NAVY
PROPOSAL SUBMISSION

INTRODUCTION:

The responsibility for the implementation, administration and management of the Navy STTR program is with the Office of Naval Research (ONR). The Navy STTR Program Manager is Mr. John Williams, (703) 696-0342, williajr@onr.navy.mil. If you have questions of a specific nature, contact Mr. Williams. For general inquiries or problems with the electronic submission, contact the DoD Help Desk at 1-866-724-7457 (8AM to 5PM EST). For technical questions about a topic, contact the Topic Authors listed under each topic only available on the website at **http://www.onr.navy.mil/sbir** under "Solicitation" before **03 March 2003.** Beginning 3 March, you must use the SITIS system listed in section 1.5c at the front of the solicitation or go to the DoD website at **http://www.acq.osd.mil/sadbu/sbir** for more information.

PHASE I PROPOSAL SUBMISSION:

Read the DoD front section of this solicitation for detailed instructions on proposal format and program requirements. When you prepare your proposal, keep in mind that Phase I should address the feasibility of a solution to the topic. The Navy only accepts Phase I proposals with a base effort not exceeding $70,000 and with the option not exceeding $30,000. The technical period of performance for the Phase I should be 6 months to commence on or about 01 July 2003. The Phase I option should be 3 months and address the transition into the Phase II effort. Phase I options are typically only funded after the decision to fund the Phase II has been made. 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. The Navy typically provides a firm fixed price contract or awards a small purchase agreement as a Phase I award.

NEW REQUIREMENT: ALL PROPOSAL SUBMISSIONS TO THE NAVY STTR PROGRAM MUST BE SUBMITTED ELECTRONICALLY

It is mandatory that the **entire** technical proposal, DoD Proposal Cover Sheet, Cost Proposal, and the Company Commercialization Report are submitted electronically through the DoD SBIR/STTR website at http://www.dodsbir.net/submission**.** This site will lead you through the process for submitting your technical proposal and all of the sections electronically. Each of these documents are submitted separately through the website. If you have any questions or problems with the electronic submission contact the DoD SBIR Helpdesk at 1-866-724-7457 (8AM to 5PM EST). Your proposal must be submitted via the submission site on or before the **5:00 p.m. EST, 16 April 2003 deadline. A hardcopy will NOT be required**. A signature by hand or electronically is not required when you submit your proposal over the Internet.

Online Submission: All technical proposal files must be in Portable Document Format (PDF) for evaluation purposes. The Technical Proposal should include all graphics and attachments, but not include Cover Sheets or Cost Proposal as they are submitted separately. Technical Proposals should conform to the limitations on margins and number of pages specified in the front section of this DoD Solicitation. However, your Cost Proposal will only count as one page and your Cover Sheets will only count as two, no matter how they print out. Most proposals will be printed out on black and white printers so make sure all graphics are distinguishable in black and white. It is strongly encouraged that you perform a virus check on each submission. To verify that your technical proposal has been received, click on the "Check Upload" icon to view your uploaded technical proposal. Typically, your proposal will be uploaded within the hour. However, if your proposal does not appear after an hour, please contact the DoD Help Desk. It is recommended that you submit early, as computer traffic gets heavy nearer the solicitation closing and slows down the system.

Within one week of the Solicitation closing, you will receive notification via e-mail that your proposal has been received and processed for evaluation by the Navy.

PHASE I ELECTRONIC SUMMARY REPORT:

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. The Phase I Summary Report is a non-proprietary summary of Phase I results. It should not exceed 700 words and should include potential applications and benefits. 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".

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 a Research Institution or subcontractor 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 funding that a firm has received based on technology developed from a Navy SBIR or STTR Phase II award. The success stories should be 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 and the strategy described to commercialize the technology discussed in the proposal. The Navy is very interested in companies that transition SBIR/STTR efforts directly into Navy and DoD programs and/or weapon systems. If a firm has never received a Navy SBIR/STTR Phase II it will not count against them.

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. Your Phase II Proposal must be submitted within 180 days of the Phase I award start date. Any Fast Track applications or proposals not meeting these dates will be declined. All Fast Track applications and required information must be submitted online through the DoD Submission website **http://www.dodsbir.net/submission**, and mailed to the Navy STTR Program Manager at the address listed on the Navy SBIR/STTR website under POCs and to the designated Contracting Officer's Technical Monitor (the Technical Point of Contact (TPOC)) for the contract. The information required by the Navy, is the same as the information required under the DoD Fast Track described in the front part of this solicitation.

PHASE II PROPOSAL SUBMISSION:

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 the proper point of contact, during or at the end of a successful Phase I effort will be eligible to participate for a Phase II award. 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/STTR website. 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). The Navy typically provides a cost plus fixed fee contract as a Phase II award. The type of award is at the discretion of the contracting officer.

Upon receiving an invitation, submission of a Phase II proposal should consist of three elements: 1) A base effort, which is the demonstration phase of the SBIR/STTR project; 2) A 2 to 5 page Transition/Marketing plan describing how, to whom and at what stage you will market and transition your technology to the government, government prime contractor, and/or private sector; and 3) At least one Phase II Option which would be a fully costed and well defined section describing a test and evaluation plan or further R&D. Phase II efforts are typically two (2) years and Phase II options are typically an additional six (6) months. Phase II proposals together with the Phase II Option are limited to 40 pages (unless otherwise directed by the TPOC or contract officer). All Phase II proposals must have a complete electronic submission. Complete electronic submission includes the submission of the Cover Sheets, Cost Proposal, Company Commercialization Report, the **ENTIRE** technical proposal and any appendices via the DoD Submission site. The DoD proposal submission site **http://www.dodsbir.net/submission** will lead you through the process for submitting your technical proposal and all of the sections electronically. Each of these documents are submitted separately through the website. Your proposal must be submitted via the submission site on or before the specified deadline. The Navy Activity that invited your PH II may also require a hardcopy of your proposal.

All Phase II award winners must attend a one-day Commercialization Assistance Program (CAP) meeting typically held in the July to August time frame in the Washington D.C. area during the second year of the Phase II effort. If you receive a Phase II award, you will be contacted with more information regarding this program or you can visit **http://www.navysbir.com/cap.**

As with the Phase I award, Phase II award winners must electronically submit a Phase II summary report through the Navy SBIR website at the end of their Phase II. The Phase II Summary Report is a non-proprietary summary of Phase II results. It should not exceed 700 words and should include potential applications and benefit. It should require minimal work from the contractor because most of this information is required in the final report.

The Navy has adopted a New Phase II Enhancement Plan to encourage transition of Navy STTR 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 STTR funds for $1,000,000 match of acquisition program funding, 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.

PHASE I PROPOSAL SUBMISSION CHECKLIST:

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

____1. Your complete STTR PH I proposal (coversheet, technical proposal, cost proposal, and DoD Company Commercialization Report) has been submitted electronically through the DoD submission site by 5:00 p.m. EST 16 April 2003.

____2. 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 cost proposal, and in the work plan section of the proposal.

NAVY 2003 STTR TOPICS

N03-T001	Advanced Materials for Rapid Manufacturing
N03-T002	Development of High Transition Temperature Shape Memory Alloy
N03-T003	Sensors and Methods to Handle UAV
N03-T004	Optimizing Human Resource Management Models
N03-T005	Haptic Rendering of Virtual Stimuli for Fully Immersive Virtual Reality Training Systems
N03-T006	High Efficiency Fuel Cell Systems for Shipboard Applications
N03-T007	Power Dense and Thermally Tolerant Passive Components for Power Electronics Filtering Applications
N03-T008	Information Centric Security
N03-T009	Mobile Collaboration in Multi-Security Level Domains
N03-T010	Intrusion Monitoring, Detection and Reporting
N03-T011	Physics-based Modeling of Acoustic Reverberation in the Littoral Environment
N03-T012	ASW Systems with Large Numbers of Advanced Autonomous Distributed Sensors
N03-T013	Innovative Vehicle Camouflage
N03-T014	Expeditionary Ammunition Packaging and Handling
N03-T015	LCAC Cargo Restraint Griping System
N03-T016	Self Contained Actuation Systems
N03-T017	Acoustic registration of seafloor features and objects
N03-T018	Advanced EO sensor for multi-mission USN/USMC UAVs
N03-T019	Advanced Anti-Jam GPS Antenna Design Concepts
N03-T020	Silicon-Based Visible/Near-Infrared Affordable Missile Warning
N03-T021	High Linearity, High-Power, Quadrature Balanced Amplifiers for Active Transmit Arrays
N03-T022	Advanced Thermal Management Technologies
N03-T023	Fast Detection of Electrical Faults in Shipboard Electrical Power Distribution Systems
N03-T024	Flow Control and Vibration Isolation for Integrated Motor Propulsor
N03-T025	Plasma-Based Oxygen Generator for Undersea Vehicle Fuel Cells
N03-T026	Multidisciplinary Optimization of Naval Ship Design and Mission Effectiveness

NAVY 2003 STTR TOPIC DESCRIPTIONS

N03-T001 TITLE: Advanced Materials for Rapid Manufacturing

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Identify, develop, and characterize materials systems (metals, ceramics, composites, and associated binders) appropriate for rapid manufacturing by utilizing dimensional three dimensional (3-D) printing technology or a similar process. Demonstrate feasibility of these materials for application and production of Navy and DoD weapon systems components.

DESCRIPTION: Material systems are sought for three-dimensional printing rapid prototyping and manufacturing. Primary interests are metals, ceramics, and composite materials appropriate for weapon systems components and directed toward the identification and pursuit of opportunities that exploit the inherent capabilities of 3-D printing rapid prototyping and manufacturing processes that are currently on the market or under development.

3-D printing provides a direct response to the DoD's critical need to quickly and economically provide spare parts for aging legacy weapons systems through a seamless procurement mechanism of just-in-time components of varied product families and specialized tooling. In addition, benefits realized for new or existing DoD weapon system designs as well as maintenance logistics are significant reduction of costs associated with extended development cycles of prototyping, reduction of time for testing and building of new parts and prototypes, and a fast response for critical spares directly from either CAD drawings or digitized artifacts.

PHASE I: Investigate potential 3-D printing material systems and identify the appropriate standards/equivalencies (ASTM, NIST, MIL, etc.) for evaluating these materials in accordance with previously identified weapon systems applications and requirements. Perform comprehensive materials testing/evaluation strategy studies, involving the use of subscale process elements, representative of full-scale operational equipment, intended for the fabrication by 3-D printing rapid manufacturing. Phase I activity could include (among other activities): (1) 3-D printing material selection (to include metals, composites, and associated binders), (2) performance evaluation criteria, (3) material performance data correlated to weapon system design and performance requirements.

PHASE II: Demonstrate rapid material qualification on weapon system components. Characterize and analyze material samples in accordance with specifications outlined in Phase I. Phase II demonstrations should include: (1) identification and qualification of materials and material suppliers, (2) test configuration and applicable standards for evaluation, (3) test component fabrication using 3-D printing and (4) material inspection, analysis, and qualification. The strategy and demonstration should be an iterative process based on statistical experimental design that will result in the greatest amount of information in the shortest amount of time.

PHASE III: Deliver 3DP components applicable for commercial and military use.

REFERENCES:

1. Government-Industry Data Exchange Program Home Page. http://www.gidep.org/

2. T. Glum, "DoD DMS Initiatives: Support for the Warfighter," (Paper presented at the 1997 DMSMS Conference, San Antonio, Texas, August 1997), http://smaplab.ri.uah.edu/dmsms2k/presentations/glum.pdf

3. L. W. Stoll and R. P. Ernst, "Naval Aviations Challenge: Maintaining Yesterday's Fleet," (Paper presented at the 1997 DMSMS Conference, San Antonio, Texas, August 1997), http://smaplab.ri.uah.edu/dmsms2k/presentations/stoll.pdf

4. Solid Freeform Fabrication Symposium Series, (Editors: David L. Bourell, Joseph J. Beaman, Richard Crawford, Harris L. Marcus, and Joel W. Barlow), The University of Texas at Austin, Austin, Texas, 1990-2002.

5. John DeGaspari, "New materials and process improvements are stretching the boundaries of prototyping techniques." Mechanical Engineering, March 2002. http://www.memagazine.org/backissues/mar02/features/rapidev/rapidev.html

KEYWORDS: Rapid Manufacturing; Rapid Prototyping; Solid Freeform Fabrication; Computer-Aided Design (CAD); Electronic Based Manufacturing; Materials Processing; Machine Design;

N03-T002 TITLE: Development of High Transition Temperature Shape Memory Alloy

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMA 275, PMA 263 and PEO (W)

OBJECTIVE: To explore and develop a high transition temperature shape memory alloy material to enable compact, powerful and reliable solid state actuator system for naval aircraft applications.

DESCRIPTION: The use of technologically advanced materials for electric actuation as was directed by OSD in Vision 21, is an important strategic advantage in a combat offensive maneuver. Shape-memory alloys (SMA's) have emerged as a material with unique thermal and mechanical properties that have potential to be used in many naval electric actuation applications. For one example, the aerodynamics of the V-22 Ospray rotor vary in the transition from the hover mode to the cruise mode. It is thought that the shape-memory behavior of a SMA could be utilized to reconfigure the shape of the blade during flight, thus maximizing aerodynamic efficiency for each flight mode. Similarly, weapons systems and other aircraft platforms including UAV may also benefit from incorporating the use of solid state actuation for control systems and adaptive structures. It is anticipated that this new and affordable material technology will have a significant payoff to Naval aviation in terms of vehicle reliability, weight and volume.

To improve performance envelope and increase capabilities of the naval aircraft, the U.S. Navy is interested in developing and characterizing a high transition temperature SMA for various actuation applications at elevated temperatures. Currently, the austenite final temperatures for the commercially available SMAs such as binary NiTinol are limited to about 100C. In addition, the transition temperatures of the SMAs are very sensitive to the compositions and the post processing conditions. The exploratory high temperature SMAs of interest should possess a predictable, reliable and high temperature capable shape memory behaviors. For survival in the naval service environment, the transition temperatures for the martensite final and the austenite final need to be ate lest 70C and 100C, respectively. Other properties of interest include the thermal and mechanical fatigue under service loading and a corrosive environment. These materials should enable the air-component engineers to select new and innovative methods to optimize design criteria, and to tailor these designs based on the exploratory material characteristics.

The Navy will only fund proposals that are innovative address R&D and involve technical risk.

PHASE I: Provide an initial development effort that demonstrates scientific merit and capabilities of the proposed alloying compositions and manufacturing processes for making the high transition temperature shape-memory materials. Laboratory scale specimens should be fabricated and characterized thermally and mechanically.

PHASE II: Fabricate and characterize prototype tubular and flat forms (in tubular form, up to 18 inches in length, 2-3 inches outside diameter, and 0.25 inch in tube thickness. In this phase, the fabricated specimens in tubular and flat forms should be actuated using a controlled heating device to insure rapid and uniform heating. Specific properties of interest include both the martensite final and the austenite final temperatures, induced force at the austenite final temperature, and the thermal-fatigue behaviors under representative service loading (40,000 actuation cycles) and a corrosive environment. It is anticipated the material also needs to have good creep resistance (less that 0.5% of working strain during the life).

PHASE III: Produce high temperature SMA for use in fabricating solid state actuator systems, and coordinate with air vehicle OEMs.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Successful development of the high transition temperature SMA should enable the design engineers to select new and innovative methods to optimize design criteria, and to tailor these designs based on the exploratory material characteristics. Presently, there is a strong need to develop high temperature SMA actuators for uses in various air, land and sea based vehicles. These exploratory material systems, compatible with scaleable manufacturing process, will enable the high temperature applications in the actuator systems for both commercial as well as military aircraft, and can help transition to any other activity needing compact actuation.

REFERENCES:

1. D. Golberg, et al, "Improvement of a Ti50Pd30Ni20 High Temperature Shape Memory Alloy by Thermomechanical Treatments" Scripta Metallurgica et Materialia, Vol.30, No.10, pp.1349-1354 (1994)

KEYWORDS: Shape Memory Alloy; High Transition Temperature; Compositions; Thermal and Mechanical Properties; Actuator; Naval Aircraft

N03-T003 TITLE: Sensors and Methods to Handle UAV

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: Autonomous Operations FNC

OBJECTIVE: Explore sensors and algorithms that would enable an unmanned aircraft to be handled on the carrier flight deck while minimizing impact to current processes. Technologies should focus on automatic capture of human signals, obstacle avoidance and path planning.

DESCRIPTION: An issue associated with replacing manned vehicles with unmanned vehicles is how to enable a smooth transition and acceptance into the fleet. There may be a long period of time while unmanned vehicles are operated side-by-side with legacy, manned vehicles. One way to deal with this issue is to try to minimize the impact to current policies and processes, alleviating the need for added workload or training burden.

An example is the carrier flight deck. How would an unmanned air vehicle (UAV) taxi around on the deck, when they share the deck with manned vehicles? (Assume the UAV would be similar in size to a conventional aircraft.) Current practice is for directors (or “yellow shirts”) to control taxiing aircraft through a series of signals to the pilot. The director assumes the responsibility for obstacle avoidance and path planning. The pilot is dependent upon the director’s signals (e.g. come forward, move left, move right, brake, etc.) in order to avoid taxiing over the deck edge or driving into another aircraft. An automated system that seeks to minimize changes to the way the director currently performs his/her job would need to reliably capture the director’s signals in a form that could be translated as control inputs to the UAV. It would also need to sense and avoid obstacles which are numerous, stationary and moving, 3-D (other aircraft, equipment, personnel, deck structures) and 2-D (foul line markings, deck edges). Path planning would be required for both the individual aircraft (obstacle avoidance) and high-level traffic management to ensure safety.

This topic is interested in sensors and/or algorithm solutions for any or all aspects of this problem: automatic signal capture, obstacle avoidance, and dynamic path planning as it applies to the carrier environment.

The challenges to any solution lie in the carrier operations and environment. The flight deck is dynamic. Multiple aircraft can be moving at any one time and can be handled by multiple directors, who may be standing next to other. One aircraft will see a number of directors along the taxiing path. The aircraft must maintain a lock on the right director and recognize when a director "hands off" (or transfers authority) to the next director. Other people and support equipment are moving as well. There are approx. 50 aircraft on the flight deck; each aircraft is identified by a side number. Sensors must operate in the presence of electromagnetic interference, salt spray, catapult steam, hot engine exhaust, in all weather, and in all lighting conditions (day/night/dusk/bright sun). Deck clutter is considerable. The director could be between 5 and 200 feet from the aircraft, at a position 0 to +/- 90 deg from the nose of the aircraft, and could be rotated relative to the aircraft. There are 16 possible signals that would apply to a UAV. Although these signals are standardized, they could vary widely according to personal technique.

The Navy will only consider proposals that are innovative, address R&D, and involve technical risk.

PHASE I: Develop one or more concepts. Prove, either through analysis and/or demonstration, the feasibility of the concept(s).

PHASE II: Develop a system and demonstrate aboard a carrier or at a shore airfield.

PHASE III: Further development or production would occur within the Autonomous Operations FNC and be transitioned to the UCAV-N program.

PRIVATE SECTOR USE OF TECHNOLOGY: Technologies developed under this topic could be transitioned to other robotics applications in harsh or dynamic environments. These applications could include nuclear reactor maintenance, nuclear waste handling, air traffic control, construction (autonomous heavy machinery operation), emergency management (finding survivors in wreckages).

REFERENCES:

1. CV NATOPS Manual, NAVAIR 00-80T-105

2. Aircraft Signals NATOPS Manual, NAVAIR 00-80T-113

3. Aviation Deck Familiarization Website, http://cvnlhd.interactiv-lee.com/

4. Future Naval Capabilities Website http://www.onr.navy.mil/fncs/

5. Other material may be posted on the SBIR/STTR Interactive Topic Information System (SITIS), http://dtica.dtic.mil/sbir/

KEYWORDS: Sensors; Field Robotics; Obstacle Avoidance; Path Planning

N03-T004 TITLE: Optimizing Human Resource Management Models

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: Capable Manpower FNC

OBJECTIVE: Develop new technology to solve the integer-programming problem. Would advance current methods for solving difficult optimization problems associated with human resource planning models.

DESCRIPTION: Integer programming techniques like "branch and bound" and "branch and cut" can solve some large mixed integer programs. Unfortunately, the programs that can be solved in a relatively short period of time, say 24 hours or less, are either of modest size or are characterized by a sparse matrix of cost coefficients. Techniques for efficient solutions to general large mixed integer programs have not yet been discovered. One area that has yet to be fully explored is the selection of good rules for choosing the direction to be explored in hunting for a solution to these problems. In the terminology of integer programming this is referred to as "branching." Currently, algorithms use purely arbitrary rules for resolving the question of which branch to explore. This research will investigate alternative rules for branching and determine circumstances under which those rules lead to more efficient solution procedures.

The Navy will only consider proposals that are innovative, address R&D, and involve technical risk.

PHASE I: Perform a feasibility analysis of the proposed methodology including a pilot demonstrating computational improvement on sample test problems.

PHASE II: Develop a full prototype of proposed methodology, including a comprehensive assessment of the results and their computational impact on models illustrating real human resources problems from the military.

PHASE III: Transition the prototype system into the CNO's "Sea Warrior" initiative (part of Sea Power 21). This includes transition to web-based marketplace for Sailors and jobs and the human resources community. End user is N13, Plans and Policy.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The types of models addressed here for improved solution capability are commonly found in the private sector (large corporations) as well as in the military. This includes: inventory management, airline scheduling, internet/intranet management, network routing, telecommunications, and anything that maximizes product profitability. If the problem of integer programming is solved, enormous commercialization could result and the advances coming out of this work will be of tremendous value to the private sector.

REFERENCES:

1. Integrating Target Analysis and Tabu Search for Improved Scheduling Systems M. Laguna and F. Glover, Expert Systems with Applications, vol. 6, pp. 287-297 (1993).

2. Target Analysis to Improve a Tabu Search Method for Machine Scheduling F. Glover and M. Laguna, The Arabian Journal for Science and Engineering, vol. 16, no. 2B, pp. 239-253 (1991).

3. Tabu Search F. Glover and M. Laguna, Kluwer Academic Publishers, Boston, Hardbound, ISBN 0-7923-9965-X, 408 pp., July 1997.

4. Future Naval Capabilities Website http://www.onr.navy.mil/fncs/

5. Naval Transformation Roadmap at http://nardic.onr.navy.mil/pubs.htm#N

KEYWORDS: human resource planning models; manpower planning; integer programming; branch-and-bound algorithms; Tabu search; target analysis.

N03-T005 TITLE: <u>Haptic Rendering of Virtual Stimuli for Fully Immersive Virtual Reality Training Systems</u>

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: Capable Manpower FNC, Virtual Technology and Environments (VIRTE) Component

OBJECTIVE: To develop a fully wearable, haptic interface for immersive Virtual Reality (VR) training systems that complements the information presented through the visual, Head Mounted Display (HMD), interface and does not significantly encumber or impede the wearer.

DESCRIPTION: VR technology is fast becoming the training tool of choice [1]. Nowhere is the need for the flexibility and reconfigurability offered by these systems more pronounced than in the area of military training [2]. Yet, within this highly applied domain, there are many different categories of training requirements that must be met. Some, such as mission rehearsal systems for vehicles [3] can be easily supported by existing technology. Others, like Close Quarters Battle (CQB) training for dismounted infantry, which involves a significant level of physical interactions with virtually rendered objects [4], are currently limited by the degree to which these non-visual stimuli can be represented. Specifically, the ability to fully exploit VR systems for training individuals or teams moving through an immersive VR is limited by the ability to render haptic stimuli.

Haptic information is a form of sensory stimulation that is acquired through collisions with objects [5,6]. Most VR training simulations essentially ignore the haptic domain, relying instead on the visual domain and to a lesser extent, the auditory one, to provide trainees with the range of information typically encountered in the real world. This approach has been favored in part due to limitations of current technology. Haptic interfaces must render any number of a wide range of sensations (e.g. force, vibration, texture etc) while minimizing restrictions on movement, a synergy of requirements that has yet to be achieved. Currently, haptic interfaces are extremely bulky, have significant latencies, and fail to capture the range of frequencies/amplitudes typically encountered in real world settings.

Yet, haptic cues play a critical role in supporting fully immersive VR systems: during a single training exercise, trainees may repeatedly contact walls, furniture and other objects as well as each other. Additionally, given the un-naturally narrow field-of-view HMD displays currently available, haptic information is even more essential for making the user aware of where, when and what kind of contact is made with virtual objects outside of their limited field-of-view. In the real world, these collisions provide trainees with critical information that ultimately supports their mental model of the environment; in the virtual one, which lacks these cues, the mental model is consequently much poorer. When supported, training systems in which the haptic information is coupled with visual information show great promise [7]. When absent, the lack of multiple-modality information, adversely affects the degree to which the VR training enhances real world performance [2,3,8,9]. Thus, there is great training potential for developing a method for providing this information during immersive VR training.

The system must provide haptic information in a manner that is both sensorally meaningful and in synchrony with other virtually represented information modalities. The device must minimally encumber the wearer, who will already be required to wear an HMD and other devices. It must fit comfortably on a range of body sizes and be quick and easy to put on and to take off. It should also be mechanically robust, operating over a range of environmental conditions (temperature, humidity, excessive use) and should not require overly-burdensome power supplies. The system should provide a flexible application programming interface for device control.

PHASE I: Study a conceptual architecture and framework for haptically rendering virtual stimuli and perform experimental research to demonstrate the feasibility of adding this modality to other ones already supported by VR technology and provide end-design for the system.

PHASE II: Development and testing of the Phase 1 system, leading to a capability demonstration based on Measures of Performance developed and validated in the Phase I effort. Integration with a VR-based training system, supporting a field evaluation and focusing on training enhancement and system usability will provide the basis for demonstrating level of technology maturity and training efficacy.

PHASE III: Based on the Phase II results develop a haptic rendering system that can be fully integrated with Navy-sponsored Virtual Reality training systems, such as those being developed by the Virtual Technologies and Environments (VIRTE) effort, which is part of the ONR sponsored Capable manpower Future Naval Capability (FNC).

PRIVATE SECTOR USE OF TECHNOLOGY: A fully wearable haptic display system is applicable to other military applications (flight simulators, other CQB-like training systems), as well as to the gaming and entertainment industry. Furthermore, recent studies indicate that loss of situational awareness in both aviation and maritime environments may be combated through the introduction of haptic orienting cues such as those provided through the proposed system [10,11]. Finally, a modified version of this system could prove useful in assisting patients with Sensory neuropathies and Vestibular disorders maintain postural balance.

REFERENCES:

1. Cohn, J.V. & Patrey, J. (2001). Virtual Environments as a multi-modal "real world" laboratory for training. 45th Annual Human Factors and Ergonomics Society Conference, MN.

2. Cohn, J.V., Burns, J., Helmick, J., & Meyers, C. (2000). Training-Transfer Guidelines for Virtual Environments (VE). Presented at 22nd Annual Interservice/Industry Training, Simulation and Education Conference, Orlando Fl.

3. Cohn, J.V (2001). Virtual Environment Landing Craft Air Cushioned. Presented at 21st Fleet Support Conference, Little Creek, VA.

4. Templeman, J. N., P. S. Denbrook, and L. E. Sibert (1999) Virtual Locomotion: walking in place through virtual environments. Presence. 8(6):598-617.

5. Caldwell, D.G. (2000). Integrated haptic feedback. Haptics in Virtual Environments Workshop 2., IEEE Virtual Reality 2000, New Brunswick, NJ. p 7-16.

6. Durlach, N.I. and Mavor, A.S. (Eds.). (1995). Virtual reality - scientific & technological challenges. Washington, DC: National Academy Press.

7. Merril, G. (2000). Haptics in medical simulation. Haptics in Virtual Environments Workshop 2., IEEE Virtual Reality 2000, New Brunswick, NJ. p 149-164.

8. Birch, H.G. & Bitterman, M.E. (1949). Reinforcement and learning: the process of sensory integration. Psychological Review, 56:292-308.

9. Paivio, A. (1991). Dual coding theory: retrospect and current status. Canadian Journal of Psychology, 45(3):255-287.

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11. Rupert AH (ab), McTrusty TJ (c), Peak J (c). (2000). Haptic Interface Enhancements for Navy Divers. (a) NASA Johnson Space Center, Houston TX 77058, (b) Naval Aerospace Medical Research Laboratory, Pensacola FL 32508, (c) Coastal systems Station, Panama City FL 32407

KEYWORDS: Haptic; Close Quarters Battle; Virtual Reality; Training; Visual; Tactile Feedback

N03-T006 TITLE: <u>High Efficiency Fuel Cell Systems for Shipboard Applications</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: FNC: Electric Ships and Combat Vehicles and DD(X)

OBJECTIVE: Develop innovative concepts and technologies to achieve high efficiency fuel cell systems for US Navy shipboard power generation.

DESCRIPTION: The military needs compact and highly efficient fuel cell systems capable of operating on logistic fuels such as NATO F76, JP8, and diesel fuels, to enable the use of fuel cell technology for shipboard power generation. Future shipboard design and battlefield operations will require electric power generation that is silent, highly efficient, has low thermal signature, meets anticipated future environmental standards, and is scalable up to multi-megawatt levels. Preliminary ship impact assessments have quantified the benefits of applying state-of-the-art fuel cell systems in shipboard power generation. Cost benefits are derived first from high efficiency followed closely by high power density. Emerging high temperature fuel cell and fuel reforming technologies have shown potential to achieve these goals. However, complexities and size of the fuel reforming and sulfur removal processes limits this potential as the systems are scaled up to meet the required power levels. In order to achieve the desired capability, simplified and scalable fuel processing, sulfur removal and fuel cell technologies are sought to provide the required power density. The following technologies are desired: (1) Scalable and simplified logistics fuel processor systems for use with high temperature fuel cells; (2) Enhanced performance and sulfur tolerance in direct oxidation SOFC fuel cell systems; (3) Sulfur removal processes which can remove sulfur from logistic fuel without detrimental impact on fuel properties of flashpoint and storage stability, to ultra low sulfur diesel levels; (4) Processes to dispose of sulfur/sulfones in an environmentally safe manner into seawater. All proposals must be innovative, address R&D and involve technical risk.

PHASE I: Demonstrate the viability of the proposed technology with logistic fuels at the laboratory bench scale. Perform engineering studies for the following: (a) For fuel cell technology, perform preliminary engineering studies to show how the proposed technology would scale to multi-megawatt power levels; (b) For sulfur removal and disposal technology, perform preliminary engineering studies to show how the proposed technology would operate and scale with flow rates up to 500 BBLs per day of Navy logistics fuel.

PHASE II: Design, build, and demonstrate the proposed technology in an overall scalable system. The sizing will be dependent on the technology proposed. For fuel cell technology, operate an integrated fuel cell system at a size of at least 2 KW. For sulfur removal technology, operate at a level sufficient to demonstrate the feasibility and scalability of the process. The final system evaluation report should include any recommendations addressing noted deficiencies to further improve performance.

PHASE III: Productize fuel cell system or logistic and diesel fuel sulfur removal system for use on Navy Shipboard Fuel Cell component of the All Electric Warship and Combat Vehicle FNC for use in power generation.

COMMERCIAL POTENTIAL: The technology should be applicable over a wide range of power applications. Independent market studies, sponsored by the Navy and USCG, have indicated a viable marine fuel cell market for propulsion and ship service applications. In addition, this technology is applicable to future markets for fuel cell power sources in distributed power generation, remote stations, APU's, and heavy vehicle transportation applications. Sulfur removal technology is applicable to meet future fuel standards for ultra low sulfur diesel planned to be implemented in 2006.

REFERENCES:
1. FuelCell Energy (2000), "Final Report Market Evaluation for a 625kW Power Module", NSWCCD Contract No. N65540-99-M-0390.
2. http://www.onr.navy.mil/fncs/

KEYWORDS: fuel cells, fuel processing, reformer, sulfur, hydrogen

N03-T007 TITLE: Power Dense and Thermally Tolerant Passive Components for Power Electronics Filtering Applications

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: Electric Ships and Combat Vehicles FNC and DD(X) Program

OBJECTIVE: Develop innovative concepts and technologies to reduce the size and weight of shipboard and hybrid electric vehicle power electronics.

DESCRIPTION: The military is increasingly reliant on electricity to operate new weapons and sensors, and to propel hybrid electric vehicles and ships. Military systems incorporate solid state power electronics to perform functions such as AC to DC or DC to AC power conversion. Current generation power electronics are larger, heavier, more expensive, and less efficient than desired. As semiconductor switching devices become smaller, a greater proportion of the total size, weight, and cost of power electronics systems is attributable to "passive" components such as capacitors and inductors. Little research has been done in recent years to improve these components. Further, with the predicted shift to wide band gap semiconductors, the allowable operating temperature of power electronics devices is expected to increase, at which point the passive components will become the limiting factor in thermal design. Smaller, lighter, more efficient, and more thermally tolerant capacitors and inductors will enable a significant overall improvement in future power electronics' systems, enabling new military capabilities. Goals for capacitors and inductors include 70% reduction in volume and weight, losses reduced to <1%, and the capability to operate at temperatures in excess of 200°C.

The Navy will only consider proposals that are innovative, address R&D, and involve technical risk.

PHASE I: Demonstrate the viability of the proposed technology at the laboratory bench scale. Perform engineering studies to show the potential benefit for a chosen military application such as a rectifier, inverter, or motor controller.

PHASE II: Design, build, and demonstrate a prototype of the proposed component technology at full scale. If possible, integrate into a power electronics system to show size and weight benefits at the system level. Develop manufacturing techniques and cost estimates to show viability for transition to production.

PHASE III: Bring the component technology to market for use by military power electronics vendors.

COMMERCIAL POTENTIAL: The technology should be applicable over a wide range of military and commercial power applications, both for industrial and shipboard power conversion and for hybrid electric vehicles.

REFERENCES:

1. W. J. Sarjeant, I. W. Clelland and R. A. Price, "Capacitive Components for Power Electronics," Proceedings of the IEEE, 89, 6, June 2001.

2. Future Naval Capabilities Website http://www.onr.navy.mil/fncs/

KEYWORDS: capacitors, inductors, power electronics, filtering, thermal

N03-T008 TITLE: Information Centric Security

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: FNC SPONSOR: Knowledge Superiority and Assurance

OBJECTIVE: Develop an information centric security prototype for demonstration in representative operational environments and prepare for NIAP and FIPS-140 certification for commercialization.

DESCRIPTION: There are known serious vulnerabilities in providing information protection based on aggregating large volumes of information in broad enclaves using LANs and COTS workstations. The use of COMSEC concepts, techniques and devices can be effective for transport between end nodes. Within the end point nodes, information remains vulnerable to exploitation by appropriately cleared personnel conducting espionage (inside threat). Historically, our most serious losses have come from the inside. The Office of Naval Research (ONR) has previously sponsored research into the protection of information (INFOCENSEC). This research has shown promise and was found to be effective in a JBC demonstration in Millennium Challenge '00. The underlining technology has matured considerably since Millennium Challenge '00 and is now ready for a prototype that could be demonstrated in a representative operational environment. ONR desires to revisit this area of research, and develop a prototype with the objective of facilitating technology transition. Proposals must be innovative, address R&D and involve technical risk.

PHASE I: Review previous government sponsored research. Perform original research to extend the concepts previously considered, and propose a working model of an information centric security prototype. Investigate a combination client and server version based on ANSI Standard X9.69.

PHASE II: Develop a prototype that would achieve role based access control of information resident on a LAN within a protected environment that demonstrates data separability within the automated information system. Collect data concerning the performance and scalability of the prototype for sensitive but unclassified data. Investigate the feasibility of moving the prototype model into firmware.

PHASE III: Collect data concerning the predicted performance of the model in firmware, and prepare documentation that presents the design, concept of operations, and requirements for EAL-4 approval needed to apply for NIAP and FIPs 140 certification. Develop a business plan for its rapid commercialization.

PRIVATE SECTOR USE OF TECHNOLOGY: This approach to the protection of information is directly applicable to numerous civil government and industry requirements, e.g. medical information privacy (HIPPA), banking and financial records, crisis response by first responders, coalition operations (military and civil).

REFERENCES:

1. http://www.onr.navy.mil/fncs/

2. http://niap.nist.gov

3. http://www.iatf.net

4. Highly Trusted Security Model for Workstations, SBIR contract N00039-93-C-0227

KEYWORDS: ANSI Standard X9.69; internet security; information security; access control; insider threat.

N03-T009 TITLE: Mobile Collaboration in Multi-Security Level Domains

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: FNC Knowledge Superiority and Assurance

OBJECTIVE: Develop multi-security level collaboration technology for mobile, low bandwidth military users with intermittent connectivity

DESCRIPTION: Collaboration applications within the Fleet include situation awareness, cooperative planning (including joint and coalition operations), mission execution, and targeting and weapon assignment. Commercial collaboration software does not work well in an environment of low bandwidth (2.4 kilobit per second), discontinuities for significant periods of time (interruptions as often as every 20 minutes, lasting as much as 5 minutes for an interruption) and across multiple security domains (different levels of security classification). Currently the Navy uses industry standard collaboration tools such as Microsoft NetMeeting and IRC Chat. The issue then becomes making commercial available collaboration tools compatible with the military environment. Proposals must be innovative, address R&D and involve technical risk.

PHASE I: Conceptual collaboration capability resulting in a feasibility study which outlines possible techniques or designs that could be used in a wireless military network to support multi security level users with low bandwidth intermittent connectivity in dynamic planning and battle management. Phase 1 will also include a technical plan that outlines a specific design approach to develop a multi-security level collaboration capability for mobile, low bandwidth military users with intermittent connectivity. The design approach will include: trade-off studies between alternate design approaches, a development plan, and the performance specification. If possible construct a software testbed for evaluation of proposed concepts.

PHASE II: Implementation of Phase I in the building of a breadboard system for demonstrating the operational capability in a Naval environment. Develop a test plan and procedure for conducting operational testing and experimentation. Perform experiments and collect data to verify performance against operational requirements and validate compatiblity with Navy operating systems. Publish results in a system test and evaluation report and include, as part of the report, a technical plan to build a prototype system. Include within the technical plan, system specifications that include any recommendations that address noted deficiencies to further improve performance and capability.

PHASE III: Build a prototype system as defined in the Phase II STTR technical plan for testing in an operational scenario. Data will be collected to verify system compatibility and performance and will be included in a final system report. Phase III also includes the delivery of a technical plan that outlines the approach to deliver product development software to Naval Acquisition Programs. The approach will include; expected enhancement to an Enabling Capability within the Knowledge Superiority and Assurance FNC, the conditions that established the baseline, and the measurable changes anticipated at the end of the effort – as defined by current vs. improved capability. Transition capability as defined in the Test Plan into the Information Assurance Spike of the Knowledge Superiority and Assurance FNC.

PRIVATE SECTOR USE OF TECHNOLOGY: Wireless collaboration, emergency response, homeland security

REFERENCES:

1. Center for Naval Analyses is producing a report on collaboration in the naval environment http://www.cna.org

2. http://onr.navy.mil/sci_tech/futurenaval.htm

KEYWORDS: Groupware; Virtual environments; synchronous and asynchronous planning; non-colocated wireless collaboration, multi-security level; intelligent agents

N03-T010 TITLE: <u>Intrusion Monitoring, Detection and Reporting</u>

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: FNC Knowledge Superiority and Assurance

OBJECTIVE: Develop technology to monitor and detect unauthorized intrusion into Navy information systems and the techniques to predict and isolate the impact of these activities on a system.

DESCRIPTION: Changes in technology have made Navy information operations increasingly dependent on secure information systems to the point where it is possible to disrupt or degrade operations by interfering with these systems and the data they contain. The threat meanwhile grows more sophisticated and comes from both internal and external sources. Work is needed to develop real and non real-time tools and non interfering techniques to detect information attacks on military networks, systems, applications and databases and to provide restoration of services to preserve data and operational integrity. Few commercial products are available for non-interfering intrusion monitoring and detection and none focus on the quality of end-user information. There are two problems in this task that need to be solved. The first consists of analyzing and identifying properties that make Navy information systems vulnerable and then construct a model to (1) assess vulnerability against mission execution and determine levels of acceptable information performance degradation and, (2) measure the effectiveness of techniques to monitor and detect internal and external attacks from friendly to hostile operating environments. The second problem is to design, develop and prototype a general framework for detecting and reporting of attacks so as to be an aid for resource allocation (to curtail the propagation effects of degraded or manipulated data) and recovery (to mitigate its overall damage to decision making). Proposals must be innovative, address R&D and require technical risk.

PHASE I: Conceptual system resulting in a feasibility study which outlines currently available or new techniques, capabilities, or designs that could be use to detect unauthorized intrusion into military information systems and databases. This feasibility study will include an analysis that identifies properties that make Navy information systems vulnerable and develop a model to (1) assess vulnerability against mission execution and determine levels of acceptable information performance degradation and, (2) measure the effectiveness of techniques or design to monitor and detect internal and external attacks from friendly to hostile operating environments. Phase 1 will also include the delivery of a technical plan that outlines a specific design approach to develop a general framework for detecting and reporting of attacks so as to be an aid for resource allocation (to curtail the propagation effects of degraded or manipulated data) and recovery (to mitigate its overall damage to decision making). The design approach will include; trade-off study between alternate design approaches including the degree that the intrusion monitoring system is a "stand alone application or tool" and is not optimized for a single operating system but works with multiple operating systems, a development plan, and the performance specification.

PHASE II: Implementation of Phase I in the building of a breadboard intrusion detection system for demonstrating the operational capability in a Naval environment. Develop a test plan and procedure for conducting operational testing and experimentation including issues of scalability since not all systems are equal in size or complexity. Perform experiments and collect data to verify performance against operational requirements and validate technology for transition. Publish results in a system test and evaluation report and include, as part of the report, a technical plan to build a prototype system. Include within the technical plan, system specifications that include any recommendations that address noted deficiencies to further improve performance and capability.

PHASE III: Build a prototype intrusion detection system as defined in the Phase II STTR technical plan and specification for testing in an operational scenario. Data will be collected to verify performance and will be included in a final system report. Phase III also includes the delivery of a technical plan that outlines the approach to deliver product development software to Naval Acquisition Programs. The approach will include; expected enhancement to an Enabling Capability within the Knowledge Superiority and Assurance FNC, the conditions that established the baseline, and the measurable changes anticipated at the end of the effort – as defined by current vs. improved capability. Transition capability as defined in the Test Plan into the Information Assurance Spike of the Knowledge Superiority and Assurance FNC.

PRIVATE SECTOR USE OF TECHNOLOGY: An intrusion detection, assessment and recovery capability is applicable to state and local government agencies, financial institutions and commercial information networks. Any organization that uses data storage on a network (in addition to external access there also exist a potential for disgruntled employees to corrupt data sources) can use a capability to protect its privileged information from unauthorized use.

REFERENCES:

1. R. Bace and P. Mell,"Special Publication on Intrusion Detection Systems," Tech. Report SP 800-31, National Institute of Standards and Technology, Gaithersburg, MD., Nov. 2001

2. G. Vigna, R.A. Kemmerer, and P. Blix,"Designing a Web of Highly Configurable Intrusion Detection Sensors," Proc. Fourth Int'l Symp. Recent Advances in Intrusion Detection (RAID 2001), Lecture Notes in Computer Science, vol. 2212, Springer Verlag, New York, 2001, pp. 69-84.

3. Web site - Defense Information Systems Agency http://www.disa.mil/

4. http://onr.navy.mil/sci_tech/futurenaval.htm

KEYWORDS: Internet security; Fraud detection; Database security; Data auditing; Network intrusion detection; Computer vandalism

N03-T011 TITLE: <u>Physics-based Modeling of Acoustic Reverberation in the Littoral Environment</u>

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: Littoral ASW FNC

OBJECTIVE: Develop physics-based models of ocean surface, volume and floor reverberation suitable for developing and evaluating technical improvements in acoustic sensor system technologies, both mono-static and bi-static..

DESCRIPTION: The utility of the insight gained from testing acoustic sources and receivers in currently available virtual test environments is severely hampered by a lack of credible physics-based acoustic reverberation models – especially models that appropriately portray target-like clutter in shallow-water environments. Both backscatter and forward scatter functions are needed over the frequency range 100 to 40,000 Hz.

The Navy will only consider proposals that are innovative, address R&D, and involve technical risk.

PHASE I: Review current models and technical options for developing physics-based reverberation models that hold promise for meeting the objective. Consider drawing on the results of the ONR Geoclutter project. Formulate a development plan of action and milestones, and initiate work on models.

PHASE II: Develop physics-based reverberation models, integrating them with a selected set of current environmental models and comparing the virtual acoustic environment output to a selected set of in-water data. Provide a model evaluation report documenting the results of this effort and delineating the measured improvement in model fidelity.

PHASE III: Integrate reverberation models into selected virtual environments being utilized by Navy underwater acoustic laboratories in the development and evaluation of platform and undersea weapons sonar technologies.

PRIVATE SECTOR USE OF TECHNOLOGY: Underwater communications is relevant to the commercial sector. Improved ability to determine effects of sound on marine wildlife including marine mammals and fish are also feasible as a product of this work.

REFERENCES:

1. Oceanography and Mine Warfare (2000). National Academy Press, Washington, DC.

2. Wave Propagation and Inverse Problems in Ocean Acoustics, Naval Research Laboratory, www.asee.org/summer/html/nrl-8.htm

3. Research & Science, Applied Research Laboratories, The University of Texas at Austin, www.arlut.utexas.edu/researching/

4. Future Naval Capabilities Website http://www.onr.navy.mil/fncs/

KEYWORDS: clutter, modeling and simulation; reverberation, geo-clutter, object-oriented modeling, back scatter, forward scatter; acoustic propagation.

N03-T012 TITLE: ASW Systems with Large Numbers of Advanced Autonomous Distributed Sensors

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: Littoral ASW FNC

OBJECTIVE: To develop and demonstrate innovative hardware and software to enable systems containing large numbers (e.g. 100000 or greater) of short range advanced autonomous, distributed sensors for ASW surveillance, detection and tracking. System requirements include a high probability of detection and low false alarm rate with complete coverage of the undersea volume. Sensor platforms may be fixed or mobile and have the capability to operate autonomously for weeks or months. Issues include fusion of multiple sensors to reduce field false alarm rate, methods of communicating contact information to data consumers, and volume coverage such that short-range systems maintain dispersal within the full volume (includes methods of initial dispersal and methods for maintaining volume coverage). The approach should be based on novel solutions, not integration of off-the-shelf technology.

DESCRIPTION: It is envisaged that future ASW systems may be composed of large numbers of small inexpensive short-range sensors that are either netted together in place or act independently. The systems may use simple single mode sensors such as an acoustic sensor or may use combinations of multiple independent sensor types such as magnetic and acoustic that are floating/drifting buoys (surface or water column) or fixed/bottom/volume sensors. The primary platforms for dispersal will be aircraft (manned or unmanned) or fleets of autonomous underwater vehicles (AUVs). The sensors will be capable of detecting and tracking submarines and surface ships for surveillance and cooperative engagement covering areas of 10000 square kms or larger. A critical issue with systems of very large numbers of independent sensors is how to maintain a reasonable system false alarm rate. The larger the number of individual sensors, the more stringent the required individual sensor false alarm rejection must be if the overall system is not to be overwhelmed by false tracks. This consideration will obviously work against the `large-N' strategy of making the individual sensors simple, cheap and less capable and one needs to find the `sweet spot' where large numbers of simple sensors are still able to provide the needed system functionality. If the overall system is to have acceptable false track performance the false alarm rate will need to be less than one in 10000 on individual sensors or lower depending on the total number of sensors(2). Other critical issues with these concepts include techniques for maintaining volume coverage. Floating and drifting buoys are difficult to cover the volume with and in a mixed layer are unstable unless they are less compressible than seawater(2). Active buoyancy controls are possible but add to the complexity.

Issues of interest include novel sensor concepts, false alarm mitigation, concepts for full volume coverage including techniques for dispersal and techniques for maintaining volume coverage. Innovative concepts for conveying the detection information to information consumers are encouraged.. Proposals based on innovative sensor concepts that help mitigate false alarms for large numbers of sensors will be weighted heavily.

The Navy will only consider proposals that are innovative, address R&D, and involve technical risk.

PHASE I: The proposed concept will be designed and analyzed with particular attention to trade-offs.

PHASE II: Fabrication, testing and evaluation of a prototype will be accomplished. Cost trade-offs in production quantities should be analyzed.

PHASE III: Transition to a funded government or commercial program will be accomplished.

DUAL-USE POTENTIAL: Commercial applications include environmental sensing and sampling and fisheries management. The many industries associated with these activities will benefit, and this technology will likely spawn new industries.

REFERENCES:

1. Future Naval Capabilities Website http://www.onr.navy.mil/fncs/

2. Autonomous Sensors for Underwater Surveillance and ASW (U), J. Goodman, C. Callan, P. Dimotakis, M. Gregg, H. Levine, O. Rothaus, Technical Report JSR-02-205 JASON 2002

3. Intelligence missions of future subs, J. Goodman, S. Drell, M. Gregg, H. Levine, W. Munk, and J. Vesecky, Technical Report JSR-01-225, JASON, 2001.

4. Sensor Management in a Sensor Rich Environment, C. G. Schaefer, Jr. and Kenneth J. Hintz, SPIE AeroSense, Signal Processing, Sensor Fusion, and Target Recognition IX, April 24-28, 2000, Orlando, FL

KEYWORDS: Autonomous; Sensors; Underwater; Littoral; Lightweight; Surveillance; Ultra-Low Power; Acoustic Communications

N03-T013 TITLE: Innovative Vehicle Camouflage

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: FNC- Littoral Combat and Power Projection and the AAAV

OBJECTIVE: The goal for this program is a 20% reduction in the probability of detection of Marine Corps Vehicles and Shelters.

DESCRIPTION: Vehicles with current camouflage patterns can be easily detected and recognized by the human eye at close range or through unsophisticated optics at longer ranges. Recognition can be degraded by use of patterns that disrupt the internal geometry of form called the symmetry axis. Camouflage patterns using digitized pixel technology have demonstrated enhanced survivability of the individual marine up to 30% with respect to previous camouflage patterns. This technology has been incorporated into the Marine Corps field utility uniform but has not been assessed for larger objects to include vehicles. More information on this technology can be found at the Marine Corps Website provided as reference 2 and the technical publications provided by references 3 & 4.

Marine Corps vehicles in garrison are painted with the standard woodland camouflage paint scheme. When a unit deploys to the Middle East, all vehicles are repainted with a desert scheme. This process is reversed when the unit completes a deployment and transitions back to garrison. This painting and repainting process adds weight to the vehicle, which can cause serious problems on a weight sensitive vehicle like the AAAV. Current camouflage netting weighs too much and takes to much room to store. The Marine Corps requires the capability to move from one scheme to another expeditiously without a decrease in survivability or reduction in NBC decontamination capability. Proposals must be innovative, address R&D and involve technical risk.

PHASE I: Develop new and innovative camouflage patterns and application techniques keeping manufacturing issues in mind. Modeling and simulation shall be used to evaluate various vehicle camouflage patterns. Develop a test plan to define how probability of detection will be measured during Phase II. Probability of detection could mean initial detection occurs 20% closer to the platform or is not observed as often as the standard camouflage at a given range. Provide details on how the camouflage will be applied which address equipment requirements, costs and weight issues.

PHASE II: Video-simulation could be used as a preliminary step to validate the utility of a new camouflage pattern. The contractor shall apply camouflage concepts to at least two shelters and two vehicles. The contractor shall plan and conduct traditional visual concealment test method using observers during Phase II and document findings. The contractor shall also provide details on application and removal methods and costs on large scale vehicles and shelters.

PHASE III: If the results of testing are positive, the Littoral Combat FNC will further mature the techniques developed under this effort for application to a wide variety of combat vehicles.

PRIVATE SECTOR USE OF TECHNOLOGY: The use of the camouflage patterns and application techniques will have direct benefit to sporting industry for hunter camouflage. The application techniques could be used to put Logos or unique designs on commercial trucks and aircraft.

REFERENCES:

1. Future Naval Capabilities Website http://www.onr.navy.mil/fncs/
2. http://www.marcorsyscom.usmc.mil/sites/marpat/InnovativeCamouflage.asp

3. Ellis, Stephen R. (2000) Information Displays in Encyclopedia of Psychology, Kaxdin, Alan E. (ed.) American Psychological Association, Washington, D.C.

4. Salvendy, Gavriel (ed.) (1997) Handbook of Human Factors and Ergonomics. New York, Wiley

KEYWORDS: Camouflage; Concealment; Paint; Coatings

N03-T014 TITLE: Expeditionary Ammunition Packaging and Handling

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: FNC- Littoral Combat and Power Projection

OBJECTIVE: To develop a low cost, expeditionary, large-caliber ammunition packaging and handling system that reduces the weight and volume of packaging materials while increasing the efficiency and safety of ammunition distribution.

DESCRIPTION: Under current procedures, ammunition items are packaged for storage and shipment using materials and techniques developed during World War II. The weight and volume of the packaging materials are significant, reducing the number of rounds that can be delivered per re-supply mission. Additionally, handling methods have not been optimized for current and projected families of vehicles used to transport ammunition from the storage depot or ship to its firing platform. This effort is intended to apply an analytical methodology to the codification of requirements, as well as the identification, development, application, and demonstration of technology to achieve an expeditionary ammunition packaging and handling system. The contractor needs to be or become intimately familiar with the current requirements associated with the safety, packaging, storage and handling of Marine Corps ammunition items and the processes used to package, handle and ship ammunition items by manufacturers and companies worldwide. All proposals must be innovative, address R&D and involve technical risk.

PHASE I: The contractor shall develop innovative concepts for the packaging, storage and handling of large caliber ammunition. Unique and novel approaches, as well as emerging materials technology shall be identified that have potential application to this effort. A concept design will be developed and if possible some bench scale prototyping. The contractor must address the benefits and impact on costs, efficiency, and safety.

PHASE II: Prototype Development. Based on the results of Phase I, the performer shall proceed with the preliminary design of packaging and handling solutions that significantly enhance the transportability of ammunition items. The performer shall follow the systems engineering design process in the establishment of requirements, design, development and evaluation of solutions identified. Protoype concepts should be tested and evaluated based against current systems. Preliminary cost estimates of the proposed solution will be developed.

PHASE III: Technology Transition. The contractor shall proceed with the application of the technology developed to the design that is intended for field use. Production representative models will be developed and evaluated and the contractor will develop a methodology to transition this technology into use by the DoD.

PRIVATE SECTOR USE OF TECHNOLOGY: Ammunition shipping and handling for the sport industry can directly benefit from this technology. It can also provide benefit to materials used in protective shipping, could transition to the shipping and packaging industries. Material handling and techniques used in transportation could also be used in handling a wide variety of sensitive materials.

REFERENCES:

1. Naval Packaging, Handling, Storage & Transportation Center Website: http://phst.ih.navy.mil/

2. Defense Ammunition Center Website: http://www.dac.army.mil

3. Defense Ammunition Center Transportation Engineering Division Website: http://www.dac.army.mil/DET/

KEYWORDS: Ammunition; Packaging; Handling; Storage

N03-T015 TITLE: LCAC Cargo Restraint Griping System

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: FNC Littoral Combat and Power Projection

OBJECTIVE: The objective of the project is develop a quick-release cargo restraint system for the Landing Craft Air Cushion (LCAC). The system should reduce the time required to secure and release cargo on the LCAC without incurring a weight penalty over the existing lashing system.

DESCRIPTION: The LCAC is a high speed air cushion vehicle utilized for the transport of troops and materiel at speeds in excess of 30 knots from the seabase to the shore. The LCAC is capable of transporting loads up to 75 tons from over the horizon through the surf-zone and across the beach to a craft landing zone. The craft operates in a harsh marine environment including salt water spray, blown sand and debris, and temperature extremes from -40 to 110 degrees Fahrenheit. The LCAC operational seastate envelope includes full mission capability through sea state three, limited capability in sea state four, and survival in sea state five.

The Landing Craft Air Cushion (LCAC) currently uses conventional chain and adjustable length wire rope cargo restraint with an over center cam type latching mechanism to secure rolling stock vehicles and palletized cargo to the craft's open cargo deck. The existing restraints have a breaking strength that is greater than 35,000 lbs, but less than 40,000 lbs to prevent damage to the LCAC cargo deck structure. Underway dynamic forces require that all cargo be restrained to withstand a 1.5 G acceleration in the forward and vertical direction, and 1.0 g for lateral and aft direction for peacetime/training conditions. The forward G acceleration is reduced to 1.0 G, and the vertical, lateral and aft requirements are reduced to .5gs under situations when the LCAC can be exposed to hostile fire, accepting a somewhat higher degree of risk of cargo breaking free in order to reduce the number of cargo restraints that must be removed thereby reducing the craft exposure to hostile fire.

Due to the weight of some of the cargo carried by LCAC, a large number of gripes must be used. For example, the M1A1 tank requires 20 cargo restraints for securing the tank to the craft during peacetime/training transit. Craft cycle time is adversely impacted due to the considerable amount of time required for personnel to install and remove each lashing, typically 20 minutes to install and 5-7 minutes to remove. The increased cycle time reduces rate of cargo throughput in an amphibious operation, taking a longer time to build up forces ashore. Furthermore, excessive time is required for discharging cargo on the beach, even with the reduced number allowed in a wartime situation. This is very detrimental during wartime as the longer it takes to offload cargo, the longer the LCAC and crew may be exposed to hostile fire. Doctrinally, the LCAC is supposed to transport cargo to a secured or benign beach. However, the potential of hostile fire in a threat environment cannot be eliminated entirely. The threat is so serious that during operation Desert Storm the LCAC crews considered transporting vehicles without any cargo restraints in order to be able to offload on the beach as quickly as possible. This could have had severe consequences should the cargo have shifted underway. The craft could have been severely damaged, or at least rendered inoperable and non-mission capable due to the off-balanced load.

A quick-release cargo restraint system would drastically reduce the LCAC cycle time and cargo offload time on the beach under hostile fire. The risk to the LCAC and crew would be greatly reduced and cargo throughput increased, allowing a more rapid buildup of force ashore.

A wide variety of alternatives have potential in the development of a quick-release gripe system. Recently developed commercial technologies such as active materials and smart materials could be utilized. Older technologies such as explosive release mechanisms and more basic mechanical quick-release mechanisms might also have potential. The Navy will only consider proposals that are innovative, address R&D and involve technical risk.

PHASE I: Develop concepts and select or develop materials that will provide an improved quick release lashing system for the LCAC and meet defined performance requirements. Perform a tradeoff study to evaluate the merits of the design concepts and if possible build bench scale prototypes of concepts.

PHASE II: Develop the strongest concepts into prototype systems and perform some level of testing and evaluation on these systems in actual or simulated environments.

PHASE III: Test prototype systems onboard an LCAC to secure cargo under simulated operational conditions. Perform underway testing with instrumentation as required to demonstrate system capability and characterize the potential reduction in craft cycle times. Develop a transition plan for the implementation of this technology into the Naval Fleet.

COMMERCIAL POTENTIAL: The technology developed under this program shall be applicable to commercial shipping, commercial trucking, and aircraft cargo securing practices.

REFERENCES:

1. http://www.intellimat.com/materials

2. http://www.chinfo.navy.mil/navpalib/factfile/ships/ship-lcac.html

3. Future Naval Capabilities Website http://www.onr.navy.mil/fncs/

KEYWORDS: Cargo securing, gripes, cargo lashing, tie-down, cargo gripes, cargo restraint system

N03-T016 TITLE: Self Contained Actuation Systems

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: FNC: Littoral Combat and Power Projection

OBJECTIVE: Utilize developing technology in self contained actuators to reduce the complexity, weight, and maintenance costs associated with conventional hydraulic systems, while increasing the reliability and availability of the Landing Craft Air Cushion (LCAC).

DESCRIPTION: The LCAC is a high speed air cushion vehicle utilized for the transport of troops and materiel at speeds in excess of 30 knots from the seabase to the shore. The LCAC is capable of transporting loads up to 75 tons from over the horizon through the surf-zone and across the beach to a craft landing zone. The craft operates in a harsh marine environment including salt water spray, blown sand and debris, and temperature extremes from -40 to 110 degrees Fahrenheit. The LCAC operational seastate envelope includes full mission capability through sea state three, limited capability in sea state four, and survival in sea state five.

Conventional centralized hydraulic systems utilizing actuators, reservoirs, pumps, and connecting piping are currently used to move various components onboard the LCAC. These systems include flight control surfaces such as rudders and bow thrusters, ramps for loading and offloading cargo, and cushion vanes for controlling air flow to the skirt system. Conventional hydraulic systems are maintenance intensive and the piping used in high pressure systems (3000 psi) is prone to leakage. The failure of a single component or piece of tubing can result in a complete system failure due to fluid loss. The use of a self contained actuation system controlled via electronic signals at each actuator location could significantly reduce the requirement for centralized hydraulic systems and provide a significant improvement in craft reliability and availability. Additionally, self contained actuation systems could reduce the weight and space allocated to hydraulic systems allowing the craft to carry increased payloads. The LCAC rudder actuation system has been identified as a prime candidate system to evaluate the feasibility of self contained actuator systems. The LCAC is propelled by two reversible pitch, ducted air screws. Two rudders are mounted on each propeller duct, aft of the air screw to provide directional control to the craft. The LCAC rudder position is controlled by a hydraulic cylinder that responds to rudder position inputs provided by the craftmaster. Each rudder is controlled by a hydraulic actuator that is connected to a hydraulic system that also services the aft scavenge fans servicing the air filtration system. The loss of an actuator, connecting piping, or a scavenge fan can result in a complete loss hydraulic power to the remaining components. The use of a self contained actuator would isolate the failure to the single component and allow the other components to continue operating. In addition to the prime demonstration candidate of the rudder system, other systems such as the bow thruster control system could potentially benefit from this technology.

PHASE I: Feasibility study which outlines technologies that could provide remotely controlled self contained actuation systems. Determine the feasibility of applying this technology to the LCAC. Develop preliminary designs and if possible develop a bench scale system.

PHASE II: Implementation of phase I design concepts and develop into a full scale prototype rudder actuator. Develop capability to test prototype design/s on a test stand that simulates LCAC rudder environment. If possible provide prototype to Navy for limited at sea testing.

PHASE III: Based on test results make improvements and evaluate the system on a LCAC for full scale sea trials. Develop a transition plan for implementation of this technology on Navy LCAC's.

PRIVATE SECTOR USE OF TECHNOLOGY: The incorporation of self contained actuators in aircraft and high performance marine craft can significantly reduce the weight associated with conventional hydraulically actuated systems and improve system reliability. The use of self contained actuation systems in commercial aircraft flight control systems will provide significant fuel and operational cost savings for commercial airline companies.

REFERENCES:

1. http://www.dfrc.nasa.gov/Projects/SRA/eha.html

2. http://www.chinfo.navy.mil/navpalib/factfile/ships/ship-lcac.html

3. Future Naval Capabilities Website http://www.onr.navy.mil/fncs/

KEYWORDS: Hydraulic; electro; actuator; flight control;

N03-T017 TITLE: Acoustic registration of seafloor features and objects

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: Organic Mine Counter Measures FNC

OBJECTIVE: To develop an acoustic method for identifying and locating a seafloor feature or object that had been previously detected in support of future U. S. Navy mine-hunting and surveillance systems. The seafloor feature or object may be any discrete, naturally occurring structure such as a coral head, rock or pock-mark.

DESCRIPTION: The ability to re-acquire an object in sonar images, at arbitrary times and aspect angles, is critical to many applications involving underwater operations, including the reacquisition of a target, station keeping, maneuvering relative to stationary objects, mapping and navigation by landmarks. There are a number of related ongoing projects in this area [1-5]. Due to limited visibility in many underwater areas, acoustic means are preferred. Due to a number of problems related to the physics of underwater sound, including limited bandwidth, non-geometric scattering and penetration of sound into the seafloor, the theorems and methods developed for video imagery are not expected to give acceptable results. The relatively high fractional band width (low Q) of modern acoustic systems coupled with the data storage and processing power of modern computers permits new signal processing methods that were unthinkable in the past. Bandwidth is demonstrably important [6]. There has been steady progress in the acoustic classification of underwater objects [7]. The registration of complicated objects by dolphins using echolocation has been documented [8,9], but the underlying process is not understood. Attempts to understand the performance achieved by the dolphin are underway [e.g. 10]. New and original ideas appear to be needed, not just in algorithm development, but in defining the optimal strategy and the necessary system requirements.

PHASE I: (a) Basic parameters: Studies and simulations to model the acoustic response of seafloor features and objects, and to determine basic system requirements, including the level of performance that is necessary for the above applications. Performance may be quantified in terms of the probability of correct registration versus the probability of a false registration (analogous to probabilities of detection and false alarm in the evaluation of sonar detection performance) as a function of range and aspect angle separation. The basic parameters include the optimum frequency band, pulse types, range of aspect angles and maximum operating range for a variety of modeled seafloor features and objects. (b) Algorithms and Systems: Development of basic algorithms to achieve registration and the theoretical prediction of their performance, and the identification of the sonar system(s) capable of supporting the algorithms.

PHASE II: Carry out engineering development of sensor and measurement technology. Demonstrate in laboratory on a Navy representative vehicle and field setting to the extent feasible. Technology should be amenable to typical Navy vehicles.

PHASE III: Development of the best candidate algorithms with acoustic data collected at sea under a wide range of operating conditions to produce a robust algorithm that can perform under a wide range of conditions. Sufficient quantities of data are needed to make statistically significant measurements of performance. Definition of the final algorithm, performance evaluation results, and a plan for integration with compatible sonar systems.

COMMERCIAL POTENTIAL: There is private sector interest in underwater navigation and station-keeping relative to the seafloor, particularly in the growing sonar and autonomous underwater vehicle (AUV) sector. They all could benefit from this technology.

REFERENCES:

1. C. Plakas, E. Trucco, "Developing a Real-Time, Robust , Video, Tracker", MTS/IEEE OCEANS 2000, Providence, Rhode Island. September 2000, pp. 1345-1352.

2. I. Tena Ruiz, Y. Petillot, D. M. Lane, J. M. Bell, "Tracking Objects in Underwater Multibeam Sonar Images", IEE Colloquium on Motion Analysis and Tracking, London, England. May 1999, pp. 11/1 - 11/7.

3. D. M. Lane, M. J. Chantler, D. Y. Dai, "Robust Tracking of Multiple Objects in Sector Scan Sonar Image Sequences Using Optical Flow Motion Estimation," IEEE Journal of Oceanic Engineering, Vol. 23, No. 1, January 1998, pp. 31-46.

4. D. B. Marco, A. J. Healey, R.B. McGhee, D. P. Brutzman,"Control Systems Architecture, Navigation, and Communication Research Using the NPS Phoenix Underwater Vehicle" 6th International Advanced Robotics Program Workshop on Underwater Robotics, Toulon, France, March 27-29, 1996.

5. R. N. carpenter, "Concurrent Mapping and Localization with FLS," IEEE AUV98, August 1998.

6. D. Yao, M. R. Azimi-Sadjadi, A. A. Jamshidi, and G. J. Dobeck, "A study of effects of sonar bandwidth for underwater target classification," IEEE Journal of Oceanic Engineering, Vol. 27(3), 610-618, July 2002.

7. V. Chandran, S. Elgar, A. Nguyen, "Detection of mines in acoustic images using higher order spectral features," IEEE Journal of Oceanic Engineering, Vol. 27(3), 619-627, July 2002.

8. A. A. Pack and L/ M/ Herman, "Sensory integration in the bottlenose dolphin: immediate recognition of complex shapes across the senses of echolocation and vision," J. Acoust. Soc. Am. 98(2), Pt. 1, 722-733, 1995.

9. P. E. Nachtigall, W. W. L. Au, J. L. Pawloski and H. L. Roitblat, "Animal echolocation and signal processing," Proc. IEEE OCEANS'94, 259-263, September 1994.

10. C. M. Delong, W. W. L. Au, H. E. Harley, "Features of echoes bottlenose dolphins use to perceive object properties," J. Acoust. Soc. Am. 112(5), Pt. 2, 2335, November 2002.

11. The Navy Unmanned Undersea Vehicle (UUV) Master Plan, sponsored by PEO (USW), PMS403, Approved for Public Release 27 March 2001. Distribution is unlimited.

KEYWORDS: sonar; registration; acoustic; recognition; navigation; seafloor

N03-T018 TITLE: Advanced EO sensor for multi-mission USN/USMC UAVs

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: Organic Mine Countermeasures FNC program

OBJECTIVE: Develop and evaluate a prototype intelligence, surveillance, and reconnaissance (ISR) sensor package, suitable for use on organic UAVs, that employs advanced, visible-band sensor technology to support littoral-zone warfare mission products, such as oceanographic characterization (wave heights, water depths, currents, etc.) in very shallow water, including the surf; detection and characterization of stealthy or intrinsically low-contrast targets; and accurate geo-location of these products.

DESCRIPTION: Tactical UAVs are being developed by the USN/USMC to provide ISR of the littorals for the forward-deployed fleet. These systems are designed to provide optical imagery at long-stand-off ranges and low-to-moderate grazing angles to mitigate the danger from defensive ground fire. However, these systems presently utilize only very basic video technology and are not capable of deriving quantitative, militarily actionable information from the imagery they collect. A variety of advanced technologies have matured in the past several years which, individually or in combination, can be brought to bear to change this state of affairs. What is needed is an advanced-technology sensor package that can operate from modest-to-long standoff distances (3-10 km) and low-to-moderate grazing angles (10-30 degrees) and can collect high-quality image data, suitable for use with advanced algorithms that can yield ISR products that enhance intelligence preparation of the battlespace through environmental reconnaissance, improve detection of difficult-to-see targets, improve target recognition and discrimination, improve weapons targeting, and enhance the development of inputs to a common operating picture.

The Navy will only the select proposals that are innovative, address R&D and involve technical risk.

PHASE I: Develop a design for a prototype sensor package. Provide a quantitative assessment of the anticipated performance of this sensor package in an ISR role.

PHASE II: Build and test the prototype sensor package, through proof-of-concept demonstration.

PHASE III: Transition to OMCM FNC where the sensor package will undergo more extensive testing, including participation in Fleet Exercises and/or Fleet Battle Experiments, and needed advanced development, testing, and evaluation to ensure readiness for transition to an acquisition program.

PRIVATE SECTOR USE OF TECHNOLOGY: The commercial airborne survey industry needs advanced sensor packages to support improved performance (response times, accuracy, coverage rates, discrimination, etc.) for numerous emergency situations, such as forest-fire mapping (Forest Service), oil-slick tracking and coastal storm damage mapping (FEMA, NOAA), and search and rescue (USCG).

REFERENCES:

1. Future Naval Capabilities Website http://www.onr.navy.mil/fncs/

KEYWORDS: UAV, ISR, electro-optics, sensors, electronics, battlespace environment

N03-T019 TITLE: Advanced Anti-Jam GPS Antenna Design Concepts

TECHNOLOGY AREAS: Electronics

ACQUISITION PROGRAM: FNC Platform Protection

OBJECTIVE: The objective of the Advanced Anti-jam Design Techniques effort is to make a controlled Radiation Pattern Antenna (CRPA) have more elements without increasing the size, or make the same antenna (i.e., same number of elements) smaller. The more radiating elements that are available in a CRPA design, the more response nulls can be directed towards jammers.

DESCRIPTION: The inherent design problem that needs to be overcome is that the Objective GPS antenna requires closer element spacing and as a result, traditional CRPA antenna performance suffers from the electromagnetic effects of close element spacing. The cause of the performance shortfall is excessive mutual coupling, which causes the nulling algorithms to hunt longer...or, settle more slowly on a solution. Also, traditional CRPA antennas have insufficient pattern slope, which adversely effect antenna gain in the desired directions of reception.

The first approach used is a quasi-optical approach that decouples energy as a function of the change of the arrival angle, decoupling est. to be 8dB. The second approach is a circuit approach using a cancellation network. This network creates a secondary-coupling path that cancels the primary path coupling. Preliminary results are also very promising with a measured 8-dB reduction in mutual coupling, no detrimental ”side effects”, and further optimization possible.

PHASE I: Concept exploration will be directed to the reduction of mutual coupling through the use of a Frequency Selective Surface (FSS) radome (i.e., the quasi-optical approach). This effort will be further explored through the use of Stacked RF Structures as another approach to reducing mutual coupling. Each area of exploration will determine feasibility and conclusions will be documented with a final report.

Phase I will also include the delivery of a technical proposal that outlines a specific design approach. The design approach will include: a development plan, the specification of manufacturing technologies to be used, and the specification of performance capabilities and trade-offs.

PHASE II: Implementation of Phase I design in the building of an Anti-jam Antenna capable of being tested at a government test facility. Data will be collected to verify performance capabilities and will be provided in a final system evaluation report. The final system evaluation report shall include recommendations addressing noted deficiencies to further improve performance. If possible testing will be performed at NAVAIR Pax River at the expense of the Navy.

PHASE III: Productize a CRPA Anti-jam GPS antenna that implements all of the improvements demonstrated in the Phase II STTR effort. Transition the antenna for use on several navy platforms.

PRIVATE SECTOR USE OR TECHNOLOGY:
This effort will result in smaller antennas that have enhanced beam-forming and null-steering capabilities. Although this performance is of particular benefit in military applications, to suppress jammer signals, the approach can also be used to suppress other noise sources and signal multi-path. Therefore these antennas are valuable to the private sector as well as to the military.

REFERENCES:

1. “GPS in Ten Years”, Karl L. Kovach, ARINC and Karen L. Van Dyke, DOT/Volpe Center. in ION GPS-97 September 16-19, 1997 Kansas City, Missouri.
2. “Integration of GPS into the B-2 Stealth Bomber”, Anthony Abbott and Ted Hagstrom, Nothrop Grumman and Mitch Miller and Doug Atkinson USAF. In ION GPS-97 September 16-19, 1997 Kansas City Missouri.
3. http://www.onr.navy.mil/fncs/

KEYWORDS: Atenna Design, Navigation Systems, Jam Resistant Technologies

N03-T020 TITLE: Silicon-Based Visible/Near-Infrared Affordable Missile Warning

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: Fleet/Force Protection FNC

OBJECTIVE: To develop a more affordable imaging missile warning sensor for aircraft self-protection that has adequate sensitivity and wide field-of-view, while removing cost and produceability issues associated with current missile warning technologies.

DESCRIPTION: A large majority of aircraft shot down over the past three decades have been lost to infrared (IR)-guided anti-aircraft missiles. The Naval Research Laboratory has successfully demonstrated the ability of a laser-based jammer to counter threats from the most modern of these missiles[1]. One of the major factors affecting final development and deployment of an IR CounterMeasure (IRCM) system on Naval aircraft is the high cost of the system. Current SBIR and FNC efforts are attempting to reduce the cost of the laser and pointer/tracker components of such a system[2,3,4]. Success in those efforts would leave one expensive component, the missile warning sensor. There is existing work to reduce the cost of mid-IR sensors, but the materials and processes involved in their manufacture are inherently expensive. This STTR seeks a greater reduction in cost than is likely to be achieved in that band.

A great deal of money has been invested by the military and by commercial companies in development of silicon detector technology. A very detailed understanding of the material, its properties, and how to process it has resulted. Silicon technology offers a promising approach to providing a low-cost missile warning sensor. Such a sensor will use visible and/or near-IR wavelengths, and so will need to develop methods to mitigate false alarms due to the large number of natural and man-made sources of emissions in this wavelength band (sunlight, both direct and reflected, being a major background source). Wide field-of-view (FOV) performance is crucial to reducing the total number of sensors on a platform, so the sensor must have a FOV of at least 90 degrees by 90 degrees in its final form. Technical approaches which can be implemented with minimal size, weight, and power consumption and can operate in the stressing environments common to tactical aircraft should be emphasized. There are a number of ways in which silicon detector technology could be applied to the missile warning problem to meet the above requirements. However, it is expected that some form of advanced spectral or spatial filtering or processing will be needed to provide missile warning capability with low false alarm rates in the presence of cluttered backgrounds. The team selected to pursue this STTR will be encouraged to explore a broad range of approaches before selecting one for development.

The Navy will only select proposals that are innovative, address R&D and involve technical risk.

PHASE I: Concept exploration resulting in a feasibility study which outlines technologies, capabilities, or design approaches that could be used in the fabrication of a missile warning sensor possessing the above described attributes. Phase I will also include the delivery of a technical plan that outlines a specific design approach. The design approach will include: a development plan, the specification of manufacturing technologies to be used, and the specification of performance capabilities and trade-offs. An early prototype of the detector to be used in the proposed approach would be desirable, and need not have the full FOV or number of pixels required of the final sensor.

PHASE II: Implementation of Phase I design in the building of a missile warning sensor capable of being tested in the laboratory and potentially in a government-sponsored field test. Data will be collected to verify performance capabilities and will be provided in a final system evaluation report. The final system evaluation report should include any recommendations addressing noted deficiencies to further improve performance and/or reduce cost.

PHASE III: Productize the missile warning sensor that implements all of the improvements demonstrated in the Phase II STTR effort. Transition the sensor to the Fleet/Force Protection FNC - "Integrated EO/IR Self-Protection Suite for Aircraft" project for use as the missile warning sensor in that system.

PRIVATE SECTOR USES OF TECHNOLOGY: The most obvious commercial application of an affordable missile warning sensor would be on commercial aircraft as a component of a countermeasure system to protect against terrorist missile threats. Current systems are too expensive to be deployed in large numbers on commercial aircraft. The sensor developed under this task could allow greater protection of civilian aircraft. In addition, a less-expensive missile warning sensor would be applicable to other military users. One example of this is in missile warning for armored fighting vehicles, which are desperately in need of self-protection equipment but cannot afford current missile-warning technology.

REFERENCES:

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2. SBIR Topic N01-169, "Non-Mechanical Beam Steering For Infrared Countermeasure Applications".

3. SBIR Topic N99-191, "Low-Cost Mid-Infrared Laser For Infrared Countermeasures".

4. Fleet/Force Protection FNC, "EO/IR Laser Jammer" project.

5. Future Naval Capabilities Website http://www.onr.navy.mil/fncs/

KEYWORDS: Silicon detectors; missile warning; wide field of view; visible/near-infrared; spectral/spatial filtering; spectral/spatial processing.

N03-T021 TITLE: <u>High Linearity, High-Power, Quadrature Balanced Amplifiers for Active Transmit Arrays</u>

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: Fleet / Force Protection FNC

OBJECTIVE: To develop a highly linear, quadrature balanced, very broadband, high power amplifier based on a series of three moderate bandwidth (less than an octave) high-power amplifiers in order to achieve a very high third order intercept point (IP3) for use in broadband high power active transmit array modules. The amplifiers should achieve an IP3 that is at least 23 dB higher than its 1 dB compression point (P1dB) across the entire respective bands.

DESCRIPTION: It has been known for some time that a quadrature balanced amplifier is capable of completely eliminating third order intermodulation distortion provided that the circuit is perfectly balanced. This means that the input and output 90 degree hybrids must have output and input ports that are perfectly balanced in phase and amplitude, and that both amplifiers must be exactly matched in all respects. Perfect balance is of course impossible, however quadrature balanced amplifiers have been demonstrated recently that achieve very high linearity. These amplifiers have typically been developed for low frequency, low power applications. The goal of this program is to support the development of the very broadband, high power transmit amplifiers with development of a set of microwave, high-power, moderate-bandwidth (5.5-9 GHz, 8-11.5 GHz, 11-18.5 GHz) quadrature balanced amplifiers that achieve high linearity over their respective bands. The amplifiers should have moderate power gain (20 to 25 dB), and high output power (10 watts minimum, or minimum 1 dB output compression point of 40 dBm). The measured third order intercept point (IP3) of each device should be greater than 23 dB above the 1 dB compression point (P1dB). This means that an amplifier with an output P1dB of 40 dBm should have an output IP3 of at least 63 dBm. Finally, the amplifier design should lead to a device that could be miniaturized (several square millimeters) to be used in an advanced transmit array module. In order to achieve such high performance and small size, each amplifier should most likely be implemented as a MMIC. This MMIC based approach should also lead to devices that achieve excellent balance and are reproducible.

The Navy will only select proposals that are innovative, address R&D and involve technical risk.

PHASE I: Concept exploration resulting in a feasibility study which outlines currently available or new technologies, capabilities, or design approaches that could be used in the fabrication of a set of quadrature balanced amplifiers possessing the above described attributes. Phase I will also include the delivery of a technical plan that outlines a specific design approach. The design approach will include: a development plan, the specification of manufacturing technologies to be used, and the specification of performance capabilities and trade-offs. An early prototype of the new approach would be desirable. Hybrids and amplifiers should be based on MMIC or other highly integrated circuit design processes and should lead to a quadrature balanced amplifier design that is completely integrated on one chip (one for each band).

PHASE II: Implementation of Phase I design in the building of the quadrature balance amplifier set capable of being tested in a laboratory environment. Data will be collected to verify performance capabilities and will be provided in a final evaluation report. The final evaluation report should include any recommendations addressing noted deficiencies to further improve performance.

PHASE III: Productize the set of quadrature balanced amplifiers that implements all of the improvements demonstrated in the Phase II STTR effort. Transition the amplifiers to the Fleet / Force Protection FNC for use in the Advanced Multifunction Radio Frequency Concept (AMRFC) Program, and other active array programs requiring high linearity high power amplifiers for use in array modules.

PRIVATE SECTOR USE OF TECHNOLOGY: A microwave, high-power, high-linearity amplifier chip design would be very useful in many other commercial endeavors including the cell phone and satellite communication industries that require devices with ever increasing performance. The technologies developed here could be used as-is or modified for different frequency bands as needed.

REFERENCES:

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3. Mini-Circuits web-site for new high-linearity amplifiers (ZRL series): http://www.minicircuits.com/ZRL-SERIES.pdf

4. Future Naval Capabilities Website http://www.onr.navy.mil/fncs/

KEYWORDS: quadrature balanced amplifiers; high linearity: high-power amplifiers; transmit modules

N03-T022 TITLE: Advanced Thermal Management Technologies

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: DD(X); CVN (X)

OBJECTIVE: To develop advanced thermal management technologies to improve high-heat flux waste heat removal by a factor of 10X over existing technologies in electronic devices.

DESCRIPTION: Advancement in high-heat flux thermal management technology and its integration into future Navy ships is critical for future power electronic systems. Removal of waste heat via active phase change technologies, in conjunction with other heat transfer mechanisms, present the best opportunity to achieve the thermal management advances required for future Naval electronic applications. The DD(X) and CVN(X) programs have committed to the use of high-power electronics. The electronic solid state power conversion equipment used in the DD(X)'s Integrated Power System and the CVN(X) Electromagnetic Aircraft Launch System produce heat loads beyond those in today's electrical distribution systems. The introduction of additional advanced high-power electronics for radars, electromagnetic weapons, and variable speed motor drives will produce heat loads significantly higher than seen on today's ships. The power density of these high-power electronics will exceed 1000 watts/square centimeter (W/cm2). Existing waste heat removal technology is limited to approximately 100 (W/cm2). Thermal management technology capable of removing waste heat at 1000 (W/cm2) from advanced power electronic devices is needed.

The Navy will only consider proposals that are innovative, address R&D, and involve technical risk.

PHASE I: Identify and characterize advanced thermal management techniques to remove waste heat from power semiconductors (die or junction level) with heat flux densities of 1000 W/cm2. The proposed solution must be able to keep the semiconductor junction temperature below 125 F with no net waste heat added into the workspace. Provide design specifications and cost analysis for phase II prototyping.

PHASE II: Fabricate and test a 250KW prototype power module using the thermal management system defined in phase I. The testing program must verify the cooling capability of the proposed thermal management solution, and must conform to the testing requirements of MIL-STD-810 and MIL-STD-1310. Conduct an analysis to show how the proposed solution would meet the requirements of MIL-S-901D. Coordinate with DD(X) and/or CVN(X) and develop a strategy for insertion into a DD(X) Engineering Development Model (EDM) or the CVN(X) Electromagnetic Aircraft Launch System (EMALS) engineering development model, or the Land Based Engineering Site (LBES) at NSWC-CD Philadelphia. The proposed thermal management solution must demonstrate that the removed waste heat from the power electronic module components will easily interface with the Navy's zonal heat exchange for rejection to ambient shipboard environments. All testing costs for Navy facilities and personnel will be funded directly by the Navy and not funded through the small business or with STTR funds.

PHASE III: Fabricate and test a full-scale thermal management system, incorporating lessons learned from Phase II, at a DD(X) EDM, CVN(X) EMALS test site or at the LBES. Coordinate with DD(X) or CVN(X) for system integration and testing issues. Testing to meet the requirements of MIL-STD-810, MIL-STD-1310 and MIL-S-901D is required.

PRIVATE SECTOR USE OF TECHNOLOGY: Application of the technologies developed will benefit the computer industry, automotive, energy conversion, and aircraft industrial sectors.

REFERENCES:

1. Mark Zerby, Michael Kuszewski, FINAL REPORT ON NEXT GENERATION THERMAL MANAGEMENT (NGTM) FOR POWER ELECTRONICS, NSWCCD Technical Report TR-82-2002-12, March 2002

2. MIL-S-901D, "SHOCK TESTS. H.I. (HIGH-IMPACT) SHIPBOARD MACHINERY, EQUIPMENT, AND SYSTEMS, REQUIREMENTS FOR", 17 March 1989

3. MIL-STD-1310G, "SHIPBOARD BONDING, GROUNDING, AND OTHER TECHNIQUES FOR ELECTROMAGNETIC COMPATIBILITY AND SAFETY, 28 June 1996

4. MIL-STD-461E, "REQUIREMENTS FOR THE CONTROL OF ELECTROMAGNETIC INTERFERENCE CHARACTERISTICS OF SUBSYSTEMS AND EQUIPMENT", 20 August 1999

5. MIL-STD-810F, "ENVIRONMENTAL ENGINEERING CONSIDERATIONS AND LABORATORY TESTS", 01 November 2000

KEYWORDS: Active cooling; Electronics; High Heat Flux; Waste heat; Energy Efficient

N03-T023 TITLE: <u>Fast Detection of Electrical Faults in Shipboard Electrical Power Distribution Systems</u>

TECHNOLOGY AREAS: Information Systems, Ground/Sea Vehicles

ACQUISITION PROGRAM: DD(X); CVN(X)

OBJECTIVE: Develop an algorithm to (1) detect the presence of electrical faults in less than 1 millisecond from application (bolted through high impedance) in grounded, medium voltage - 1000 Volts AC (VAC) to 15,000 VAC - shipboard electric plants with high harmonic content, and (2) generate electrical data to allow coordinated identification of fault locations, in either ring or radial electric distribution systems, within a half cycle of fault application (8 milliseconds based on 60Hz system).

DESCRIPTION: Shipboard electrical casualties can produce outages that impair ship capacity to operate. This is especially critical in combat situations. Future Navy shipboard electric plants will distribute large amounts of power that must be managed quickly and intelligently. Electric propulsion concepts tied to a common ship service electric bus will introduce harmonics on the system that may interfere with the fast detection of electrical faults and the identification of these fault locations. Previous fault detection efforts, now incorporated into ships, focused on conventional low voltage, ungrounded shipboard systems with low harmonic levels. These algorithms are not directly relevant to the higher power systems being designed for future ships.

The Navy will only consider proposals that are innovative, address R&D, and involve technical risk.

PHASE I: Define an approach that will provide reliable electrical information necessary for intelligent, coordinated, fault detection and identification in medium voltage (ring or radial) grounded electrical systems with harmonic content from large electric drive electronic components.

PHASE II: Develop low complexity algorithms that are readily implementable. Implement the algorithms on low-cost, off-the-shelf distribution hardware and demonstrate its capability and reliability. In conjunction with DD(X) and/or CVN(X) prepare an insertion strategy for test at a DD(X) Engineering Development Model (EDM) or CVN(X) test facility and Land-based Engineering Site at NSWC-CD Philadelphia. Prepare a business plan and commercialization strategy. All costs for Navy facilities and personnel will be paid directly by the Navy and will not be funded through the small businesses STTR funding.

PHASE III: Using the lessons learned from Phase II, refine the algorithms and in conjunction with DD(X) or CVN(X), implement in a DD(X) EDM, CVN(X) system or the LBES.

PRIVATE SECTOR USE OF TECHNOLOGY: Since medium voltage is utilized on commercial ships, this technology can be directly applied to these designs to minimize fault propagation and collateral effects associated with a system fault. Also, in conjunction with Homeland Security, this technology can be implemented in medium voltage systems used in utility power systems, industrial sites, and buildings to also minimize fault propagation and collateral effects of a fault/s which in the bigger picture, ensures the integrity of our nation's power grid and the dependent infrastructure.

REFERENCES:

1. "Intelligent Fault Detection Devices for Shipboard Power Systems" Dan Devine, All-Electric Ship Symposium, June 2000

2. "Analysis of Shipboard Systems When Subjected to Severe Cable Damage" Dan Devine, All-Electric Ship Symposium, Sept 1998

3. "Dynamic Multiple Fault Studies of an AC Zonal Shipboard Electric Distribution System for a Given Weapon Effect" Tracy Hannon and Mike Goodnow. Naval Surface Warfare Center, August 1994

KEYWORDS: Fault Detection; Fault Protection; Medium Voltage; Grounded; Shipboard Electric Plant; Fight Through

N03-T024 TITLE: Flow Control and Vibration Isolation for Integrated Motor Propulsor

TECHNOLOGY AREAS: Materials/Processes, Weapons

ACQUISITION PROGRAM: PEO-SUB PMS-404, Undersea Weapons Program Office

OBJECTIVE: Develop flow control and vibration isolation concepts and devices for torpedo Integrated Motor Propulsor. Specifically, the flow and vibration control concepts and devices aim to improve torpedo stealth and propulsor performance.

DESCRIPTION: The Integrated Motor Propulsor (IMP) is being developed for powering the next generation torpedoes. The IMP reduces the complexity of the motor and propulsor assembly, and drive train. It is compact, light, and has the potential for reducing total ownership cost. The IMP has several desired acoustic characteristics-- low rotor rotational speeds and blade relative velocities, large blade row spacing, increased mixing and flow diffusion downstream of the inlet guide vanes, and blade/vane skew optimization. One could take advantage of these characteristics to develop flow control and vibration isolation concepts to reduce the radiated noise of the IMP, and to improve the propulsor efficiency. Previous research [1] showed flow control using wake filling or management techniques can reduce tonal noise due to rotor-stator interaction, and reduce mechanical blade vibration. Additional vibration isolation on the afterbody of the IMP, via passive or active-passive control, can reduce the overall radiated noise of the IMP further.

The Navy will only select proposals that are innovative, address R&D and involve technical risk.

PHASE I: Conduct flow control feasibility study and vibration isolation concept development for torpedo Integrated Motor Propulsor.

PHASE II: Design and develop flow control and vibration isolation devices and associated control hardware for torpedo Integrated Motor Propulsor. Experiments and testing will be conducted in the laboratory or in-water to demonstrate the validity of flow and vibration control concepts.

PHASE III: Extend the Phase II effort to incorporate flow control devices and vibration control methodology for other Integrated Motor Propulsor applications—unmanned undersea vehicles, submarines, and ships. Collaborate with Navy Labs and industry to develop flow and vibration control devices for specific Integrated Motor Propulsor applications.

COMMERCIAL POTENTIAL: The Integrated Motor Propulsor concept can be applied to ships and ferries, as well as ground vehicles and turbines in power industry. The flow and vibration control concepts can also be applied to generic turbomachinery to control noise and vibration. An example is the High Cycle Fatigue (HCF) of blades in aircraft engines.

REFERENCES:

1. Bailey, S. et al., "Wake-Filling and Reduction of Rotor HCF using Stator Trailing Edge Blowing," AIAA Paper 2000-3101, 2000.

KEYWORDS: flow control; vibration isolation; integrated motor propulsor; control devices; torpedo stealth; High Cycle Fatigue (HCF)

N03-T025 TITLE: Plasma-Based Oxygen Generator for Undersea Vehicle Fuel Cells

TECHNOLOGY AREAS: Materials/Processes, Weapons

ACQUISITION PROGRAM: ACAT II: Unmanned Underwater Vehicles Program Office (PMS 403D2)

OBJECTIVE: Develop and demonstrate an oxygen generator that employs a plasma-based system to decompose a solid-state oxygen storage material to gaseous oxygen. The plasma-based system should demonstrate rapid startup and shutdown and be capable of generating oxygen over a range of gaseous oxygen delivery rates. The solid-state oxygen storage material should be stable under ambient conditions, possess a high oxygen content by weight, and be amenable to mechanical recharge or replenishment under submarine and surface ship operating conditions.

DESCRIPTION: Underwater vehicles will serve as key elements in integrated operations of future surface ships and submarines, providing a range of support functions including autonomous surveillance, mine counter measures, and special forces transport. However, current power sources for these vehicles (rechargeable silver-zinc batteries or high-energy primary batteries) do not meet the energy requirements for future missions, or they impose a tremendous logistics burden on the host vessel. Fuel cells offer a viable option for meeting mission energy requirements, and at the same time, they can reduce the host vessel logistics burden if the fuel and oxidizer can be stored in a high energy density format.

Fuel cells operating on hydrogen or more complex fuels (such as high energy density hydrocarbons) and oxygen are attractive as underwater power sources because they are efficient, quiet, compact, and easy to maintain. The total energy delivered by a fuel cell system is limited only by the amount of fuel and oxygen available to the fuel cell energy conversion stack. Unlike ground and air transportation fuel cell systems that only require an onboard fuel, underwater vehicles must carry both the fuel and the oxygen source because the oxygen concentration in the ocean is insufficient to meet vehicle power requirements. The underwater vehicle oxygen source must possess a high oxygen content (both weight and volume based) to accommodate the weight and volume constraints of the vehicle design and be amenable to safe handling and storage onboard submarines and surface ships.

Solid-state oxygen sources such as sodium chlorate ($NaClO_3$) and lithium perchlorate ($LiClO_4$) possess high oxygen contents and are stable under ambient conditions. Decomposition of these materials to gaseous oxygen typically employs thermal methods that are often difficult to start, stop, and control. On the other hand, plasma decomposition methods offer the potential for rapid startup and shutdown, and in addition, controlled feed of the oxygen storage material into the plasma should provide throttleable oxygen generation rates.

Therefore, an innovative approach to oxygen generation is sought that employs a plasma-based system to decompose a solid-state oxygen storage material. The oxygen storage material may be fed to the plasma as a solid or in a carrier fluid (preferably water) as a slurry or a solution. The ability to mechanically recharge or replenish the oxygen source should be considered in the design of the plasma-feed subsystem. To meet nominal undersea vehicle power requirements, throttleable oxygen delivery rates should be sufficient to power a typical fuel cell stack from 50 W to 5 kW. Oxygen storage capacity should be scalable to provide a minimum of 50 kilograms of useable oxygen gas. The available oxygen capacity should be maximized on a total system weight basis (i.e. weight percent oxygen), while maintaining a high volumetric density for the overall system.

The Navy will only consider proposals that are innovative, address R&D, and involve technical risk.

PHASE I: Demonstrate the use of a plasma-based system to decompose a solid-state storage material to gaseous oxygen with concurrent removal of inerts from the plasma region. Show rapid startup and shutdown capabilities

PHASE II: Construct and evaluate a plasma-based oxygen generator with integrate feed and inert-removal subsystems. Demonstrate controlled oxygen generation rates, start/stop/restart capabilities, and oxygen source recharge or replenishment capabilities. Make system available for attachment to a fuel cell for Naval laboratory testing.

PHASE III: Design and construct a fully integrated plasma-based oxygen generator for operation in Navy-designated undersea vehicle powered with a fuel cell.

DUAL-USE POTENTIAL: High-density oxygen storage and generation systems will make it possible to power commercial underwater vehicles with fuel cells. Portable oxygen generators can be used to replace high-pressure oxygen cylinders for many industrial applications requiring on-site oxygen or enriched air processing.

REFERENCES:

1. Fuel Cell Systems, Leo J. M. J. Blomen, Michael N. Mugrewa, Ed., Plenum Publication Corp., NY (1994).

2. Undersea Vehicles and National Needs, National Research Council, National Academy Press, Washington D.C. (1996).

3. An Assessment of Undersea Weapons Science and Technology, National Research Council, National Academy Press, Washington D.C. (2000).

4. Russel R. Bessette, et al., J. Power Sources, 80 (1999) 248-253.

5. Øistein Hasvold, et al., J. Power Sources, 80 (1999) 254-260.

KEYWORDS: Plasma, Oxygen; Fuel Cell; Underwater; Power; Energy

N03-T026 TITLE: Multidisciplinary Optimization of Naval Ship Design and Mission Effectiveness

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PEO STRIKE, PEO CARRIERS, PEO EXW

OBJECTIVE: To develop a methodology and modeling and simulation environment for performing multidisciplinary, multivariate optimization of ship system characteristics, relative to complex Naval missions.

DESCRIPTION: The design process for a naval ship involves the synthesis of a very complex system of systems (the ship) to provide the capability to meet requirements for multiple sets of complex mission objectives. The process is further complicated by the need to balance mission effectiveness with cost and risk. The design space of all possible configurations that must be considered is huge. Finding the best combination of parameters that meet performance, cost, and risk requirements is a formidable task, not easily attained by the application of traditional tradeoff methods. In addition, in early stage design, the parameters describing the ship are not well defined; design must be accomplished in the face of uncertainty in data inputs. The naval design community has some tools that utilize limited optimization processes to help design and synthesize a ship. These processes have generally resulted in a point design, and uncertainty arising from data inputs is not considered. There are existing mission effectiveness tools that can assess ship performance within specified mission scenarios. These tools have not been integrated with ship design/synthesis tools. The objective of this research would be to apply newly developed Multidisciplinary Optimization (MDO) methods to the ship design optimization process. This will enable ship designs that are simultaneously optimized in terms of performance, cost and risk, allowing for uncertainty in data inputs, within a multi-objective naval mission. The goal is to integrate existing ship synthesis and mission effectiveness tools with MDO tools and techniques, to provide an optimization framework that can be applied over a range of naval ship designs and missions, including early stage designs. MDO tools have been successfully used in optimized design of affordable aircraft and engines by aerospace industries.

The Navy will only select proposals that are innovative, address R&D and involve technical risk.

PHASE I: Identify and assess tools and techniques that can be used to provide the desired capability. Develop an initial methodology to be used in the optimization framework. Perform a demonstration of this methodology in sufficient detail to access its viability to support the ship design problem.

PHASE II: Refine the optimization methodology based on the results of PHASE I. Implement an initial version of the optimization framework that integrates existing design and mission assessment tools with the support of multidisciplinary optimization processes. Demonstrate the framework capability to support at least two ship designs with disparate missions. Demonstrate the optimization methodology and framework using future ship concept designs being formulated by the Center for Innovative Ship Design at NSWC-CD

PHASE III: Investigate the potential for new technology applications in naval ships. Enter teaming arrangements with a shipyard to apply the methods for design/technology insertion studies on an actual platform.

PRIVATE SECTOR USE OF TECHNOLOGY: Shipyards under contract to DoD. Shipyards producing commercial vessels.

REFERENCES:

1. http://www.asdl.gatech.edu/frames_outline.html (Click on "Publications")

2. Brown, A.J., and Thomas, M. (1998), “Reengineering the Naval Ship Concept Design Process”, Research to Reality in Ship Systems Engineering Symposium, NSWC Carderock.

KEYWORDS: Affordable Ship Design, Mission Effectiveness, Multidisciplinary Optimization