new product design, and designs for producibility. Commercial best practices may include areas such as production planning and control, accuracy control, and supplier relationships. Process and technology implementation may include new business and manufacturing processes, adaptation of product design and material standards to new market segments or processes, and the implementation of new software and robotics. While the above would pertain to all torpedo systems, the Navy desires to demonstrate these technologies in a 6.25 inch torpedo. The 6.25 inch diameter device represents the most limiting volumetric design constraint, and therefore technologies demonstrated will be scalable to other torpedoes.

Reference (1) contains detailed drawings of components and subassemblies for the 6.25" technology "bread board" vehicle and is available to interested parties as part of discussions with the Navy or its agents for candidate applications. The 6.25" diameter vehicle has, as all torpedoes have, a guidance and control system consisting of an acoustic array and electronic components to transmit, receive and process signals, a propulsion section consisting of steam turbine, gearbox, condenser, pump and auxiliary mechanical and electronic subsystems, and, a high-performance propulsor with hydrodynamicly designed inlet and exit guide vanes, shroud and rotor subassemblies. The vehicle also has power, power distribution and regulation, inertial measurement, auto pilot and control systems, with mechanical, electrical and electronic sub-assemblies. The control system includes actuator and fin components in the propulsor. Prime candidates for work under this SBIR include all engine, propulsor and vehicle system mechanical assemblies, including the hull sections which form the water-tight body of the torpedo. References (2) and (3) contain comprehensive descriptions of the 6.25" torpedo systems and technology, and are valuable sources of information to assist prospective bidders in choosing technology areas to target for this topic.

Proposals should describe the technology for reducing the cost of a component, subsystem or group of components/subsystems from reference (1) in order to reduce the overall cost of a torpedo. The proposal should also describe how the proposed components or subsystems will be developed, what the estimated benefits will be and how it will be transitioned into the torpedo industry. Teaming with other industry partners to form integrated project execution and implementation teams will improve transition potential and is strongly encouraged.

PHASE I: For components selected from reference (1), develop innovative, lower-cost approaches to torpedo design and fabrication, prove feasibility for improvements and detail where and why they will impact 6.25 inch torpedo affordability and/or value. Include a Return-On-Investment (ROI) analysis for industry implementation.

PHASE II: Develop, fabricate and test working prototype production system or prototype product to demonstrate its performance characteristics.

PHASE III: Procure advanced prototype and production units in coordination with the 6.25" torpedo program, and the lightweight/heavyweight torpedo program.

COMMERCIAL POTENTIAL: The technology developed under this topic will be applicable to commercial high technology manufacturing plans and processes.

REFERENCES:
1. 6.25" Diameter Technical Data Package developed by the Applied Research Laboratory, Pennsylvania State University for the Office of Naval Research and the Naval Sea Systems Command.
2. "6.25" Counterweapon Technology Report to ONR, PMS415 (U)" of 10 February, 1998.
3. "6.25" Counterweapon Technology Report to ONR, PMS-404, PMS-415 (U)" of 15 October, 1999.

KEYWORDS: torpedo; affordability; production; manufacturing; processes; maintainability

N01-085 TITLE: <u>Investigation into the use of wireless technology to eliminate cabling in Submarine Command, Control, Communications and Computers (C4I) System Design</u>

TECHNOLOGY AREAS: Electronics

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO, Submarines

OBJECTIVE: Research and develop new wireless technology to replace cable interconnects between C4I System components.

DESCRIPTION: A significant portion of the cost for design, construction, and upgrade of Submarine Command, Control, Communications, and Computers (C4I) Systems relates to cabling. Much of this cost could be eliminated if wireless links replaced the cables. However, these benefits cannot be realized until the numerous technical challenges to implementing wireless links are overcome. Wireless transmission of data will also offer the potential to eliminate expensive cabling changes, thus reducing ship impacts and installation/maintenance costs. New ship construction can be more affordable through cable elimination, and can take advantage of the space and weight reductions. This program will address those challenges with a focused research and development effort.

Commercial wireless technology is ill suited for the task of moving massive amounts of data over short distances inside a steel hull submarine. Through innovation it may be possible to adapt wireless products to the submarine environment - where strict FCC band allocation, power limitations, and atmospheric considerations do not apply. For example, the entire television broadcast band could be subdivided into multiple high-data-rate channels suitable for carrying sonar beam data.

This research and development program will prioritize those cables to be replaced, identify requirements for the wireless links, and determine how to adapt existing wireless products, or develop new wireless technologies, to meet those requirements. The research will address risk areas including but not limited to multipath and other interference, line of sight options, electromagnetic compatibility with shipboard systems, bandwidth and power optimization, channel interleaving, signaling and bit rate performance, information security (especially dockside), reliability and availability, and rugged packaging for tactical system application.

Specific risks that will need to be addressed in the studies and demonstrations will be:
a. Compatibility with secure data transmission devices/techniques.
b. Power consumption - wireless sensors offer lower installation costs, but continued maintenance for battery replacement negates that savings, so a low power, high performance wireless technology enjoying long lasting life for inboard the submarine hull is a key element to be addressed otherwise wireless sensors may not be worthwhile.
c. Outboard to inboard wireless transmission of sensor data is an area ripe for success or failure with many applications on any vehicles and has the same risks as inboard applications but in a severe environment.
d. Military applications will require substantially higher data rates than current technology can provide. Even in a benign inboard ship application, the structures, RF and EMI provide a hostile environment for many potential applications.
e. Meeting Information Security (INFOSEC) requirements.

PHASE I: The contractor will analyze cable considerations including cost, space, weight, and probability of replacement (to accommodate C4I technology infusion). Trade studies will assess the feasibility and payback of replacing candidate cables with wireless links. Requirements for those wireless links will be documented and used to evaluate commercial wireless technologies such as "Personal Area Networks" and "Pico-networks." The contractor will draw conclusions about the feasibility of wireless links on submarines, and will offer creative ideas and a plan for adapting COTS products and/or developing new technologies and methods to meet the special requirements.

PHASE II: Proceed with the plan recommended in Phase I. Implement prototypes of the innovative concepts for integrated Wireless networks. Demonstrate application to representative wide-bandwidth and narrow bandwidth C4I components, and assess the ability to exchange data through wireless networks while meeting system requirements.

PHASE III: Develop a system production modification kit that permits installation of Wireless Technology into existing C4I systems.

COMMERCIAL POTENTIAL: The technologies and methods developed in this program can be applied to numerous electronics systems, potentially including Naval platforms, shielded data centers, underground command bunkers, and large space-borne equipment such as space stations.

KEYWORDS: Wireless; Submarine; Command; Control; Communications; Computers; Data-Transfer; Cabling

N01-086 TITLE: Transient Shock Resistance of COTS Electronics

TECHNOLOGY AREAS: Electronics

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO submarines

OBJECTIVE: To develop an analytical modeling capability for the evaluation of the transient shock resistance of COTS electronics items. This includes assessment of the validity of innovative linear and nonlinear analysis tools in predicting the response of isolated deck modules and rafts to underwater explosion (UNDEX) induced shock and bubble loadings, and the comparison of these computed equipment environments to measured thresholds identified during laboratory evaluations of COTS.

DESCRIPTION: The current climate of rapidly changing technologies, coupled with the need to swiftly integrate these developments into service, has led to widespread use of COTS equipment items. This is especially true for sophisticated electronics systems found in the most current submarine and surface ship designs. Other benefits of utilizing COTS have been identified, including reduced procurement and testing costs, as well as improved performance. COTS equipment items, however, are inherently fragile and usually require some degree of shock isolation in order to remain survivable under the effects of UNDEX. In modern submarine and surface ship designs, it is often most feasible to incorporate groups of COTS equipment in large modular deck or rafted systems which are then connected to supporting structure through the use of state-of-the-art isolation and damper systems. Each type of isolation strategy must be capable of mitigating the complex effects of both shock wave and bubble loadings, which collectively span both the high and low ends of the frequency spectrum. With such a complex dynamic loading environment from which to isolate, coupled with the variable and often unknown fragility of COTS items, the introduction of isolated deck modules and rafts to protect COTS equipment brings about an element of uncertainty to predicting the overall survivability of the submarine or surface ship. The current state-of-the-art is lacking in the area of well-defined COTS failure threshold levels, failure modes and statistical variability. In addition, the use of currently available linear and nonlinear analysis codes for analyzing the complex dynamic loading environment of isolated modular systems, as well as the use of mathematical algorithms to represent mount, snubber, and damper hysteresis motions have not been adequately validated. Also, there is currently no documented guidance for the adequate mathematical representation of isolated deck structures. Since the acceptability of COTS electronic equipment requires the capability to accurately predict the shipboard environment and to compare that environment to actual measurements and laboratory assessments of electronic equipment robustness. Candidates are requested to develop this capability, which must necessarily include the development and evaluation of innovative, state-of-the-art computational tools, as well as robust procedures for comparing predicted shipboard environments with well defined equipment survivability levels measured and demonstrated in laboratory shock tests.

PHASE I: Develop concepts for analytical tools and models to analyze or simulate UNDEX effects upon COTS equipment and supporting structures in a submarine (primary) and surface ship (secondary) environment. Identify high risk and technical issues related to design level UNDEX-environment analytical computations and for comparison of these environments with COTS survivability levels established from laboratory tests.

Modeling approaches should include but not be limited to those which incorporate innovative algorithms or elements in finite element models that can represent the response of the system in all areas (e.g., mounts, damper, distributed and non-rigidly supported systems (cables, piping), non-welded connections (e.g., bolted) in structure and between structure and COTS components and within COTS components).

Capabilities to be explored and developed include characterization of design level UNDEX induced shipboard loads, development and mathematical representation of mount, snubber and damper dynamic force-deflection-velocity characteristics, modeling of modular deck and raft structures as well as representation of mounted COTS equipment items, and the adequate modeling of dissipation through structural and material damping.

Analytical tools should possess a variety of both linear and nonlinear features, including fluid-structure interaction (FSI) capabilities and nonlinear material and geometric effects including yielding. Comparison studies must synthesize existing COTS survivability data, laboratory test measurements and performance statistics. Perform parametric studies identifying pertinent issues and risks associated with the process.

PHASE II: Develop procedures, tools and models for the prediction of shipboard environments on isolated decks in ships and submarines, as well as a process for comparison of the computed results with experimental COTS equipment levels. These models, tools and procedures must address the previously identified modeling and COTS threshold deficiencies in the current state-of-the-art. Demonstrate the validity of these tools and processes in achieving survivable COTS isolation designs through comparisons with available UNDEX data sets (e.g., numerous SITE and ASSIST test series). Included in these applications will be UNDEX environment development and validation, mount characterization and resulting algorithm development and validation, and validation of applied COTS survivability criteria through study of the actual tested COTS equipment performance. Error function analyses will be applied to the analyses (e.g., Geers, Russell, etc.), and the results will be used to more thoroughly evaluate the validity of these candidate tools and processes for their intended purposes. In addition, levels of risk will be assigned to each element of the analysis process.

PHASE III: Full/large scale demonstrations of the improved analytical modeling capability and associated COTS equipment data comparison process will be conducted using available and developed data, as appropriate. The overall process will be demonstrated for both submarine and surface ship applications, resulting in a comprehensive large scale process evaluation and risk assessment.

COMMERCIAL POTENTIAL: Improved analytical modeling capability and associated COTS equipment certification process may be used by the commercial shipbuilding industry to evaluate new design risks related to vibration and noise control as well as dynamic loads encountered due to wave slamming, sea keeping, grounding, docking loads and collisions at sea.

REFERENCES:
1. Deck Design Procedure for VIRGINIA Class Submarines.
2. Jagaczewski, A., Messina, G., Cain, D., Hnat, P. "Interim New Attack Submarine (NSSN) Shock / Acoustic Isolator Technology Evaluation Phase III (SITE Phase III) Equipment Response Data Report", Newport Division, Naval Undersea Warfare Center, Test Report No. 64214, 12 November 1996.
3. Camp, G. H., IV, F. A. Costanzo and E. L. Luft, "Design Guidance for Isolated Equipment Rafts Installed on US Navy Surface Combatants", Carderock Division, Naval Surface Warfare Center, Bethesda, Maryland, Survivability, Structures and Materials Directorate, Research and Development Report.

KEYWORDS: Shock; Isolation; UNDEX; COTS; Model; Statistics

N01-087 TITLE: <u>Low Cost Compression Techniques Applied To Encrypted Data Distribution System</u>

TECHNOLOGY AREAS: Information Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PMS 465 Cooperative Engagement Capability Program

OBJECTIVE: Develop an innovative low cost encryption compatible compression technique which can be applied to the Navy's Cooperative Engagement Capability (CEC) Data Distribution System (DDS).

DESCRIPTION: CEC is a system that allows battleforce units to share sensor data with rapid timing and precision. The data transfer element of CEC is the DDS that must ensure highly reliable transfer of data within a stringent time budget. It must do this without constraining the rate or capacity of reported data within the CEC networking. It also must send the data using an NSA approved encrypted format. Develop innovative low cost lossless compression technique will allow more encrypted data to be transferred within the fixed bandwidth capacity of the DDS. The challenge is finding a innovative technique which can work within CEC's time constraints as well as Multi-Level Security (MLS) requirements.

Compression algorithms can replace repeating data with shorter representations, compressing large amounts of data into a fraction of their original size. However, not all current algorithms are created equal. The best compression algorithm for one type of data is often the worst for other types of data. The encryption aspect of this problem will influence the type of compression algorithm selected or developed. A innovative new compression technique (which can be implemented with software and/or hardware) will be required so that timing and multi level security requirements are not sacrificed.

PHASE I: Develop innovative lossless compression and encryption technology and analyze performance in multi level security environments. Develop and analyze innovative compression and encryption techniques in relationship to given timing and MLS requirements.

PHASE II: Design innovative compression and encryption prototype which can be incorporated into the CEC system. The prototypes will be evaluated into CEC land-based test sites in order to validate the improvement of data capacity and ensure no loss of the DDS timing and verify that MLS requirements are met.

PHASE III: Develop the compression and encryption product for production. Ensure that it can be easily manufactured and incorporated into the CEC system. Supply enough units for CEC production or provide the specifications required to build the compression and encryption product by another source.

COMMERCIAL POTENTIAL: Cable and phone companies, as internet infrastructure providers, and companies owning content to populate the internet, have realized that a capable network coupled with improved computing and compression techniques can soon be capable of delivering interactive services in a profitable manner. These services can include interactive entertainment, distribution of news and information, on-demand video services, home shopping, interactive multi-user games, and digital multimedia libraries accessible from home. A key component to this vision becoming a reality is a high bandwidth, highly reliable, real-time compression product. Incorporating an encryption component will also make this product very desirable in the business realm where companies are developing critical information systems which use the internet infrastructure. Encryption will protect their proprietary data.

REFERENCES:

1. Prediction-Capable Data Compression Algorithms for Improving Transmission Efficiency on Distributed Systems, Hann-Huei Chiou, Alexander I-Chi Lai and Chin-Laung Lei, Proceedings of the The 20th International Conference on Distributed Computing Systems (ICDCS 2000) Institute of Electrical and Electronics Engineers, Inc., 2000
2. Compression Algorithms for Real Programmers, Peter Wayner, Morgan Kaufmann Publishers, San Francisco, CA 1999.
3. A Mathematical Theory of Communication, C. E. Shannon, The Bell System Technical Journal, Vol. 27, pp. 379-423, 623-656, July, October, 1948.

KEYWORDS: Data compression; Multi-Level Security; Encryption; Distributed Systems

N01-088 TITLE: <u>Affordable High Performance Shock and Vibration Mitigating Mount</u>

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: DDG-51 (PMS 400D)

OBJECTIVE: Develop a low cost multiple performance generic machinery mount system, which has varying static properties and provides dynamic shock and vibration mitigation over a wide operating load range. These mounts should be capable of meeting or exceeding shock and vibration performance specifications for several mounts/load ranges as given in for example MIL-M-17185 (General Mount Spec.), MIL-M-17191 (P-Type Mounts), MIL-M-17508 (E-Type Mounts), MIL-M-19379 (M-Type Mounts), MIL-M-19863 (5B5000 Mounts), and MIL-M-21649 (5M10000 Mounts).

DESCRIPTION: Isolation mounts are used extensively on Navy ships to 1) protect equipment from the effects of shock, 2) reduce vibration noise from the hull to sensitive acoustic interrogation systems, and 3) to minimize the transmission of vibration energy of machinery to the ship hull. The Navy currently uses over 60 different types of mounts to provide shock and vibration isolation for loads ranging from 0.5 lbs to 10,000 lbs. This program would seek to develop a generic mount configuration that could be utilized for a large range of combined shock mitigation and vibration load isolation requirements. Successful development of a single multiperformance shock and vibration mount system will yield numerous benefits including reduction of inventoried items, reduction in costs associated with fewer parts fabricated, and standardization of installation and maintenance procedures. The incorporation of shock mitigating capabilities will also permit the use of low cost Commercial-Off-The-Shelf (COTS) equipment. This will result in very large cost savings for the Navy.

PHASE I: Develop a system configuration which, through a combination of analytical (and) experimental means, will exhibit potential for providing shock mitigation and vibration isolation for a significant (the full Navy mount load range) range of loads. Identify configurational requirements that must be considered in developing a multi-element system. Develop/identify potential low cost fabrication methods for manufacturing the systems. Prepare a preliminary product specification, reflecting the identified performance and configurational requirements.

PHASE II: Transition analytical/experimental findings into prototype mount concept and design for a family of mount(s). Design, fabricate and characterize the static and dynamic properties and fabricate of the prototype mount concepts. Fabricate associated hardware and conduct shock and vibration testing to assess performance. These shock and vibration requirements should be established with NAVSEA support. Develop preliminary specifications for performance and mechanical requirements along with mount drawings for NAVSEA evaluation. Provide prototype mounts for sea trials. Provide similar mounts for evaluation in industrial applications where vibration isolation and shock mitigation from rotating equipment is required, particularly in harsh and corrosive environments.

PHASE III: Develop use of these mounts for low cost Commercial-Off-The-Shelf (COTS) equipment which will result in a very large cost savings for the Navy. Transition mounts to the fleet through installation of mounts for numerous fleet applications. Provide industry with a range of mounts for vibration isolation of machinery components.

COMMERICIAL POTENTIAL: This type of system could be utilized in numerous industrial applications where shock, noise and vibration are of concern. The potential use is very wide, which includes rotating and reciprocating equipment, isolation of precision equipment, as well as civil applications such as earthquake management.

RERFERENCES:
1. Rivera, Rimi O., "Non-metallic 15P150A Machinery Mounts", CARDIVNSWC-SSM-64-94-14, Aug 1994, 99p.

KEYWORDS: Mounts; Shock Isolation; Vibration Isolation; Corrosion Resistance

N01-089 TITLE: Dynamically Optimized Team Performance

TECHNOLOGY AREAS: Human Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PMS 467

DESCRIPTION: The Navy is planning to introduce new weapons, surface combatants and planning, coordination and control capabilities into the Fleet over the next 5-10 years. Shipboard operators will face high demands during tactical operations. At the same time, the Navy desires to reduce current shipboard manning levels. A resulting need is for an innovative adaptive system to optimize team performance by automatically distributing, in real time and dynamically, tasks among a team of operators. This project would develop and demonstrate a prototype of such an adaptive system, furthering the current state of human systems technology. If successful, this SBIR effort would be transitioned by maturing the adaptive system and integrating it into tactical shipboard systems.

PHASE I: Devise innovative concepts and technical means to monitor the conditions and workload of a team of operators performing real time tasks; apply this information in real time to optimize team performance during tactical operations. The contractor will devise means by which operator alertness, ability to handle current and new tasks, and operator stress levels will be monitored in real time (e.g., using such approaches as eye and/or head tracking and/or other biometrics, with preference given to non-intrusive technologies) during tactical operations. The contractor will identify innovations that will allow the rapid distribution of tasks to operators on the team as demands on the team, operator alertness, stress and workload conditions change. The innovative concepts selected in phase I shall be scalable to various team sizes and respond to large fluctuations in operator conditions and demands on the team while minimizing the redistribution of tasks among the team.

PHASE II: Develop a prototype adaptive system to demonstrate the Phase I innovations and measure the effectiveness via metrics established in Phase I. The prototype must be scalable to varying team sizes and provide a means for a human supervisor to monitor team workload, alertness and stress conditions, and the distribution of tasks among the team, both in real time. The system must also be easily portable to a variety of hardware and operating system platforms, to support migration to new shipboard computing platforms, which are based on commercial off-the-shelf hardware and software. The contractor will also address the impact of the selected approach on the ability of the operator(s) to maintain task/process awareness, and mitigate operator disorientation due to the interruption of tasks. The prototype must ease the transition of an operator from termination of one task to the initiation of the other during tactical operations.

PHASE III: The contractor will mature the product of this innovative adaptive system in preparation for integration into one or more of the following shipboard systems: the Area Air Defense Commander (AADC) system, the DD 21 combat system, the Tactical Tomahawk Weapon Control System (TTWCS), the AEGIS combat system and/or the Naval Fires Control System (NFCS). There are also potential transition opportunities to NASA`s [manned] Mars Mission systems and its other space crew/vehicle integration efforts, and for the U.S. Coast Guard`s Integrated Deepwater System. PMS 467, PMS 500, PMA 282, the NASA Johnson Space Center (Space Human Factors), NASA Langley Research Center (Crew/Vehicle Integration) and the Department of Transportation`s SBIR program office (on behalf of the U.S. Coast Guard) have all endorsed this SBIR topic.

The other potential military applications are numerous, including: the SSGN (conversion) submarine combat system, Navy and Joint mission planning systems, Unmanned Aerial Vehicle (UAV) control systems and joint service command & control centers.

COMMERCIAL POTENTIAL: The commercial potential is extremely high for a capability to monitor team workload and stress in real time and rapidly distribute/redistribute tasks to members of the team during operations. Potential applications include, but are not limited to: emergency response or non-profit organization's telephone call-handling center; industrial/manufacturing plants; control systems for power generation/ distribution facilities, commercial air traffic control and police dispatchers; and technical support centers for software companies.

KEYWORDS: Workload; Team Performance; Operator Effectiveness; Adaptive Workload Management; Task Supervision; Operator Performance

N01-090 TITLE: TBMD Tactical Telemetry Transmitting System

TECHNOLOGY AREAS: Sensors, Electronics

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: Navy Theater Ballistic Missile Defense Program/STAN

OBJECTIVE: Develop and demonstrate telemetry equipment and processes to provide the capability for multiple airborne system to simultaneously transmit high volume/high data rate analog, digital, and video information for reception by a shipboard receiving system. The air-borne transmitting equipment must have sufficient effective radiated power and use a modulation/encoding technique to ensure reception by the ship. The receiving system will receive and record each telemetry signal.

DESCRIPTION: Tactical Telemetry capability, consisting of a missile telemeter with associated radiating antenna and a shipboard receiving system supports the Navy's Theater Ballistic Missile Defense (TBMD) Program. The TBMD program requirements are for the Navy to have the capability to launch several missiles at an array of targets. Each missile must possess the capability to provide the Battle Group with in-flight performance data consisting of analog, computer words, Doppler video, IR seeker video and fuzing video. This data is to be received and processed by a shipboard receiving system. Data latency/ processing delay by the telemeter must be kept to a minimum in order to prevent loss of transmitted data caused by telemeter demise due to warhead detonation at intercept. The received and processed data quantity/quality/resolution must be sufficient to provide reconstruction of missile functions. The "normally-used" telemetry S-band is not capable of supporting the telemetry links for the specified number of missiles in the battlespace simultaneously using PCM/FM-NRZL modulation schemes. Presently this band has been divided into 11 channels with a bandwidth of 15-16 MHz/channel. This falls short of satisfying the TBMD program requirement. The purpose of this development is to develop innovative equipment and processes to allow significant increase in the number of in-band signals/channels that can be transmitted (Number of channels is to be proposed by the offeror) while using reduced receiving antenna aperture to minimize impact to shipboard "real estate." Use of alternate frequency bands, within the military allocated frequency spectrum maybe explored. However, proposed frequencies must be compatible with ship systems (i.e. will not interfere with or be interfered with by other ship systems). The offer may propose an approach, which utilizing various methods such as data compression, coding, modulation techniques, or any new and innovative approach, providing the resulting decoded data is not significantly degraded. Control of the missile-borne hardware will be through the missile initialization message before launch and through uplink messages after launch.

PHASE I: Provide innovative design concept for telemetry system. Conduct and provide feasibility study for proposed system to demonstrate concept. Define receiving system requirements necessary to receive, record, and process telemeter data.

PHASE II: Design, fabricate, test, and deliver prototype telemeter hardware to conduct "proof of concept" Conduct Proof of design testing and provide final report.

PHASE III: Design and package telemeter to survive "cradle-to-grave" environments and fit within the allocated space envelope of the missile, ensure mechanical and electrical integration with the missile, design and demonstrate producible, and provide documentation package with sufficient level of detail to support procurement.

COMMERCIAL POTENTIAL: The increased rate of data transfer within a reduced bandwidth would have application in the telecommunications and PCS industries.

REFERENCES:
1. IRIG STANDARD 106-96

KEYWORDS: Telemetry; data compression; modulation techniques; spectral efficiency; communication link; telemeter

N01-091 TITLE: Interference Suppression Techniques Development for Future Combat Scenarios

TECHNOLOGY AREAS: Electronics, Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: AEGIS Combat System (PMS400B)

OBJECTIVE: The objective of this topic is to develop advanced innovative practical, affordable, electronic interference cancellation to be implemented in radars.

DESCRIPTION: As radars become more sensitive, new techniques will be needed to provide radars with necessary interference suppression. Future radar systems will be designed to include such capabilities from their inception. Current radar systems that are undergoing upgrades will encounter the same interfering environments and will, therefore, also have to have their suppression capabilities enhanced. However, their enhancement potential will be constrained by their existing hardware configuration. For example, new antenna-based suppression techniques would be expensive to implement in existing antenna systems with in-place beamforming hardware. Relative to such systems, new waveforms and processing techniques, with modest attendant waveform generator and receiver hardware upgrades will constitute more affordable and practical alternatives.

PHASE I: Develop innovative suppression techniques to effect practical and operationally meaningful improvements in existing radar performance against existing and anticipated interference sources. Develop the attendant architectural requirements, and analyze and quantify the detection and angle measurement performance improvement via a computer simulation. Use the results to demonstrate the feasibility and practicality of such solutions.

PHASE II: Fabricate a prototype interference suppression set to demonstrate and validate the techniques developed in phase I, using a combination of simulations and recorded I/Q data from an existing radar. The test radar can be an operational radar, or a prototype under development that will be identified by the Program Office.

PHASE III: Insert this new technology into one, or more, existing Navy radars, or into radar systems of another DOD component.

COMMERCIAL POTENTIAL: The technology developed within this project can become an integral part of many future radar designs. These can involve a variety of applications, i.e., shipboard, airborne, ground based and satellite radars. The technology is also applicable to reducing interference on commercial satellite systems.

KEYWORDS: Navy Radar Systems; Electronic Counter-Countermeasure; coherent repeaters; noise jammers; digital radio frequency modulating (DRFM); littoral operations

N01-092 TITLE: Dynamic Sensor/Weapon Alignment Algorithms

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PMS 473 Advanced Integrated Electronic Warfare System

OBJECTIVE: Develop innovative system to support automated dynamic alignment between ship sensor systems and sensor to weapons systems. To support sensor-to-sensor and sensor-to-weapon cueing and track correlation, high resolution (ES and IR) Angle of Arrival (AOA) sensor measurements must be aligned to the receiving sensor or weapon using a common reference system.

DESCRIPTION: To maintain alignment between spatially separated systems requires a low latency - high accuracy alignment system that compensate for ship's flexure, temperature differentials, and navigation sensor latency. A need exists to adaptively identify the contributing factors to sensor alignment errors including those that are static and those that vary as a function of time or ship's motion. The dynamic alignment system must offset the contributing errors. The data content, the latency of the data, and the response time of the dynamic alignment system need to be specified such that the algorithm does not significantly contribute to track correlation and cueing accuracy errors.

PHASE I: Develop innovative accuracy alignment system concept in sufficient detail to address implementation regarding integrating into legacy systems and those currently in development. Develop a plan including cost for prototype demonstration.

PHASE II: Design, build and evaluate the prototype accuracy alignment system. Perform modeling and simulations to initially test the system in the lab followed by at-sea testing. Characterize the performance achieved and provide recommendations concerning the specifications required for Fleet implementation. Identify the risks associated with the accuracy alignment system and identify interface specification requirements on the host sensor/weapons systems.

PHASE III: Develop a system production kit that can be used on both Fleet deployed units (back fit) and systems in production (forward fit).

COMMERICIAL POTENTIAL: Air Traffic Control, commercial ship multi-radar system, oil explorations.

REFERENCES:

1. "Real-Time Tracking Filter Evaluation and Selection for Tactical Applications" Singer and Behnke, IEEE AES Vol AES-7, No. 1, Jan 1971.
2. "SRS for RTS of the NAVSSI AN/SSN-6 Block 3" NAVSSI-B3-SRS-RTS-ROCO 18 Jan 2000.
3. ESM and IR Sensor Accuracy Requirements for Multifunction Radar Cueing, Technical Report, Task 3-1-19, Sensor Performance Analysis. R.J. Prengaman John Hopkins Applied Physics Laboratory, December 1988
4. Precision Electronic Support Measures (ESM) Requirements for Radar Cueing, by L.D. Sumner and T. W. Kimbrell, Tactical EW Systems Division Electronics Systems Department, Naval Surface Warfare Center, Dahlgren, Virginia, February 1992.

KEYWORDS: Sensor; Sensor-Weapon Cueing; Tracking correlation; High resolution; AOA sensor measurement

N01-093 TITLE: Advanced Personal Communicator (APC)

TECHNOLOGY AREAS: Information Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: DD-21 (PMS 500)

OBJECTIVE: This SBIR will develop an advanced innovative system that coordinated local common tactical picture (CTP) for field use by warfighters via a wearable networked computer system producing voice or touchpad computer generated maps. These maps would be communicable back to a base site for feedback to the larger CTP and would receive downward updates from that same larger CTP. The APC system will also include a fully windows compatible heads-up display with audio, video and GPS capability.

DESCRIPTION: The APC System will provide the relevant aspects of the CTP and other needed supporting data to sailor teams, Marine Corps Squads and individual warfighters via an innovative virtual Data Mall. Supporting Data Mall areas will include; job aids, performance support systems, condition based maintenance trends/analyses, maintenance manuals, personnel info, training materials, stores data, damage control, medical and logistics support etc.

The APC System will map evolving localized operational situations in near real time, so that there is a localized CTP from which to work. Annotations of GPS coordinates, named objects, and hand drawn graphics are beginning to be added to displayed maps, though not usually in an interactive format. These mapping additions are made after receiving field information through voice communications at base sites away from the front lines or when teams report in after being relieved. Most maps so created are at least one working shift behind. Teams do not generally leave for the field with a fully updated site map necessitating warfighters to conduct operations and planning from the base site with less than completely updated assessments of problems and conditions.

Coordination with other National Defense initiatives. National defense programs have developed an initial global C4I networked warfighting system that uses sophisticated data fusion techniques to create and display the CTP. ACTDs such as the Extended Littoral Battlespace (ELB) and Military Operations in Urban Terrain (MOUT) are implementing this C4I system to support decisions makers at the Commanding Officer (CO) level onboard ships and company commanders ashore.

The APC System would accomplish these tasks using innovation networked, hands free, voice activated, wearable computers with integrated head mounted displays, earphones, microphones, Video Cameras, and GPS integrated with appropriate mapping software.

PHASE I: This effort will develop smart system model via computer modeling and simulations, perform laboratory measurements and analysis.

PHASE II: A prototype systems will be constructed, integrated, evaluated, and tested a number of operational military demonstrations of key phases of a typical system will be demonstrated. This will assist in developing the ORD. Modifications will be made as dictated by this comprehensive series of field-testing demonstrations.

PHASE III: Final combined shipboard, underwater and land capable APC units, will be developed. A demonstration in an integrated exercise will be planned.

COMMERCIAL POTENTIAL: Near Real-time information overlaid in some graphical format has uses for numerous industries and government areas, including law enforcement and fire protection. The APC System provides near real-time information management throughout a large area that is extremely valuable.

KEYWORDS: Autonomous; Coordinated; Common Tactical Picture; Real Time Multimedia; Wearable Computer; Networked Computer

N01-094 TITLE: Model Based Tools and Methodologies for Embedded Systems Software Development

TECHNOLOGY AREAS: Information Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT 1: AEGIS Combat System (PMS400B)

OBJECTIVE: Demonstrate a complete and rigorous advanced Unified Modeling Language (UML) based process for high reliability and high performance systems such as weapons embedded software development. The process must provide robust code generation, flexible system partitioning, open software architecture design, rigorous and complete analysis capture in UML, software/hardware integration, compatibility with non-analyzed components, project manageability and reliable project scope estimation.

DESCRIPTION: The complexity of embedded systems development and maintenance for theater surface combatants is challenging. The multiple systems and subsystems and their interdependencies are difficult to specify and implement using current software development practices. This context requires a model-based analysis process to support the rigorous specification of the system software, while supporting a flexible translation to implementation. This translation must provide complete project-specific control over the generated implementation, with full platform independence, and freedom to employ any required performance optimizations. The tools must be highly automated, requiring no manual modification of the generated implementation. Once the implementation for the system has been automatically produced the process must also provide direct tools support for the evaluation and debugging of the analysis and the architecture models at the UML semantic level. There must also be a flexible model query, analysis and reporting facility to allow the construction and exercise of sophisticated automated project-specific semantic verifications of the analysis models.

PHASE I: Develop innovative software architectures via complete implementation code translation from UML architecture models. Establish the feasibility that functionality of the software architectures can be captured in the UML and translated into source code that satisfies the system requirements.

PHASE II: Develop and demonstrate a prototype system showing that the functionality of the software architecture is captured in the UML and translated into source code that satisfies system requirements. This prototype will specifically focus on the modeling of high-performance and high-reliability analysis translation mappings and mechanisms. The prototype should also explore significant subject matter-specific model analysis reports (static checks) to investigate and verify mission-critical and reliability-critical aspects of the system.

PHASE III: Develop a robust advanced UML system on a military/commercial project for demonstrating the complete process on a complex mission critical system, including the application of translation modeling, and subject matter-specific model analysis reports

COMMERCIAL POTENTIAL: Embedded software development for highly specialized, high-reliability and high-performance systems. A small sampling of this type of application includes medical instruments, space flight software, avionics, commercial marine vessel management and automotive vehicle management.

REFERENCES:

1. Final Report, "NSF Workshop on a Research Program for the 21st Century," www.cs.umd.edu/projects/SoftEng/tame/nsfw98/.
2. OMG Unified Modeling Language Specification Version 1.3, Object Management Group, Inc., (June 1999), www.omg.org/cgi-bin/doc?ad/99-06-08.
3. B. Douglass, "Doing Hard Time: Developing Real-Time Systems with UML, Objects, Frameworks and Patterns," Addison-Wesley (1999)
4. S. Shlaer and S. Mellor, "Object Lifecycles," Yourdon Press, NJ (1992).
5. G. Booch, J. Rumbaugh and I. Jacobson, "The Unified Modeling Language User Guide", Addison-Wesley (1999).6. B. Boehm, "Gaining Intellectual Control of Software Development," Computer May 2000, pp. 27-33.

KEYWORDS: Auto-code generation; UML; model-based development; software engineering; software pattern and frameworks; software reuse

N01-095 TITLE: Main Beam Jamming Nulling in Phased Array Radars

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT 1: AEGIS Combat System (PMS400B)

OBJECTIVE: Develop and demonstrate an innovative main beam and sidelobe jamming cancellation system for a phased array radar. The system will employ adaptive algorithms, which will preserve monopulse accuracy and permit effective operation in a littoral (clutter) environment.

DESCRIPTION: Stand-off jamming is the technique of choice to reduce the effectiveness of military radar systems in performing their assigned task of early detection of threats. Techniques such as low antenna sidelobes and/or adaptive jamming cancellation (coherent sidelobe cancellation) are widely used to reduce the effectiveness of such standoff jamming. As the angular separation between the stand-off jamming and the targets of interest becomes smaller, jamming will begin to enter the radar via its main beam and the effectiveness of traditional techniques ceases. Main beam nulling of the jamming using existing sum and difference beams at the array output can provide a solution, but the need to preserve monopulse measurement accuracy has hindered its practical application. Also, the main beam jamming cancellation technique requires orders of magnitude increases in jamming cancellation capability, which have been difficult to achieve in the past. The purpose of this effort is to explore new innovative techniques for achieving a high degree of main beam jamming cancellation while preserving the monopulse measurement accuracy and to construct an experimental system, which can be demonstrated on an existing phased array radar. It is assumed that the target phased array does not have access to its subarrays. Additionally, it is desired to determine how such a main beam canceller can be combined with more conventional sidelobe cancellation algorithms for suppressing very strong jamming in the antenna sidelobes simultaneously with the weaker jammers in the main beam region. Finally it is desired to investigate techniques for making the adaptive algorithms compatible with high level, high duty cycle clutter returns in the main beam, as may be expected in the littoral operating environment of Navy ships.

PHASE I: Define a candidate hardware implementation of a JAMMING CANCELLATION system to be tested on an existing radar. Address the combined problems of main beam jamming suppression, sidelobe jamming suppression, monopulse accuracy, and compatibility with good clutter suppression in the littoral environment.

PHASE II: Develop a brassboard PROTOTYPE of the system concept defined during Phase I and integrate with a designated radar system at a Navy test site. Participate in measurements to demonstrate the effectiveness of the system.

PHASE III: Under contract with the cognizant Navy organization, build production auxiliary jamming suppression processors for retrofit into existing radars.

COMMERCIAL POTENTIAL: The algorithms and processing techniques developed during Phase I and II will have applications to interference mitigation in non-military radar and communication systems.

REFERENCES:

1. J.E. Dennis and R.B. Schnabel, Numerical Methods for Unconstrained Optimization and Nonlinear Equations, Prentice-Hall, 1983.
2. R.O. Schmidt, A Signal Subspace Approach to Multiple Emitter Location and Spectral Estimation, Ph.D Dissertation, Stanford University, Stanford, CA., November 1981.
3. H.L. Van Trees, Detection, Estimation, and Modulation Theory Part I, John Wiley & Sons, New York, 1968.
4. U. Nickel, Monopulse Estimation with Subarray output Adaptive Beamforming and Low Sidelobe Sum and Difference Beams, 1996 IEEE International Symposium on Phased Array Systems and Technology, Boston, MA, 15-18 October 1996.
5. Tim J. Nohara et al, Adaptive Mainbeam Jamming Suppression For Multi-Function Radars, IEEE National Radar Conference, Dallas, TX, 12-13 May, 1998.
6. Roy N. Adams, Adaptive Main-Beam Nulling For Narrow-Beam Antenna Arrays, IEEE Transactions on Aerospace and Electronic Systems, Vol. AES-16, pp.509-516, July 1980.
7. V. Gregers-Hansen, Low Sidelobe Antennas and Adaptive Nulling Against Stand-Off Jamming (SOJ), AOC Radar / EW Conference, Applied Physics Laboratory, Johns Hopkins University, 12 February 1997.

KEYWORDS: Phased arrays; main-beam jamming; adaptive nulling; sidelobe cancellation; monopulse; clutter returns

N01-096 TITLE: New Non-Cooperative Target Recognition (NCTR) Techniques Development

TECHNOLOGY AREAS: Information Systems, Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT I: AEGIS Combat System (PMS400B)

OBJECTIVE: To develop and demonstrate an advanced system that can support NCTR algorithm development and testing.

DESCRIPTION: Techniques for NCTR of aircraft include the exploitation of jet engine modulation, inverse synthetic aperture radar imaging, and High Range Resolution (HRR) profile imaging. High Range Resolution (HRR) imaging together with the use of sophisticated recognition algorithms can be used to achieve a level of target recognition/discrimination. The development of such algorithms, and the HRR requirements to achieve stated level of discrimination in given environments, are at an early stage of maturity. HRR waveforms and processing algorithms as well as the recognition algorithms must be refined. Validation of these techniques under controlled conditions requires the application of computerized tools.

PHASE I: Develop an advanced framework for the simulation tools necessary to achieve the required support for NCTR algorithm development and testing, using a wide range of radar parameters and radar HRR waveforms. Identify and assess the size of the effort and the required investment.

PHASE II: Develop and assemble the prototype system, demonstrate their operation and validate their capability toward the stated NCTR application.

PHASE III: Develop a robust innovative NCTR development station into Navy and other DOD component programs concerned with this application. Validate system under critical threat and environmental conditions.

COMMERCIAL POTENTIAL: Support NCTR algorithm development activities throughout the Navy community in the TBMD, Ship Self Defense, and Ship Area Defense arenas. Could also support similar activities within the DOD's Air Force, Army, and BMDO components. Application to future FAA programs is also possible.

KEYWORDS: radar systems; Target Recognition; target discrimination; high range resolution; algorithms; signal processing

N01-097 TITLE: Electrostatic Discharge Analysis of Reactive Material Formulations

TECHNOLOGY AREAS: Information Systems, Materials/Processes, Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: Standard Missile; PMS 422

OBJECTIVE: Develop an affordable and improved method to accurately and reproducibly determine the electrostatic discharge (ESD) sensitivity of static sensitive reactive and energetic materials.

DESCRIPTION: Electrostatic discharge sensitivity is a common, critical test in the development of energetic materials. The various testers in use show common trends, but the data is not transferable. Reactive materials don't have standard C, H, N, O ingredients and products, so an ESD test apparatus, along with an associated detection system (i.e. gas analysis, spectrophotometer, etc.) needs to be developed. Generally, reactive material formulations are metal-metal, metal-metal hydrides or metal-metal oxide combinations. They include thermites, intermetallics, metal/halogenated compounds and ultrafine powders.

PHASE I: The initial effort will develop innovative concepts for a new and improved ESD tester.

PHASE II: Develop a prototype tester and run preliminary experiments (on materials approved by the Navy) to validate hypothesis and provide accuracy and consistency of measurements. The prototype tester will be delivered to the Navy.

PHASE III: Produce production hardware for commercial and government use.

COMMERCIAL POTENTIAL: Will provide ESD sensitivity data for any activity concerned with metal powders, as well as energetic materials.

REFERENCES:

1. P. Goguen, T. Krawietz, T. Piatt and P. Stevens, "Utilization of Gas Analysis to Determine ESD Go/No-go Endpoints, presented at the JOCG Explosives and Propellants Subgroup, 20-21 Sep 1999.
2. Operating Manual for Model 150 ESD Sensitivity Tester, Hercules Aerospace Company, Allegany Ballistic Laboratory, Rocket Center, WV.
3. MIL-STD-1751A, 20 August 1982. Method 1031.

KEYWORDS: Electrostatic discharge; test methods; reactive materials; characterization; sensitivity; safety

N01-098 TITLE: <u>A Navigation Agent (NavAgent) Tool for Shipboard Navigation & Weapons Systems Integration</u>

TECHNOLOGY AREAS: Information Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT I: AEGIS Combat System (PMS400B)

OBJECTIVE: Develop a innovative navigation agent tool that will greatly simplify the task of designing and deploying navigation information data interfaces for new shipboard navigation & weapons systems and significantly reduce the cost of deploying and integrating new systems.

DESCRIPTION: The needs for Navigation Information (NavInfo) in shipboard environments continue to evolve and grow. As different systems are brought into service or are integrated with others, they must be able to receive and post any desired NavInfo.

Today, NavInfo integration is a complex task that requires systems engineers to understand and adapt to the intricacies of another system vendor's implementation of proprietary and non-proprietary interface standards. A system design must either adapt to existing data interfacing standards and structures or succeed in getting development done by the other system's development team. The data interfacing standards are often rigid enough that unnecessary bandwidth and real-time processing are wasted on parsing for desired information. Additional software development to support these integration efforts increases the costs and duration of systems integration. The problem is further compounded when systems from multiple nations are integrated as is the case with foreign military sales (FMS) of the AEGIS Weapons Systems (AWS).

What is needed is an innovative navigation agent software tool, integrated within a standards based information management platform, that would simplify the task of NavInfo integration within ship-board navigation and weapons systems networks and that would significantly reduce the cost of managing these systems.
The tool would allow the definition of Navigation Agents (NavAgents) that would adapt the information needs of a new system into an existing infrastructure. The NavAgents could be defined either by a system itself or by an administrator through a network management console. This allows maximum flexibility while not necessarily requiring that the new system support NavAgents directly. Each NavAgent could be defined for selective processing and mixing of the any NavInfo being integrated.

The NavAgent on the network management console would serve as a very powerful tool for solving interfacing problems during installation and integration as well for normal ship's maintenance. The activities of NavAgents could be trapped to a file for later analysis or playback. This allows the interfacing problems to be easily isolated, diagnosed, and resolved.

PHASE I: Design the software architecture for a shipboard NavAgent utilizing NavInfo requirements of various military and commercial navigation systems and their relationships with existing military and commercial navigation information data standards.

PHASE II: Build and demonstrate in a laboratory environment a prototype NavAgent management tool. The tool should allow the definition of NavAgents that would adapt the information needs of a new system into an existing infrastructure. A system must adapt to existing data interfacing standards and structures.

PHASE III: The contractor will work with the Navy to test in a shipboard environment a full-scale NavAgent management tool that supports the Navy's Navigation Sensor Systems Interface (NAVSSI), NMEA0183, and NMEA2000 interfacing protocols. The results of testing will be used to transition the NavAgent management tool into a full-fledged re-useable component that can be inserted into various Navy programs of record.

COMMERCIAL POTENTIAL: The end product of this effort would be a low-cost, software-based navigation information integration tool that will work with existing standards based navigation products to greatly reduce the cost and complexity of integrating and managing shipboard navigation information networks.

REFERENCES:
1. Standard for Interfacing Marine Electronics Devices (NMEA 0183), Version 2.30, National Marine Electronics Association, www.nmea.org/products.htm, New Bern NC, March 1998.
2. The Network Standard for Interfacing Marine Electronics Devices (NMEA 2000), BETA Version, National Marine Electronics Association, www.nmea.org/products.htm, New Bern NC, January 2000.
3. W. Stallings, SNMP, SNMPv2, and CMP - The Practical Guide to Network-Management Standards, Addison-Wesley, Reading MA, 1993
4. B. Douglass, Doing Hard Time: Developing Real-Time Systems with UML, Objects, Frameworks and Patterns, Addison-Wesley (1999)
5. Navigation Sensor Systems Interface (NAVSSI) Website, http://navssi.nosc.mil/navssi.html.

KEYWORDS: Navigation; flexible integration; shipboard networks; integrated systems; information management

N01-099 TITLE: Utilization of Atmospheric Refractivity Information to Improve Radar Operation in Littoral Environments

TECHNOLOGY AREAS: Information Systems, Sensors

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: AEGIS Combat System (PMS400B)

OBJECTIVE: To develop innovative system to utilize the knowledge of atmospheric refractivity conditions to enhance the operational effectiveness of Navy radars, and to demonstrate these enhancements via analysis and/or simulation

DESCRIPTION: Significant work has been performed during the past few years, to obtain accurate assessments of the atmospheric refractivity in real time in order to support radar operation. Relatively little effort has been expended on developing a innovative to improve radar operation, e.g., to optimize waveform selection. This SBIR topic calls for identifying the various aspects of radar operation that could be optimized using such information, and quantifying the improved performance using simulations. A mix of littoral and open ocean scenarios should be included. The refractivity conditions should include standard propagation, evaporation ducts, and surface ducts.

PHASE I: Identify the various aspects of radar operation that could be improved using the knowledge of refractivity information, e.g., doctrine, waveform, STC selection, and processing techniques. Develop system concept to utilize such knowledge, coupled with information about the surrounding terrain, to optimize radar operation, and demonstrate the feasibility thereof via analysis and computer simulation.

PHASE II: Demonstrate the effectiveness of these techniques via a combination of I/Q data from extant Navy radar and simulation techniques.

PHASE III: Integrate this system enhancement into Navy candidate radars that operate in refractive environments.

COMMERCIAL POTENTIAL: Improved radar operations across many programs, commercial and military, by optimizing their performance based on available knowledge of the environment. This should not require expensive upgrades to any of the existing radar system and would, therefore, be applicable to many systems.

REFERENCES:
1. "Radio Wave Propagation" by Lucien Boithias published by McGraw Hill 1987 ISBN 0-07-006433-4.
2. "Propagation of Short Radio Waves'" Donald Kerr editor. Dover Publications 1965. Library of Congress Catalog No. 65-22731.

3. "Fundamentals of Atmospheric Physics (International Geophysics Series, Vol 61" by Murry L. Sabby. Academic Press. May 1996 ISBN 0126151601.
4. "Atmospheric Science: An Introductory Survey" by John M. Wallace. Academic Press March 1977 ISBN 0127329501.
5. Proceedings of the 1996 Battlespace Atmospherics Conference 3-5 December 1996, Technical Document 2938 Dec 1996, Naval Command, Control and Ocean Surveillance Center RDT&E Division. (There are a number of good papers here.)
6. Proceedings of the Electromagnetic/Electro-Optics Prediction Requirements & Products Symposium 3-5 June 1997 Held at the Naval Postgraduate School Monterey, CA. DoD and DoD contractors only.
7. Ku-Band Propagation Measurements in the Low Altitude Region, Janet Stapleton, Steve Kang, W. Thornton, October 1995, NSWCDD/TR-95/66, This was submitted to DTIC but DoD and DoD contractors only.
8. Wideband Low Elevation Microwave Propagation Measurements, James L. Queen, Janet Stapleton, Steve Kang, NSWCDD/TR-95/18 Feb 1995, Submitted to DTIC and Unlimited Dist.

KEYWORDS: Radar systems; refractivity; littoral environment; ducting; propagation; waveform selection

N01-100 TITLE: Mission Planning for Tactical Shipboard EW Systems

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace, Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT II: PMS 473 Adv. Integrated Electronic Warfare

OBJECTIVE: Develop a methodology for the utilization of information from mission objectives and a wide variety of platform, sensor and intelligence databases to effectively adapt tactical shipboard sensor resources to a dynamically changing tactical environment and to increase the time available to develop appropriate responses to changes in the tactical environment.

DESCRIPTION: Existing systems currently do not adapt to dynamically changing conditions. Sources, locations and parameters may change faster than operational centers , can provide updates to affected systems. Users need the ability to analyze the various databases, and visualize information from organic and non-organic sources. Utilizing this information, operators should be able to generate system resource management doctrine, that will best utilize system resources thus improving the operators overall situational awareness and increasing the time available for developing responses.

PHASE I: Identify methods to allow the user to visualize the anticipated environment. Identify tools that allow the user to adapt reference databases to the anticipated environment. Identify tools to develop and test resource management doctrine. Define innovative hardware and software elements, development and operational software environments and identify a real-time application with which to demonstrate the architecture.

PHASE II: Demonstrate a new integrated architecture composed of a state-of-the-art processor configuration which makes maximum use of off-the-shelf components, open system architecture, relies on commercial industry standard communication media and physical connections, and drastically reduces the number of unique components. This effort should show that the existing defense computing system components could be upgraded and/or changed without extensive application code development.

PHASE III: Full development and production for application to specific tactical shipboard Electronic Warfare Systems.

COMMERCIAL POTENTIAL: Commercial applications for situation awareness visualization techniques, integrated database analysis tools and tools that allow the user to develop rules to optimize system resource include: 1) FAA Air traffic control - Sensor Mapping, Weather Mapping, AIR Traffic Routing with re-routing rules.

2) Cellular telephone and Pager Systems - Tower Site Coverage Mapping with Interference and outage re-routing rules
3) Commercial Satellite - Coverage, Interference control with bandwidth utilization rules
4) Internet - Site mapping, Message routing and re-routing rules.

In each of the above applications, geographic mapping displays integrated with a database with interactive database query mechanisms with innovative data visualization techniques allow the commercial user to plan for and respond to very dynamic situations.

KEYWORDS: Database visualization; rule based resource management; COTS; real time computing systems; signal processing

N01-101 TITLE: Maintenance Skills Training Through Distributed Learning Principles

TECHNOLOGY AREAS: Human Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: NAVSEA O4L

OBJECTIVE: To design test and field a distributed learning system that supports the development of core and advanced technical skills through web enabled interactive mentoring and technology infused curricula providing physical stimulation of the senses currently provided by stand up technical instruction. This development effort must leverage the usage of associated government technology based curricula development software programs, while undertaking the task of creating integrated data management software. The implementation of the developed software must serve as a collaborative tool for legacy and newly procured technical training.

DESCRIPTION: Maintenance and technical skills training is required to build individual proficiency within the US Navy battle groups as well as many of the independent operating units. Force reduction initiatives and budget constraints have caused the Department of the Navy to decommission several of the surface ships maintenance tenders. The results of that decision resulted in transferring the responsibility of developing the required technical skill within the battle group to the large deck ship and battle force commanders. The qualified technical talent required to keep our forces operational while deployed is developed through technical training at Naval Training Centers (NTC), Fleet Training Activities (FTA) and through onboard training in large deck ships. Further reductions in the in force levels and budget constraints will require developing innovative approaches to accomplishing comparable technical and skills training employing distributed learning methodologies. Presently the instructor provides the mentoring necessary for acquiring the proper techniques to enable success in job performance. Training aides, actual equipment and graphics support the learning process when combined with effective instruction. Once initial training is completed, there is no effective program to support maintaining skills proficiency nor the mentor protege, and on-the-job training, for other shipboard maintenance personnel. The needed training must capture the intuitive instructional techniques that are associated with proficient instructors at the various trades and skills. The program developed must address knowledge capture and presentation functionality that will promote stimulation of the senses as well as methods instruction to support the touch and feel characteristics of instructor led curricula. The intent of this development is to promote using and adapting current training syllabus, as well as extending the virtual training site to access other materials existing in other government and commercial activities. The software and programs developed must be capable of storing information in shareable units to be available for multiple applications such as skills and technical training, technical study, maintenance, test and checkout, operation, and supply systems interface. The system must be capable of delivering multimedia materials at the point of training and at the point of maintenance. The training system must be able to gain access web enabled materials for use in maintenance skills training in the classroom and onboard deployed ships.

PHASE I: Develop a systems design document that describes the technologies and methods intended to be employed in developing the learning and data storage system. The design must describe the data flow, storage hierarchy, software and hardware technical descriptions including functional diagrams depicting final configuration and performance expectations. Produce a system architecture document must be produced that delineates internal and external operability requirements. Data management shall be described in a separate document and be submitted at completion of Phase I.

PHASE II: Develop and fabricate a prototype system using actual skills training courseware that fully demonstrates system functionality and provides a systematic evaluation process to compare formalized standup training with the virtual classroom supported by real time instructor accessibility via web enabled interactive informational exchange. The real time instructor functionality shall be available for problem solving and diagnostics support. When completed a fully functional data management system must serve as a standardized shareable data repository and a platform that enables distance support technical solutions for shipboard equipment and maintenance personnel.

PHASE III: Demonstrate full producibility of a technically accurate, standardized and dynamic technical information management system for NAVSEA cognizant systems and equipment. The technical database shall supports skills training and interfaces with various training systems that are either web accessible or available through unclassified DoD data systems that may be managed as proprietary or restricted to use by DoD personnel only. Produce and distribute as data specification that will be applicable as procurement guidance for ship acquisition managers for logistic and technical data development by equipment manufacturers and suppliers.

COMMERCIAL POTENTIAL: The commercial derivative of this system will support a more cost effective methodology and logistic support system for equipment and machinery repair. This system will provide real time assistance to those maintenance personnel that frequently find themselves deployed in the field away from supporting system engineers or in remote locations where travel costs are excessive and time is critical.

REFERENCES:

1. NAVSEA Instruction 3502, Management Procedures And Policy For The Shop Qualification Improvement Program, Reserve Shop Qualification Improvement Program And Onboard Maintenance Training Program
2. Advanced Distributed Learning Shareable Courseware Object Reference Model (SCORM), Version 1.0 January 31, 2000

KEYWORDS: Certification; Collaborative; Data Management; Database; Distributed; Job Performance Aiding; Maintenance; Network; Training

N01-102 TITLE: Risk-Based Maintenance Strategies to Reduce Total Ownership Costs

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT I: PMS 317 LPD-17 Amphibious Transport Dock S

OBJECTIVE: Develop a practical methodology and procedure for implementing risk in the decision-making process for structural maintenance & repair.

DESCRIPTION: Risk & Reliability-based methods are playing an increasing role in structural design as well as maintenance and inspection strategies. Traditional ship inspection is time-based and involves various degrees of inspections being performed at prescribed intervals of time. These inspections range from simple visual surveys to dry-docking. With limited life-cycle budgets, many of these types of time-based inspections are not feasible and often result in inspections being skipped or, in the case of Navy ships that are ABS-classed, ships taken out of class.

PHASE I: Develop a risk-based decision tree framework that takes into account the critical function of structural components, the consequence of their failure, and the accessibility of structural details for inspection.

PHASE II: Expand the risk-based framework developed and accepted in Phase I to incorporate strategies existing in current commercial standards. Provide both qualitative and quantitative risk-based structural inspection procedures that includes probability of failure estimates for the structural components and throughout the hull combined with a consequence ranking for the components and members.

PHASE III: Demonstrate the application of risk-based maintenance strategy on a newly constructed commercial vessel and the LPD 17 hull. Collect, compile and compare data produced from conduct of scheduled inspections with data produced under the risk-based framework.

COMMERCIAL POTENTIAL: Application to commercial processes is extremely likely, since many of the classification societies already employ risk-based maintenance strategies. This method, however, is primarily applied to machinery & equipment and is not mature for application to ship structure.

REFERENCES:

1. Det Norske Veritas Rules for Steel Vessels
2. ABS Rules for Building & Classing Steel Vessels.
3. NORSOK standard for maintenance, inspection & structural design philosophy: http://www.nts.no/norsok

KEYWORDS: Inspection; Service Life; Life-Cycle Costs; Maintenance; Risk; Structural Repair

N01-103 TITLE: Ultra Wideband Active Acoustic Conformal Array Module

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: SEA 93 ASTO; PMS425 SQQ-10; PMS450; PMS500; PMS415

OBJECTIVE: Develop an ultra wideband (10 Khz - 85 Khz) conformal array module for use on submarines.

DESCRIPTION: This effort will design, develop, and characterize an ultra wideband conformal array module intended for primary use aboard submarines with applicability to surface ships and autonomous underwater vehicles. Modules are expected to be thin (< 5" and less is desirable) panels of modular subarray configuration capable of being built or expanded into modules ranging from 25 elements to 400 elements with the goal of including transducer elements, T/R switching circuitry, power amplifiers, and receive preamplifiers within a self-contained module. The array module concept should have the versatility to permit specific array configurations ranging from planar to conformal (complex curvature of greater than 3' radius for submarine application to up to approximately 21" for other applications) and aperture designs focused on complex steering requirements. Alternative innovative concepts with novel array configurations, separate but coincident projectors and hydrophones (with a receive band nominally 1 Khz - 120 Khz), or integral transducers/amplifiers are encouraged. The desired power output of each transducer element is dependent upon the array concept but may involve a large array of low powered transducers or a compact array with a radiated power density of at least 11 watts/cm2 over the frequency band; the array needs to be steerable electrically to 45 degrees from broadside at the highest frequency without detrimental grading lobes forming. The array configuration and module architecture shall have the design flexibility to permit a variety of planar and complex curve conformal array shapes. The array module must be able to withstand submarine depths and potential explosive shock conditions and be sufficiently rugged to permit flush mounting without the need for separate sonar windows. Transducer element designs shall utilize high energy density drive materials and innovative transduction mechanisms affording the maximum electroacoustic power transfer efficiency between the input power supply and radiated acoustic power.

Existing planar arrays operate over bandwidths smaller than the 10 to 85 kHz envisioned, and cannot be used to detect certain features that are of interest or to perform certain required functions.

PHASE I: Detail the total array concept including transducer design, array configuration and structural details, and outboard electronics design. Conduct preliminary design of the transducers and modules. Design feasibility and trade-off studies will be undertaken to quantify the individual and system risks. The performance of the notional system will be quantified and a detailed analytical or numerical model formulated and exercised to demonstrate the ability to meet the intended goals. During Phase I a production cost goal will also be formulated.

PHASE II: Construct multiple array modules for testing and characterization. During this phase, the reliability and other performance characteristics will be demonstrated, and an estimate of production cost leading to the agreed upon cost goal will be provided.

PHASE III: Further development and evaluation of a prototype conformal array using the developed modules.

COMMERCIAL POTENTIAL: This technology hasa diverse variety of commercial applications ranging from underwater mapping arrays for the oceanographic industry to medical ultrasonic imaging systems. The integration of transducers and power electronics can be exploited in the area of smart actuators and controls.

REFERENCES:

1. Wilson, O.B., Introduction to Theory and Design of Sonar Transducers, Peninsula Publishing, Los Altos, CA, 1988
2. Stansfield, D., Underwater Electroacoustic Transducers, Bath University Press, Bath, UK, 1991
3. Butler, J.L., Underwater Sound Transducers and Arrays, Image Acoustics, Cohasset, MA, 1983
4. J.F. Lindberg, "The Application of High Energy Density Transducer Materials to Smart Systems", Mat. Res. Soc. Symp. Proc. Vol. 459, 509-519 (1997)
5. S.C. Butler, J.F. Lindberg, and A.E. Clark, "Hybrid Magnetostrictive/Piezoelectric Tonpilz Transducer", Ferroelectrics 187, 163-174 (1996)
6. S.C. Thompson, M.P. Johnson, E.A. McLaughlin, and J.F. Lindberg, "Performance and recent developments with doubly resonant wideband transducers", Chap. 21 in Transducers for Sonics and Ultrasonics, ed. by M.D. McCollum, B.F. Hamonic, and O.B. Wilson (Lancaster, PA, Technomic, 1993)

KEYWORDS: Acoustic Sensors; High Frequency Sonar; Conformal Array Modules; Advanced Broadband Transduction; Ultra Wideband Arrays; Submarine Sonar

N01-104 TITLE: Underwater Velocity Indicator

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT I: PEO-SUB, Virginia Class (PMS450), SEAWOLF

OBJECTIVE: Develop and demonstrate a compact saltwater velocity indicator system, which can be calibrated and mounted easily on a submersible platform. The device will be able to measure either 1) total velocity (U) and angle of attack and drift, or 2) total velocity (U) decomposed into longitudinal (u), span wise (v) and vertical (w) velocity components. The measurement method may be based on micro-impulse, MEMS, hot film, fiber optic, acoustic and other technologies.

DESCRIPTION: Accurate and reliable free stream velocity (speed and direction) data is critical for submersible operations and correlations with related model testing and computer predictions. Such a critical measurement must be made with many demanding constraints in an ocean environment: 1) environmental effects (deep submergence, temperature and salinity changes, biofouling, corrosion), 2) interference from ship's own electronics, 3) signature detectability of structure-borne or data measurement noise, 4) compact size for easy calibration, servicing and mounting. In addition to these design considerations, a velocity measurement device must also deliver a) speed accuracy and resolution better than 0.1 kn, b) angle of attack and drift accuracy and resolution of 0.25 deg or better, c) 8 Hz real time or near real time sampling rates, and d) operability in steady and unsteady maneuvers from 0 to 40 kn.

PHASE I: Demonstrate technical feasibility and proof of concept of the velocimetry device. Phase I testing must demonstrate accuracy and repeatability of the device up to 10 kn in water and the potential for miniaturization and protection against environmental, noise signature, and electronic interference effects.

PHASE II: Further evaluate accuracy, resolution, and signal drift to 40 kn in water and deliver a compact, well packaged, user friendly system which is resistant against environmental, signature, and electronic interference effects. Data collection and analysis software must be included. A prototype must be delivered to the Navy for full-scale evaluations.

PHASE III: Develop commercial production and distribution capabilities with industrial or other Government agencies.

COMMERCIAL POTENTIAL: Such a velocity indicator can be used on commercial pleasure craft or in industrial facilities requiring cost effective flow measurement data.

References:
1. Method and Instrumentation System for Measuring Airspeed and Flow Angle - US Patent # US5299455 (4/5/1994). Tao Systems, Williamsburg, VA
2. A MEMS-Based 5 Sensor Probe, R. Allen, L. Traub, E.S. Johansen, O.K. Rediniotis, T. Tsao, AIAA paper-2000-0252, 38th AIAA Aerospace Sciences Meeting and Exhibit, 10-13 January 2000, Reno, NV

KEYWORDS: Velocity, angle of attack, wide band, acoustic, MEMS, fiber optic, micro-impulse

N01-105 TITLE: All Optical Towed Array Position Measurement System

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT I: VIRGINIA Class SSN

OBJECTIVE: Design and develop an all-optical multiline towed array position measurement system (PMS).

DESCRIPTION: The U.S. Navy is developing optical towed array technology to reduce costs, increase reliability and improve performance. The focus of this SBIR topic is the design and development of an all-optical based approach to sensing and computing an estimate of the full three dimensional shape of a multiline towed array (MLTA) sensor. These high gain multiline arrays will have significantly more acoustic sensing channels than existing towed sensors. In order to obtain the full performance associated with MLTAs, the beamformer must be corrected for any array motion or geometric distortion resulting from dynamics associated with towing the sensor. Specifically, the distortion within each individual line must be estimated as well as the location of each line relative to some pre-defined spatial reference. Existing position measurement systems utilize electrical power that is converted to acoustic or magnetic emissions which, in turn, are detected by dedicated receive channels. The received PMS signals are processed to obtain a full three dimensional spatial estimate of the towed system. Optical based towed array systems have the potential of providing significant cost reductions and are viewed as an enabling technology for future large MLTA systems. Typical accuracy requirements for position measurement systems are one fourteenth of a wavelength at the highest frequency of interest. Additionally, the optical position measurement system must be compatible with existing towed array handlers and future handler concepts.

PHASE I: Design an all-optical position measurement system suitable for use with a multiline towed array. The system design should clearly describe the theory of operation of the proposed system implementation. Additionally, a simple proof of concept demonstration for any high risk or critical system component(s) is highly desirable.

PHASE II: FABRICATE a prototype optical towed array position measurement system BASED ON THE PHASE I DESIGN. This prototype towed system shall be suitable for static testing and evaluation as well as dynamic tow testing. Additionally system compatibility with towed array handlers shall be demonstrated.

PHASE III: The focus of the Phase 3 effort will be the transition of the prototype all optical towed array position measurement to a production array and subsequent testing on a submarine.

COMMERCIAL POTENTIAL: This all-optical approach to position measurement has application in the seismic oil exploration industry. Additionally this all-optical approach to position measurement would have applicability to any problem where knowledge of the shape of a flexible hose is of importance.

KEYWORDS: optics, towed arrays, position measurement, accuracy, beamforming, handling systems

N01-106 TITLE: Propulsion Shaft Interrogation

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT II: Strategic & Attack Submarines, PMS392

OBJECTIVE: Determine feasibility of using advanced innovative technology to carry out shipboard interrogation/testing of propulsion shafts on Navy submarines without removing the shaft. Defects to be detected include shaft wall thinning from general corrosion or pitting, and debonding of the protective fiberglass wrap.

DESCRIPTION: The US Navy has a goal of reducing maintenance and support costs by implementing condition based maintenance. A condition based maintenance approach allows maintenance to take place as needed based on the condition of the system or part. This is in contrast to time based maintenance that is scheduled at fixed discrete time intervals regardless of the condition of the system or part. Navy surface ship and submarine propulsion shafts are currently on a time based maintenance schedule at a cost of several hundred thousand dollars per event. After the costly removal is performed in the shipyard, many shafts, during post removal inspections are found to be adequate for continued service. Incorporating a condition based maintenance approach offers the potential for longer service life and total ownership cost reductions. To implement this idea, an accurate capability to determine the condition and remaining lifetime of propulsion shafts without dry-docking the ship and removing the shaft is needed. Access to the majority of the length of shafts is limited because they extend through several confined spaces. In addition, a large percentage of the shaft is covered with a FRP wrap, preventing direct access to its surface. Damage can occur at any point along the entire length of the shaft, and a low cost, rapid technique is needed that can quickly assess the entire length of the shaft without requiring its removal or dry-docking the ship. A non-invasive method and process will have the ability to bring lower total ownership costs for Naval Ships Shaft maintenance programs in this type of scenario.

PHASE I: Develop innovative low costs techniques to detect corrosion, predict life time of a propulsion shaft without removing the shaft from the ship. A laboratory scale level test system should be utilized to demonstrate the feasibility of the test methods developed. A design concept for a full-scale system that will operate shipboard should be developed.

Phase II: Develop a prototype system and demonstrate the prototype on-board a submarine. The prototype should be easy to operate with minimal training, and sufficiently rugged to meet the rigors of use aboard Navy vessels.

PHASE III: Address any conceptual or design issues raised by the Phase II prototype demonstration, develop the product and conduct testing as required to transition the system to the fleet.

COMMERCIAL POTENTIAL: The techniques and processes developed could be widely sold to evaluate commercial ships shafts of cruise ships, oil tankers, and cargo ships. Also testing of insulated components in wide area piping systems in industrial centers, petrochemical plants, various types of shafts in any various types of machinery used on oil rigs and commercial ships. In addition, evaluations of buried pipes can be accomplished.

REFERENCES:
1. Percival, W.J. and Birt, E.A., "Study of Lamb Wave Propagation in Carbon Fibre," Insight, 39, 10, 1997, 728-735.

KEYWORDS: Propulsion shafts, corrosion, delamination, materials, testing

N01-107 TITLE: Concentric Stock Dynamometers for Measuring Flap Loads on Flapped Appendages

TECHNOLOGY AREAS: Ground/Sea Vehicles

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: ACAT I:PEO-SUB, VIRGINIA Class Acquisition(PMS450)

OBJECTIVE: Develop and demonstrate a small scale dynamometer design capable of measuring the flap loads on a roughly 1/20 the scale NSSN submarine model. The design should be capable of surviving the large transient loads encountered during handling. The design should also have a minimum lifetime of 5 years.

DESCRIPTION: As part of the Hydrodynamics experimental program at NSWCCD, appendage loads are measured on all test models. To date, no hardware has been located that will allow the measurement of these loads on each independent flap in a concentric shaft arrangement such as is currently employed by the NSSN. The design should be capable of measuring loads as large as 200 pounds and 200 inch pounds with deflections of no more than 0.1 degree and 1/16 inches. The dynamometer design should be capable of surviving loads as high as 200% of the designed measurement maximum without damage. The design must be water proofed to a minimum of 30 feet. The flaps are roughly 4 inches long and 4 inches wide and have a maximum thickness at the shaft attachment of 0.7 inches. The flaps are internally ganged together inside the model so that the outer flaps (Port and Starboard) and the inner flaps (Port and Starboard) move together. The support for the planes can be obtained by installing bearings from the control shafts to the fixed portion of the stern planes. Currently, single flap loads are measured using a dynamometer with strain gages. A new methodology or technology may be required to meet the space, load and waterproofing constraints. The reference below requires a security clearance in order to obtain and read it. A temporary clearance can be obtained by contacting the Naval Surface Warfare Center, Carderock Division Security Office.

PHASE I: Develop a theoretical mechanical design and provide mechanical strength analysis to demonstrate conformance of the new methodology or technology used with the above load, bending and twisting specifications.

PHASE II: Provide implemented hardware for the NSWCCD NSSN submarine model for the testing of concept.

PHASE III: Demonstrate the ability to produce and develop an implementation plan to provide at least 4 concentric stock dynamometers for use on model experiments at NSWCCD.

COMMERCIAL POTENTIAL: This dynamometer design could be used in cases where the loads on concentric stock situations such as aircraft control surfaces and contra rotating propellers.

REFERENCES:

1. Chang, Ming-Shun (1998). "The Prediction of Forces and Moments Acting on an Appended Body of Revolution Performing Arbitrary Maneuvers (U)," CRDKNSWC-HD-1003-10. Carderock Division NWSC, Bethesda, MD. CONFIDENTIAL

KEYWORDS: Concentric Stock; Dynamometers; Loads; Strain Gage; Structural Loads; Flap Loads