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 Ms. Dottie Vincent, (703) 696-4792, vincentd@onr.navy.mil. If you have questions of a general nature regarding the Navy's STTR Program, contact Ms. Vincent. For inquiries or problems with 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 before **13 March 2006**. Beginning **14 March**, for technical questions you must use the SITIS system **www.dodsbir.net/sitis** or go to the DoD website at **http://www.acq.osd.mil/sadbu/sbir** for more information.

The Navy's STTR program is a mission-oriented program that integrates the needs and requirements of the Navy's Fleet through R&D topics that have dual-use potential, but primarily address the needs of the Navy. Companies are encouraged to address the manufacturing needs of the Defense Sector in their proposals. Information on the Navy STTR program can be found on the Navy STTR website at **http://www.onr.navy.mil/sbir.** Additional information pertaining to the Department of the Navy's mission can be obtained by viewing the website at **http://www.navy.mil.**

PHASE I PROPOSAL SUBMISSION:

Read the DoD front section of this solicitation for detailed instructions on proposal format, submission instructions 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 base should be 7 months and will commence on or about 01 August 2006. 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 technical proposals, including the option, have a 25-page limit (see section 3.4). 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.

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 Submission 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 is submitted separately through the website. To verify that your technical proposal has been received, click on the "Check Upload" icon to view your uploaded technical proposal. 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 before **6:00 a.m. EST, Friday, 14 April 2006**. An electronic signature is not required when you submit your proposal over the Internet.

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. Please make sure that your e-mail address is entered correctly on your proposal coversheet or you will not receive a notification.

PHASE I ELECTRONIC SUMMARY REPORT:

In addition to the final report required in the funding agreement, all awardees must electronically submit a non-proprietary summary of that report through the Navy SBIR/STTR website. It must not exceed 700 words and should include potential applications and benefits. Submit the summary at **http://www.onr.navy.mil/sbir**, click on

"Submission", and then click on "Submit a Phase I or II Summary Report". This summary will be publicly accessible via the Navy's Search Database.

PHASE II PROPOSAL SUBMISSION:

Phase II proposal submission is by invitation only. Only those Phase I awardees who achieved success in Phase I, measuring the results achieved against the criteria contained in section 4.3, will be invited to submit a Phase II proposal. If you have been invited to participate, follow the instructions provided in the invitation. The Navy will evaluate and select Phase II proposals using the evaluation criteria in the DoD solicitation. All Phase II proposals must be submitted electronically through the DoD SBIR/STTR Submission website.

All awardees, during the second year of the Phase II, must attend a one-day Transition Assistance Program (TAP) meeting. This meeting is typically held during the summer in the Washington, D.C. area. Information can be obtained at **http://www.dawnbreaker.com/navytap**. Awardees will be contacted separately regarding this program. It is recommended that Phase II cost estimates include travel to Washington, D.C. for this event.

As with the Phase I award, Phase II award winners must electronically submit a Phase II summary through the Navy SBIR/STTR website at the end of their Phase II.

PHASE II ENHANCEMENT:

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 may provide a one-to-four 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.

ADDITIONAL NOTES:

1. The Small Business Administration (SBA) has determined that the Naval Academy, the Naval Post Graduate School and the other military academies may 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.

3. Any contractor proposing research that requires human, animal and recombinant DNA use is advised to view requirements at website **http://www.onr.navy.mil/sci_tech/ahd_usage.asp**. This website provides guidance and notes approvals that may be required before contract work may begin.

PHASE I PROPOSAL SUBMISSION CHECKLIST:

All of the following criteria <u>must be met</u> or your proposal will be REJECTED.

____1. Make sure you have added a header with company name, proposal number and topic number to each page of your technical proposal.

____2. Your complete STTR Phase I proposal (coversheet, technical proposal, cost proposal, and DoD Company Commercialization Report) has been submitted electronically through the DoD submission site by 6:00 a.m. EST, Friday, 14 April 2006.

____3. After uploading your file and it is saved on the DoD submission site as a PDF file, review it to ensure that it appears correctly.

____4. The Phase I proposed cost for the base effort does not exceed $70,000. The Phase I Option proposed cost does not exceed $30,000. The costs for the base and option are clearly separate, and identified on the Proposal Cover Sheet, in the cost proposal, and in the work plan section of the proposal.

Navy STTR 06 Topic Index

N06-T001	HSU Charge Prediction Software for the EFV
N06-T002	Remote Detection of Ocean Surface Roughness Changes
N06-T003	High Torque High Efficiency Electric Motor Technology
N06-T004	Command and Control for Embedded Systems
N06-T005	Navy Applications of 4th Generation Deeply Coupled Computing Architectures
N06-T006	Conventional Training Versus Game-Based Training
N06-T007	Aircraft Electrical Power System Diagnostics and Health Management
N06-T008	Transportable Six Degree of Freedom, Sustained Negative G, Motion Base
N06-T009	High Linearity-High Efficiency Power Amplifiers Based on Digital Signal Processing Techniques and Wide Bandgap Devices
N06-T010	Miniature Electronic Sniffer for Navy Vertical Take off Unmanned Aerial Vehicles (VTUAVs)
N06-T011	Non-Destructive Evaluation / Inspection (NDE/NDI) for Aero Turbine Hot Section Castings and Coatings
N06-T012	High Speed, Precision Machining of Silicon Carbide Ceramic Matrix Composites
N06-T013	Polymer Based, Thermally Conductive and Erosion Resistant Boot Materials/Concepts for Rotor Blade Leading Edge Protection
N06-T014	Delamination Resistant Coating System for Zinc Sulfide Domes and Windows, Utilizing a Compliant Layer.
N06-T015	High Cycle Fatigue (HCF) Prediction, Detection, and Prognosis for Gas Turbine Integrally Bladed Rotors (IBR, Blisks)
N06-T016	Advanced System of Systems Design Capability
N06-T017	Advanced Composites Research to Reduce Cost
N06-T018	Automation of Analysis Model Creation
N06-T019	Research 3-D Screen Technology Utilizing Autostereographics and the impacts on Tactical Operartors in the Command and Control Center.
N06-T020	Power Harvesting for Encrypted Wireless Sensor Clusters
N06-T021	Development of Lightweight and Low Cost Advanced Structural Materials for Off-board Surface Vessels (OBVs)
N06-T022	Waterjet Wake Characterization Suite
N06-T023	High Power Density Swaging Device
N06-T024	Viscous Drag Reduction Using Hydrophobic Surface
N06-T025	Decision Making Constructs for a Distributed Environment (DCODE)
N06-T026	Harvesting Electric Power from Walking
N06-T027	Binary Multi-Taggant System for Unique Target ID
N06-T028	Affordable Monolithic Power Digital to Analog Conversion for Radar, Electronic Warfare, and Communications
N06-T029	RF Waveform Library Reader
N06-T030	Micro-factory for Miniaturization, Portability and Remote Production
N06-T031	Functionalized Nanotubes for High Performance Composites
N06-T032	Compact High-Frequency Antennas
N06-T033	Fault Diagnostics, Prognostics, and Self-Healing Control of Navy Electric Machinery
N06-T034	New Material Compositions That Expand the Operating Domain of Piezoelectric Single Crystals
N06-T035	Cryogenic Processing of Nano-Aluminum Powder and Consolidation of Armor Nano-Aluminum Composite Plates
N06-T036	Acoustic Pattern Recognition for Security Breaching Noise Detection
N06-T037	High Resolution Micro-meteorological Tools for Global War on Terrorism (GWOT) Contaminant Transport and Dispersal Predictions
N06-T038	STTR Friction Stir Processing for Superplastic Forming
N06-T039	High-Power Fiber-Optical Switch for Infrared Countermeasure (IRCM) Laser Applications
N06-T040	Alternative Room Temperature Cure and VARTMable High Temperature Resin Systems for Large Scale Composite Ship Component Manufacturing

Navy STTR 06 Topic Descriptions

N06-T001 TITLE: HSU Charge Prediction Software for the EFV

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: DRPM AAA

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop a nitrogen gas charge software model for the EFV's Suspension System. Twenty-eight unique charge values must be determined in order to correctly charge the EFV's full compliment of HSUs. This is a complex and challenging task requiring that all twenty-eight nonlinear EFV gas springs be modeled as an interrelated system which provides adequate lift, vehicle orientation, and spring stiffness at each of the 14 unique HSU hull locations. The model will need to take into account both adiabatic and isothermal gas spring behavior.

DESCRIPTION: The Marine Corps EFV is a 76,000 lb. armored and tracked troop carrier designed to operate over harsh off-road terrain and in oceans and rivers. In the future, more military vehicles will be using nitrogen gas-charged suspension systems in order to improve ride performance and save weight. The EFV and potentially a significant number of the FCS (future Combat Systems) and MEFFV (Marine Corps Family of Fighting Vehicles) variants will utilize the first of these new type suspension systems and will be deployed in the relatively near future. The EFV is supported by a suspension system that contains fourteen nitrogen/oil charged hydropneumatic suspension units (HSUs). Each individual HSU contains two separate nitrogen/oil gas charges (for a total of 28 gas springs 2 charges x 14 HSUs). The benefits of a dual spring (charge) HSU is improved performance at the cost of significantly increased complexity. This also means that maintenance, in some instances, is much more complex and difficult. Both charge pressures must be correct in order to ensure optimum ride quality, adequate ground clearance, and sufficient cross country speed to keep up with other military vehicles such as the M1 Abrams tank. In order to maintain optimum vehicle mobility, the charge pressures must be readjusted whenever the ambient temperature changes significantly. Currently, charging HSUs must be accomplished in a maintenance facility and requires disconnecting the track system, placing the vehicle on jack-stands, and following a lengthy and detailed procedure to achieve optimum results. This is very time consuming and takes substantial manpower. However, charging HSUs without lifting the vehicle up onto jack-stands is currently not possible. Without jack-stands, each HSU will (in most instances) be in a slightly different angular position and require a different set of charges. In other words, twenty-eight (2 x 14) different charge values must be determined in order to correctly charge a vehicle's full compliment of HSUs. The twenty-eight gas springs are nonlinear and both adiabatic and isothermal behavior must be taken into account. This is a complex and challenging task with significant technical risk due to the difficulties typically encountered in modeling a system this complex. Some degree of error is expected in determining charge predictions but if the error cannot be minimized to an acceptable level, the charge predictions will be useless. All twenty-eight gas springs must be modeled as an integrated and interrelated system which provides adequate lift, vehicle orientation, and spring stiffness at each of the 14 unique HSU hull locations. Determination of accurate charge pressures for these dual spring HSUs will take into account ambient temperature, oil volume in gas, vehicle center of gravity, HSU angular position, vehicle weight, adiabatic and isothermal nitrogen gas behavior, vehicle ground height, vehicle orientation, and many other parameters associated with the internal workings of the HSU. The charge modeling software must be able to take into account all of these variables, parameters, and some empirical data to quickly and accurately provide maintenance personnel with a charge model which provides charge pressures at each HSU station. The software should be portable and capable of running on a personal computer (PC) as well as the vehicle's onboard computer. Providing this capability will allow Marine Corps and Army personnel to independently determine and correct suspension charge pressures at any geographic location without having to rely on maintenance facility support. Another benefit, in the case of HSU battle damage, is that HSUs could be replaced and correctly charged at remote field locations. This capability allows the vehicle to be repaired and quickly put back in service. Marines familiar with EFV consider the goal of this STTR topic an essential capability that is not yet available to them. It is also important to note that this software can be adapted for use on future military and

commercial vehicles which make use of gas charged suspensions and will, in most instances, be considered an essential maintenance tool.

PHASE I: Investigate the EFV HSU charging requirements and conditions. Determine user requirements and propose a detailed software design concept that addresses these needs.

PHASE II: Develop, test and refine the HSU charge modeling software for both a PC and the EFV on- vehicle computer.

PHASE III: Develop detailed and comprehensive software manuals covering both software use and software code design. Develop PC based tutorial/training software to facilitate correct use of the software. Conduct user juries and incorporate improvements and refinements. Provide face-to-face training on software use to civilian and Marine personnel.
Support software distribution throughout the Marine Corps including new revisions and continued support for training.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Software can be used to predict optimum charge pressures for multi wheeled commercial nitrogen charged suspension systems under varying loads. This has potential benefit of offering improved stability for heavy load carrying commercial vehicles. This will improve handling, safety, and vehicle reliability and durability.

REFERENCES:
1. Engineering Design Handbook, Automotive Series Automotive Suspensions, 14 April, 1967, published by United States Army Material Command, pg. 1-22
2. Fundamentals of Vehicle Dynamics, Gillespie, T. D., Copyright 1992, published by Society of Automotive Engineers, pg.147-189

KEYWORDS: nitrogen, charge, HSU, hydropneumatic, software, model

TPOC: Craig Harvey
Phone: (703) 492-3327
Fax: (703) 492-5330
Email: harveyct@efv.usmc.mil
2nd TPOC: Dave Christy
Phone: (703) 490-7236
Fax: (703) 490-5115
Email: ChristyDC@EFV.USMC.MIL

N06-T002 TITLE: Remote Detection of Ocean Surface Roughness Changes

TECHNOLOGY AREAS: Air Platform, Sensors, Battlespace, Space Platforms

OBJECTIVE: Develop innovative and robust algorithms to remotely detect subtle changes to the ocean surface roughness in satellite and airborne imagery resulting from the movement of submerged bodies.

DESCRIPTION: Submerged moving bodies in the ocean can generate a variety of ocean surface hydrodynamic anomalies. Subtle changes in the ocean surface roughness are of particular interest. Near surface currents that cause the roughness changes can result from sources such as submarine generated internal waves or fast surface gravity waves associated with open ocean tsunamis [1, 2, 3]. For example, recent observations [4] of tsunami shadows, i.e. extended darker strips on the ocean surface, along the front of a weak tsunami off Oahu, Hawaii suggest that tsunamis in the deep ocean may be remotely detected through changes in the ocean surface roughness. Another observation of a tsunami shadow is described in [5]. A tentative explanation of the physical mechanism which leads to formation of the tsunami shadow has been given by Godin [6, 7]. His theory predicts that changes in the surface roughness occur as a result of air-sea interaction, more specifically, due to tsunami-induced perturbations in the

wind velocity close to the ocean surface. Theoretically predicted tsunami-induced perturbations of the mean wind velocity are much greater than current velocities in the water and can reach 10% of unperturbed wind velocity.

Measurements of microwave brightness temperature and microwave backscattering cross-section are sensitive to changes in ocean surface roughness. Tsunami-induced changes in the roughness can be recorded, in particular, by sensors already in orbit, such as scatterometers and radiometers currently used to determine surface temperature, wind velocity and wind direction.

A number of scientific and technological questions need to be resolved in order to assess the viability of a broad area sensor system capable of robust detection of surface roughness changes generated by submerged bodies. A key test of the concept could be the analysis of available satellite imagery from the 2004 Sumatra tsunami. The ultimate goal is to extend these results to the detection of submarine generated changes in surface roughness from an airborne sensor.

PHASE I: Develop a theory of surface roughness variation due to interaction of a fast surface gravity wave with turbulent wind. Model radiometric, scatterometer, and SAR microwave signatures of tsunami and submarines. Demonstrate proof of concept by collecting available satellite imagery of the Sumatra 2004 tsunami away from shore. Using computer models of recent destructive tsunamis, search for corresponding tsunami signatures in available satellite data from SSM/I, Quikscat, ERS-1 and 2, NSCAT, and Radarsat.

PHASE II: Investigate effects of atmospheric stability and sea state on wind field perturbation by a tsunami and submarine. Evaluate sensitivity of predicted levels of wind perturbation to the chosen models for the unperturbed atmospheric boundary layer and the Reynolds stresses in the turbulent atmosphere. Develop robust algorithms for roughness change detection in satellite and airborne imagery. Demonstrate the feasibility of real-time detection without a priori information, in microwave imagery from existing sensor systems. Evaluate parameters and determine feasibility of radars and radiometers necessary for an airborne detection system.

PHASE III: Working with sensor system OEMs, develop real-time detection algorithms suitable for evaluation in an operationally representative test environment. A sensor system utilizing proven detection algorithms could be utilized in for submarine detection by a fixed or rotary wing aircraft.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: These methods could also be used on a satellite or aircraft-based system for early tsunami detection and warning.

REFERENCES:
1. Stefanik, T. Strategic Antisubmarine Warfare and Naval Strategy, Institute of Defense and Disarmament Studies, Lexington Books, Lexington MA, 1987
2. Gonzalez F. I. Tsunami!, Scientific American, 280, N 5, 56-65, 1999.
3. NOAA Scientists Able To Measure Tsunami Height From Space, available online at http://www.noaanews.noaa.gov/stories2005/s2365.htm
4. Walker D. A. Observations of tsunami “shadows:“ Technique for assessing tsunami wave heights?, Science of Tsunami Hazards, 14, 3-11, 1996.
5. Dudley W. C. and Lee M. Tsunami!, Univ. of Hawaii Press, Honolulu, 1998. P. 5.
6. Godin O. A. Air-sea interaction and feasibility of tsunami detection in the open ocean, J. Geophys. Res., 109, CO5002, doi:10.1029/20021JC002030 (2004); Science, 304, 1569(2004)
7. Godin O. A. Wind over fast waves and feasibility of early tsunami detection from space, Proceedings of the 2nd International Conference “Frontiers of Nonlinear Physics” (Nizhny Novgorod - St. Petersburg, Russia, 5-12 July 2004), in press.
8. Irisov V. G. Azimuthal variations of the microwave radiation from a slightly non-Gaussian sea surface, Radio Sci., 35, 65-82, 2000.

KEYWORDS: Electromagnetic Scattering; Oceanic Technology; Radar Scattering; Maritime Surveillance; Algorithms; Imagery

TPOC: (301)342-2637
2nd TPOC: (301)342-2043

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N06-T003 TITLE: High Torque High Efficiency Electric Motor Technology

TECHNOLOGY AREAS: Air Platform, Ground/Sea Vehicles

ACQUISITION PROGRAM: F-35/Joint Strike Fighter

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop a new class of high torque high efficiency electric motor that is suitable for a replacement of current leading edge flap drive systems.

DESCRIPTION: Current leading edge flap drive systems are actuated by complex hydraulic/electric gear motors that incorporate electrical and hydraulic parts with gear transmissions. These high torque, high power systems are too heavy and complex, adding weight, volume, and increasing likelihood of failure in moving parts. Innovative high power density electric motor technology suitable for the use with flight surface actuation is sought. Successful electrification of actuation elements in aerospace systems would significantly change the design of future platforms, reducing weight, volume, operations and maintenance cost, and systems complexity, and increasing the prospect of system redundancy.

Proposed system designs must be able to meet form-factor, g-force (80g) min requirements for the range of aerospace actuation applications. Torque densities 100 N-m/l min., power-density (35 kW/l) min, torque range (50 – 250 N-m), power (50 –150 kW) and efficiency are also key development objectives. It is desirable for system design to be scalable in torque and power for utilization in linear and rotary formats. Approaches involving motor gear combinations with minimum moving parts are desirable and should be cost effective. Low gear tooth contact pressure, zero gear lash, weight and volume are also important characteristics.

System development approaches should account for integration into existing platform thermal management systems, i.e. designed solutions should include the capability to be effectively and reliably cooled/heated using directed air/high temperature coolant. A fixed armature shows promise for dynamic cooling that is impossible for moving armature systems.

PHASE I: Demonstrate the feasibility of the proposed high density electric motors design for use in current JSF and F/A-18 leading edge flap systems.

PHASE II: Develop a prototype electronic motor based on Phase I study that meets or exceeds current JSF and /or F/A-18 leading edge flap system specifications. Demonstrate described operational capabilities through testing.

PHASE III: Complete development effort and insert the product into the Joint Strike Fighter or other program, as systems are upgraded.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The high torque, high power density electric motor has tremendous potential in the electric automotive field. A light-weight small volume motor permits insertion into wheel hub assemblies for any high torque application. The low sprung weight offers a tremendous savings potential for all-wheel drive systems in heavy warehouse and construction type equipment. Lighter, smaller, high power systems will also be applicable to any military or commercial aircraft, ship, and/or transport system.

REFERENCES:

1. Navy Electrical Power and the Future: http://www.nap.edu/html/tech_21st/t8.htm

2 NASA goals and future requirements for electric propulsion systems http://www.grc.nasa.gov/WWW/RT/2004/RS/RS08S-kascak2.html
3. NASA high power density technical forecast for the future: http://www.grc.nasa.gov/WWW/RT/2004/RS/RS19S-johnson.html
4. Leading Edge Flap Mechanical Drive Group System, Boeing/MDC Procurement Spec number 74-660056

KEYWORDS: High Torque, High Power Density Motor; Electronic Actuators; Fly by Wire; Aircraft Electric Propulsion; Ship Propulsion; Submarine Propulsion

TPOC: (301)342-8549
2nd TPOC: (301)757-2314

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N06-T004 TITLE: Command and Control for Embedded Systems

TECHNOLOGY AREAS: Information Systems, Sensors

OBJECTIVE: Develop application frameworks and tools for exploiting proximal sensors within the context of large Navy Command and Control (C2) systems.

DESCRIPTION: Embedded systems are generally thought of as a combination of special purpose hardware and software that exists inside a device such as is used in automobiles, medical equipment, even poker chips, or as is common in the military, unattended ground sensors. Embedded systems work with low-end processors with scaled down operating systems and languages. Small, unattended sensor systems that can be deployed in a dense network that exists in close proximity to potential targets can provide future military operations with engagement solutions that could not otherwise exist. These simple, inexpensive sensors can obtain precision situational awareness information on battlefields that are filled with clutter, such as urban areas. Since they may be deployed in huge numbers, the benefit of accurate target acquisition and tracking will be balanced against new demands on command and control systems requiring collaboration, communications, data aggregation and interpretation.

The Navy is interested in finding ways to exploit embedded systems data as an integral part of time-sensitive-targeting (TST). The means of exploitation should go beyond static reports or representations of sensor data within larger scale sensor reporting systems. The goal is to interact with the sensor fields to adjust event reporting, data filtering, collaboration and fusion based on the needs and availability of supporting systems. Proposed C2 methods should accommodate both embedded systems hardware and current TST applications.

PHASE I: Initial development effort to include a conceptual architecture framework for integrating embedded systems within available C2 systems. Present a software solution and show the feasibility for managing large numbers of unattended sensors in a real-time environment while providing exploitable data about a particular target.

PHASE II: Interoperability demonstration involving an applicable C2 system and a cluster of embedded sensors. Include a virtual TST scenario wherein real-time engagement requires manipulation of embedded sensor field properties such as reporting speed, filtering, etc.

PHASE III: Evolve system demonstration to product design that includes fusion with other existing battlefield ISR systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The commercial market for embedded systems is growing. Standardization of software languages and operating systems and frameworks for human interaction and control of embedded systems is evolving. This project will leverage commercial embedded hardware and software for this application. Aggregation techniques and human computer interfaces developed under this program can transfer to commercial applications.

REFERENCES:
1. Author: D. Gay, P Lewis et al, "nesC 1.1 Language 3eference Manual
2. Crossbow Extreme Scaling Mote Hardware System, XSM6ooCA www.xbow.com
3. G. Simon, P. Volgyesi, et al, Vanderbilt University, "Similation-based Optimization of Communication Protocols for Large-scale Sensor Networks."
4. A. Arora, P. Dutta, et al, "A Line in the Sand: A Wireless Sensor Network for Target Detection, Classification, and Tracking."

KEYWORDS: Embedded Systems; Unattended Sensors; C2; Targeting; Sensor Fields; Exploitation

TPOC: (301)904-3502
2nd TPOC: (301)342-0060

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N06-T005 TITLE: Navy Applications of 4th Generation Deeply Coupled Computing Architectures

TECHNOLOGY AREAS: Information Systems, Electronics

OBJECTIVE: Investigate and demonstrate the advantages of applying 4th generation deeply coupled computing architectures to Navy operational, simulation, and/or virtual testing systems. Deeply coupled computing for this project refers to any computer where inter-processor interactions and synchronization occur at intervals ranging from instantaneous on a chip to less than one microsecond for massively scaled systems.

DESCRIPTION: Most military systems today employ digital processors that execute serial code to perform various functions from sensing a threat or detecting a target to operating the entire weapon system or network of systems. The Department of Defense spawned the semiconductor industry during the Minute Man Missile era and has watched it grow to a huge worldwide industrial base where the basic transistors and even entire processors are becoming essentially free. These integrated circuits (IC's or "chips") have enjoyed an unprecedented era of innovation where their performance and efficiency have about doubled every two years as the geometries of their critical components scale to ever smaller dimensions measured in 100-200 nanometers today. They have followed "Moore's Law" that would indicate that this scaling will now drop to 90 nm, then 65 nm, then 45 nm, then 32 nm and so on. The workhorse of this era of computational plenty has been the uniprocessor and it has become more embedded into ever larger functions with each technology generation. Recently however, it is becoming more apparent that this continual technology move forward may be nearing an end or, at a minimum, may require a more holistic approach to achieve the future promises. The uniprocessors have given way to multiprocessors but these too have limits associated with the need to move data between processors or to/from memory (latency). In fact, these computer system latencies have actually been increasing when measured as the number of processor clock cycles required to access off-chip memory. Even super computers today suffer from these limitations. Fortunately, semiconductor-manufacturing tools permit scaling to the degree that entire systems can be built on a single chip. This System-on-Chip (SoC) era combined with novel deeply coupled architectures can enable complete inter-processor interaction and synchronization to occur at intervals ranging from instantaneous on-chip to less than one microsecond for massively-scaled systems, and enable workloads to be effectively shared across large arrays of processors. In turn, high bandwidth, low latency inter-processor interactions allow fine grain parallelism to be exploited, providing the means to extract parallelism from seemingly sequential code.

This program will explore the applications of this fourth generation technology to Navy systems where innovation beyond the microprocessor generation enables more efficient and cost effective solutions to complex problems. This disruptive innovative holistic approach to hardware and software is expected to yield benefits to existing applications as well as to new simulation capabilities, virtual testing capabilities, and efficient network centric operational capabilities.

PHASE I: Provide a conceptual developmental plan for applying SoC technology and 4th generation architectures to a selected set of Navy processor intensive applications (e.g., space-time adaptive processing, virtual range clutter generation, high performance clock-accurate virtual systems modeling, etc.) and/or size constrained applications

such as on-board sensor processing in UAV's. Prototype conceptual hardware demonstrations may be performed. Advance software partitioning concepts may be demonstrated.

PHASE II: Apply advanced systems design and modeling tools to demonstrate the advantages of applying 4th generation deeply coupled architacture technology to a selected Navy system application. Demonstrate the ability to partition software for fine-grained processing enabled by deeply coupled computing. Provide beta hardware and software for demonstrating the efficacy of the chosen technology for meeting Navy needs.

PHASE III: Provide the tools and technology necessary for systems designers to apply deeply coupled architectures to Navy weapons systems, simulation systems and test systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Fourth generation deeply coupled computing architectures along with System-on-Chip technology will have a profound direct impact on several commercial applications including high productivity computing/super computers, high-performance modeling and simulation (e.g., for automotives, commercial aircraft/spacecraft, pharmacuticals, genetic engineering, etc.).

REFERENCES:
1. Keynote address entitled "Driving Systems Performance – A New Paradigm (For most technologists)," delivered by Dr. Bernard S. Meyerson, Vice President and Chief Technologist, Systems and Technology Group, IBM Corporation, during the 2004 Fall Microprocessor Symposium
2. CPU Technology Whitepaper "The New Frontier... Deeply Coupled Computing" found at http://www.cputech.com/papers/DCCoverview1104.pdf

KEYWORDS: System-on-Chip; Deeply Coupled Architecture;

TPOC: (301)904-3502
2nd TPOC: (301)904-3184

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N06-T006 TITLE: Conventional Training Versus Game-Based Training

TECHNOLOGY AREAS: Information Systems, Human Systems

OBJECTIVE: Develop innovative tools capable of evaluating and optimizing specific functional characteristics of game based training for Navy applications and demonstrate with empirical evidence the benefits over conventional training methods.

DESCRIPTION: In order for games to be used in training in both the military and in the private training arena, evidence of their strengths for training and increasing human performance is crucial. Currently, use of game-based trainers is being made from anecdotal evidence, and it is not known when or how to apply game based training. . Successful completion of this project will help establish a scientific foundation for determining whether games are appropriate for various training arenas. Additional research is needed to determine which types of training (simulation, e-Learning, or classroom competitions) are best for different types of training objectives.

The entertainment industry has long produced games that use PC-based simulations in order to provide interactive experiences and challenging situations that are similar to the experiential learning that occurs in expensive military simulators, or live training exercises. To optimally harness this ability of games, first requires empirical evidence directing the development and fielding of such training and quantifying when the effort is worth the time and resources being spent. Research must be performed to compare human performance learned in game-based training with that learned in a traditional training curriculum. The output of this research effort will be a tool for evaluating and recommending specific functional characteristics of games that are appropriate for specific types of training objectives. If successful, the proposed research findings would form a foundation for comprehensive training/gaming development, further Instructional Systems Design, and provide return on investment (ROI) metrics

for any future game based training developments. This will represent a significant scientific contribution to the theory and practice of Instruction System Design.

PHASE I: Conceptualize, and design an innovative method for evaluating training requirements and for determining the most effective combination of training game characteristics between a game based solution and a non-game based solution. Gaming examples can range from simple didactic competitions to fully immersive multiplayer exercises that are cognitively complex and require interaction with others in a cooperative team type of competition. Identify measurable performance variables provided by the use of game-based training solutions. Provide a taxonomy of gaming characteristics; a grouping of training objective types and a theoretical framework linking game characteristics and training objectives. Demonstrate technical feasibility of a proposed tool that provides guidelines and assistance for developing game based training solutions. Identify Navy training courses suitable for testing hypothesized relationships. Potential training categories include: problem solving skills, ambiguous situation training, decision making in rapidly changing environments, tactical skill development of large teams, and high performance tasking.

PHASE II: Refine, design and develop a game variant(s) of the selected training course(s) and execute experimental comparisons. Analysis of data from the experiments should define when and how games should be used for training, as compared with conventional learning paradigms, as well as provide a baseline for further development of the tool.

PHASE III: Refine and produce a prototype product that details the proper application of game based training solutions to educational curriculum. Products shall be training domain independent and applicable to military as well as commercial applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL: It is expected that these decision tools will be viable in not only military training but also in academic and commercial training environments. These tools will help gaming companies identify potential training applications for their products and help to clarify the role that their gaming products can play in meeting military training objectives. Sample commercial application areas include training involving medical, electronic and mechanical diagnostic skills, decision making skills, and language training.

REFERENCES:
1. Driskell, James, Dwyer, Daniel, 1984, Microcomputer Videogame Based Training, Educational Technology, February 1984
2. Garris, R., Ahlers, R., & Driskell, J. E. (2002). Games, motivation, and learning: A research and practice model. Simulation & Gaming, 33(4), 441-467.
3. Prensky, Marc, 2001, Digital Game-Based Learning, McGraw-Hill, New York, NY.
4. Aldrich, Clark, 2003, Simulations and the Future of Learning, Pfeiffer
5. Aldrich, Clark, 2005, Learning by Doing: A Comprehensive Guide to Simulations, Computer Games, and Pedagogy in e-Learning and Other Educational Experiences, Pfeiffer

KEYWORDS: Game-Based Learning; Serious Games; Simulation; Training; Gaming; Instructional System Design

TPOC: (407)381-8682
2nd TPOC: (407)380-4833

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N06-T007 TITLE: Aircraft Electrical Power System Diagnostics and Health Management

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: PMA-290

OBJECTIVE: Develop diagnostic and prognostic technologies for aircraft electrical power systems and integrate these into the overall vehicle health management system providing improvements in aircraft maintenance, readiness, and safety.

DESCRIPTION: Typical failure modes for aircraft electrical power systems include bearing and winding failures in the generators, overcharging and heating of the batteries, and open and short circuits in the wiring system. The majority of these failures can be managed with the appropriate diagnostic and prognostic technologies and supporting systems. This capability, when integrated into the overall vehicle health management system, would provide aircraft with substantial improvements in maintenance, readiness, safety, and cost. The intent of this effort is to address health monitoring for power system components such as generators, converters, and batteries. Wiring system diagnostics have been addressed by previous efforts.

Innovative research is needed to solve the technical challenges associated with developing and integrating power system diagnostics and prognostics into aircraft. Technical challenges include, but are not limited to: 1) characterizing the faults that occur in aircraft components and correlating these failures to the health of the component (e.g. determine failure type, severity, and location), 2) developing appropriate algorithms to differentiate between these failure modes and normal aircraft operational modes and environments, 3) developing or selecting sensors that can withstand the harsh aircraft environment and provide the required performance criteria, 4) simplifying data analysis and developing a graphical user interface that is easily interpreted by the maintenance community, and 5) packaging and integrating the technology into the aircraft electrical power system and vehicle health management system.

PHASE I: Define a technical approach and develop an implementation plan for integrating power system diagnostics and prognostics into aircraft. Validate the approach analytically or provide test data or bench top hardware that validates the approach.

PHASE II: Design, develop, and demonstrate a prototype health monitoring system for selected aircraft power system component(s). Demonstration includes a high-fidelity laboratory environment and/or aircraft ground demonstration.

PHASE III: Complete packaging and integration of the prototype health monitoring system for use in a Navy aircraft platform, complete safety of flight certification, and perform a flight demonstration. Transition technology to NAVAIR Program Offices for final system integration, flight evaluations, and procurement.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The technology developed under this effort has potential application in space, sea, air, and land vehicles. This technology will result in an increase in safety and reliability for these vehicles while reducing maintenance troubleshooting times and maintenance costs. Commercial airlines are specifically interested in diagnostic technologies for electrical power systems. Also, the results of this work can be applied to consumer products and industrial applications, such as an extension to the arc fault circuit interrupter (AFCI) technology being implemented in residential homes and commercial buildings. Other private sectors that face similar power system degradation and safety concerns include the power utilities, automotive industry, and production plants.

REFERENCES:
1. “For HUMS Read Improved Safety” and “The Technology Behind HUMS”, Smiths Industries Aerospace Review, Number Seventy, Winter 2000, pgs 6-13, www.smithsind-aerospace.com.

KEYWORDS: Electrical Power Systems; Diagnostics and Prognostics; Health Management; Condition Based Maintenance; Generator; Battery

TPOC: (301)342-0816
2nd TPOC: (301)342-0815

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N06-T008 TITLE: Transportable Six Degree of Freedom, Sustained Negative G, Motion Base

TECHNOLOGY AREAS: Air Platform, Space Platforms, Human Systems

ACQUISITION PROGRAM: MH-60S

OBJECTIVE: Develop a new generation of low-cost, transportable, motion-stimulation trainers through research and development of innovative vestibular cuing technologies capable of stimulating sustained negative-g sensations, spins, rolls and heave/ thrust.

DESCRIPTION: Current flight simulators offer severely limited range of motion, only 40 to 60 degrees of pitch and roll and limited translation. In addition, today's flight simulators are stationary and require dedicated facilities that are costly and consume a great deal of space. Recent advances have demonstrated how vestibular cueing can be remotely stimulated through a small device worn on the neck.1, 2 Galvanic vestibular stimulation, or GVS, remotely stimulates a trainees sense of balance, and creates a sustained sense of leaning or turning by simply electronically altering the users perceived center of balance. NASA researchers have noted "Despite the widespread use of motion in research and training simulators, many aspects of motion cues have not been objectively determined."3

While GVS research has demonstrated that postural rotational or tilt sensations can be separated from auditory stimulations, a device that reliably excites specific and verifiable cues from the vestibular system is not currently available.4 The finding that GVS interacts with other sensory systems, led Bense, Stephan, Yousry, Brandt and Dieterich (2001) to theorize that it may provide a basic mechanism for creating a sense of spatial orientation and self-motion.5 It is known that uncoupled motion significantly impacts ($p < .05$) both task performance as well as self-reported simulator sickness scores (Muth, Walker, and Fiorello, in press).6 The potential of GVS for elimination of the uncoupled motion cue conflicts is unknown, but if successful, GVS may offer a technology that both enhances performance and reduces motion sickness.

Additional applied research is required to achieve the full potential of external vestibular cueing to safely replace or augment today's physical motion trainers. If vestibular cueing technologies were found to be safe, and if such cueing could also be refined enough to reliably induce the same motion sensations (across subjects); a new generation of low-cost, transportable, motion-stimulation trainers could be developed. Furthermore, today's training devices may also be enhanced by this research by adding motions not commonly available in current flight simulations (such as catapult launches, spins, rolls). However, to validate such motion the actual forces of those motions would need to be calculated and then physically modeled in the laboratory, then tested against incremental additions of vestibular stimulation. For example, the auditory and visual cues of being launched off the deck of a carrier can be simulated today, but the amount and location of simultaneous vestibular cueing needed to safely and reliably complete that illusion –has yet to be determined. Proposals combining expertise in the scientific research of motion systems, experience in research of the physiology of vestibular functioning, experience in flight simulation research and motion sickness research, as well as an environment recognized for innovative engineering are sought.

PHASE I: Determine the feasibility of an innovative motion-base device capable of at least two concurrent 360 degree rolls and/or spins while maintaining full flight-simulation functionality. Develop an experimental framework for analysis of variables such as: Degree of Motion, between subject variability, and types of tasks being trained.

· Identify critical tasks that involve heave, surge, and sway and are not adequately addressed by current motion base technology (e.g., carrier launch, rotor tail damage, VSTOL emergency procedures, inverted flight, sustained negative-g maneuver (red out) 180 degrees).
· Define motion cues of identified tasks.
· Focus on technical feasibility of small lightweight devices capable of inverting user(s) and modeling the identified critical tasks.
· Propose alternative methods of stimulating the motion experienced during performance of the identified tasks, such as GVS and other methodologies.
· Propose methods of determining the long and short term side effects of vestibular cueing.
· Determine industry (and entertainment) cost/performance capabilities of COTS motion base systems.

PHASE II: Develop a prototype training system based on Phase I research.. Establish laboratory experimental protocols. Validate effectiveness and safety of improved motion cueing for transfer of tasks identified in Phase I in joint Navy/University research through testing.

PHASE III: Produce a next generation, six-degree of freedom (stimulated or otherwise), sustained negative-g, transportable trainer for transition to the military and commercial flight training markets. If warranted, broaden GVS research into other simulation based training applications (wheeled vehicle motion, surface ship movements, submarine trainers, prescreening candidates for flight training, long-term side-effects, etc.).

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Successful development of the sustained negative-g motion cueing would mean that dedicated facilities would no longer be required for motion-base simulation. A device that targets areas of the vestibular system to reliably create the illusion of different types of motion across users would benefit the entire aviation training industry. If vestibular cueing devices were added to static trainers in classrooms, perhaps even eventually on-board ship6 etc., they could provide the degree of realism necessary to maintain flight qualifications7, 8 –at a fraction of today's costs. Combining vestibular cueing with head mounted displays, could lead to a new generation of simulation that safely provides an experience of altered spatial orientation and motion through the use of a single (helmet like) device. A possibility exists that static or fixed-base trainers could also benefit through enhancement of induced motion cueing. Other branches of the military would benefit, as could the commercial aviation industry. If a new device could safely, reliably, and remotely produce motion sensations, (e.g., forward, back, up, down, left right, etc.) the commercial gaming industry would also be interested for entertainment purposes.

REFERENCES:

1. Remote Control Humans. http://www.forbes.com/technology/2005/08/04/technology-remote-control-humans_cx_lh_0804remotehuman.html

2. Fitzpatrick, R; and Day, B. (2004). Probing the human vestibular system with galvanic stimulation Journal of Applied Physiology, 96: 2301-2316

3. Vertical Motion Simulator Research. NASA Ames Research Center, SimLabs, VMS. http://www.simlabs.arc.nasa.gov/vms/research.html

4.Muth, E.R., Walker, A.D., Fiorello, M. (in press). Effects of uncoupled motion on performance. Human Factors.

5. Bense, S.; Stephan, T.; Yousry, T.; Brandt, T.; and Dieterich, M. (2001). Multisensory Cortical Signal Increases and Decreases During Vestibular Galvanic Stimulation. The Journal of Neurophysiology Vol. 85 No. 2 February 2001, pp. 886-899

6. ERIC R. MUTH AND BEN LAWSON. (2003) Using Flight Simulators Aboard Ships: Human Side Effects of an Optimal Scenario with Smooth Seas. Aviation, Space, and Environmental Medicine' Vol. 74, No.5' May.

7. Telban, Robert, J; Cardullo, Frank, M; Houck, Jacob, A., Developments in Human Centered Cueing Algorithms for Control of Flight Simulator Motion Systems Report number(s): AIAA 99-4328 Date: August 9-11, 1999

8. Longridge, Thomas, Bürki-Cohen, Judith, Go, Tiauw H., Kendra , Andrew J. Simulator fidelity considerations for training and evaluation of today's airline pilots. Proceedings of the 11th International Symposium on Aviation Psychology, Columbus, OH, 5-8 March 2001 www.hf.faa.gov/docs/508/docs/VolpeLongridge2001.pdf

9. Lobel, Elie; Klein, Justus F; Bihan, Denis Le; Anne, Leroy-Willig; Berthoz , Alain, Alex. (1998). Functional MRI of Galvanic Vestibular Stimulation. The Journal of Neurophysiology Vol. 80 No. 5 November 1998, pp. 2699-2709. http://jn.physiology.org/cgi/content/full/80/5/2699

KEYWORDS: Motion-base; aviation; training; cross-platform; six degree of freedom; negative G; vestibular stimulation

TPOC: (407)380-4631

2nd TPOC: (407)380-8458

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N06-T009 TITLE: High Linearity-High Efficiency Power Amplifiers Based on Digital Signal Processing Techniques and Wide Bandgap Devices

TECHNOLOGY AREAS: Air Platform, Sensors, Electronics, Weapons

ACQUISITION PROGRAM: E-2 Advanced Hawkeye

OBJECTIVE: Achieve high linearity and high efficiency for power amplifiers in airborne communication systems through innovative digital signal processing (DSP) techniques in conjunction with wide bandgap semiconductor devices.

DESCRIPTION: The information age has driven the DoD to transform military airborne and ground systems from platform-based to network centric. The DoD is allocated and owns a limited portion of the frequency spectrum and therefore must utilize its spectrum efficiently. This demand for wireless systems for airborne and mobile carriers has created a need for high linearity-high efficiency power amplifiers [1]. In communication systems, high linearity is required to minimize signal distortion, reduce bit error rate, adjunct channel interference and improve spectral efficiency [2]. In practice, high linearity is achieved by backing-off the saturated power level. Consequently, backing-off reduces the amplifier power-added efficiency (PAE). The amplifier PAE has a significant impact on the size, weight, and power consumption of the total system [3][4]. Low-efficiency power amplifiers consume valuable system prime power and dissipate unwanted heat. As a result expensive and large thermal circuitry must be incorporated into the power amplifier architecture, which increases the system size, weight and decreases the system reliability.

Next generation communication systems must be designed to support multiple users, transmit large quantities of information, and transmit non-constant envelope waveforms at high data rates over wide operational and instantaneous bandwidths. Advancements in high-speed DSP techniques facilitate increasing power amplifier linearity through digital predistortion, feedback and feed-forward techniques [1][2]. High linearity techniques are expected to compensate for inherent amplifier non-linearities and increase spectral efficiency due to the limited usage of the frequency spectrum. With the advent of wide band-gap semiconductors, such as silicon carbide (SiC) and gallium nitride (GaN), power amplifiers can now produce higher power densities, perform with higher power-added efficiencies, and are capable of operating at higher temperatures than conventional power amplifiers [5].

This effort seeks to integrate the innovative capabilities of both high-speed DSP techniques and wide bandgap semiconductors to achieve high linearity and high efficiency for power amplifiers in airborne communication systems. This proposed synergy of digital techniques and wide bandgap device technologies is expected to maximize the linearity to achieve high efficiency of power amplifiers and maintain signal integrity for orthogonal frequency division multiplexing (OFDM) waveforms. The targeted operational bandwidth is the L-band (1-2 GHz). Desired capabilities across the band are 150 watts average output power with peak-to-average power ratio between of 8 to 12 dB, 50% PAE, 30 MHz of instantaneous bandwidth, and -50 dBc intermodulation distortion (IMD). Proposed approaches should reduce signal distortion, harmonics, and adjacent channel interference. Concept designs should meet small airborne form factor and operate with available prime power.

PHASE I: Research and investigate the feasibility of a high linearity-high efficiency DSP-enabled power amplifier using wide bandgap semiconductor devices to demonstrate the described capabilities and maintain signal integrity for complex modulation waveforms.

PHASE II: Develop a prototype high linearity-high efficiency power amplifier architecture for an airborne or UAV application. Demonstrate the described operational capabilities using accurate computer modeling and simulation tools.

PHASE III: Demonstrate and transition the power amplifier architecture for a UAV, E2D, or MMA platform.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The RF power amplifier has the largest impact on the cost, size, weight and power of wireless communication systems. The results of this research have direct applications to the mobile cell phone, fixed base stations, satellite systems and automobile automatic collision avoidance systems. There is a continuing demand to transmit multimedia information while minimizing signal distortion. This requirement can be achieved with high linearity high efficiency amplifiers.

REFERENCES:

1. L. Larson, P. Asbeck, D. Kimball, "Next Generation Power Amplifiers for Wireless Communications Squeezing More Bits Out of a Few Joules", 2005 IEEE Radio Frequency Integrated Circuits Symposium, June 2005, pg. 417-420.

2. E. G. Jeckeln, F. M. Ghannouchi, and M. A. Sawan, "A New Adaptive Predistortion Technique Using Software-Defined Radio and DSP Technologies Suitable for Base Station 3G Power Amplifiers", IEEE Transactions on Micorwave Theory and Techniques, vol. 52, no. 9, September 2004, pg. 2139-2147.

3. Wangmyong Woo; Miller, M.; Kenney, J.S.; "Predistortion linearization system for high power amplifiers", Microwave Symposium Digest, 2004 IEEE MTT-S International, vol. 2, 6-11 June 2004, pg. 677 – 680.

4. Kenington, P.B.; High Linearity RF Amplifier Design, Norwood, MA: Artech House, 2000.

5. R. T. Kemerley, H. B. Wallace, and M. N. Yoder, "Impact of Wide Bandgap Microwave Devices on DoD Systems", Proceeding of the IEEE, vol. 90, no. 6, June 2002, pg. 1059-1064.

KEYWORDS: Power amplifier; DSP; wide bandgap; linearity; efficiency; OFDM

TPOC: (301)342-9094
2nd TPOC: (301)342-9135

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N06-T010 TITLE: Miniature Electronic Sniffer for Navy Vertical Take off Unmanned Aerial Vehicles (VTUAVs)

TECHNOLOGY AREAS: Air Platform, Chemical/Bio Defense, Sensors

OBJECTIVE: Develop an innovative smaller, lighter, and more sensitive electronic sniffer sensor that detects Chemical, Biological, Radiological, explosive, and illegal drug residue.

DESCRIPTION: The addition of sniffer sensor capability to a small, VTUAV would provide a vital remote inspection capability to small Navy and Coast Guard vessels. Currently, the US Navy Cyclone Class patrol boats are patrolling the waters of the Arabian Gulf with the mission of surveillance and interdiction of insurgent, terrorist and drug trafficking surface vessels. The primary threat to Navy vessels, and our sailors, is from being approached by explosive filled vessels, possibly manned by suicide bombers, such as occurred with the USS Cole. Our sailors board these vessels for inspection unaware of the explosive threat. A small VTUAV such as the Voyeur which is currently being developed under the Sonochute Launched UAV (SL-UAV) STTR, would provide a stand-off inspection capability of surface vessels with the ability to detect explosives, chemical, biological, radiological agents and some illegal drugs. Current sniffers have limited capability, and are too large and heavy to be mounted on a VTUAV small enough to be operated from a Cyclone class (170ft long, no helo pad) sized vessel. The sniffers also lack the sensitivity required to consistently and accurately identify the target substances from a practical range. The Voyeur VTUAV, for example, can reasonably hover within 10 feet of a suspect vessel but the target substances bay be contained down within the vessel making the effective sniffing range much greater. The objective would be to have a weight threshold of just under 5 pounds with the ultimate goal to be under 1.5 pounds. Currently, the Voyeur VTUAV can carry payloads up to 1.5 lbs based on the constraints of being launched from a Sonochute Tube.

PHASE I: Develop the design approach and demonstrate feasibility to meet the above requirements for a small, light, ultra sensitive airborne sniffer to be mounted and operated remotely from a VTUAV.

PHASE II: Develop, produce and demonstrate a prototype sniffer that could be mounted on a VTUAV such as the Voyeur. The demonstrations should be at various altitudes, ranges and positions relative to this boat in order to test/verify the capabilities of the sniffer. The sniffer, demonstrated in this phase, may not be "full spectrum" capable, i.e. it might not detect explosives, chemical, biological, radiological agents AND illegal drugs, but at a minimum it should be able to detect explosives.

PHASE III: Produce a qualified, producible, airworthy electronic sniffer with full spectrum or multiple substance capabilities that returns real time results through the VTUAV's digital radio data link.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Coast Guard and TSA safety and homeland defense aspects would benefit greatly from this technology. Such sensors and UAVs would be ideal for rapid response to public safety situations. Small, light, and fast UAVs capable of detecting harmful agents would be able to crisscross a suspect area and determine the boundary of affected areas. In addition, these systems could be used to identify, inspect and pre-screen foreign vessels before they enter US ports.

REFERENCES:
1) http://www.sandia.gov/LabNews/LN05-30-03/key05-30-03_stories.html#microhound
2) http://www.sandia.gov/media/NewsRel/NR1999/sniffers.htm
3) http://www.sciencenews.org/articles/20030823/fob3ref.asp
4) http://www.saferamerica.com/explosivesdetectors.asp
5) Draft Sonochute Launched – Unmanned Aerial Vehicle (SL-UAV) Performance Based Specification (PBS), 17 November 2004
6) Additional information on Voyeur VTUAV specifications will be placed on SITIS at: http://www.dodsbir.net/sitis/

KEYWORDS: Sniffer; Explosives; Detection; Sensor; VTUAV; Chem/Bio

TPOC: (301)342-9108
2nd TPOC: (301)995-4201

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N06-T011 TITLE: Non-Destructive Evaluation / Inspection (NDE/NDI) for Aero Turbine Hot Section Castings and Coatings

TECHNOLOGY AREAS: Air Platform, Ground/Sea Vehicles, Materials/Processes

OBJECTIVE: To develop innovative Non-Destructive Evaluation / Inspection (NDE/NDI) methods for advanced component design, development validation, and acceptance testing of turbine airfoils and hot section components.

DESCRIPTION: Gas turbine engines of military and commercial aircraft require extremely durable, reliable and affordable hot section components in order to meet their design life requirements in extreme environments. Defects in fabrication and repair processes adversely affect turbine hot-section performance and decrease component durability. These defects are difficult to detect without destructive evaluation of parts. Existing NDE/NDI methods for turbine hot sections are labor intensive, complex, expensive, and provide limited resolution, preventing detailed flaw detection, characterization, and evaluation. As a result, the capability to increase hot section component life is jeopardized. Proposed NDE/NDI technologies and/or methods should provide the capability to: detect small cracks and casting defects, inspect turbine coating quality and cooling hole blockage, and check for component/structure deterioration after a period of service.

PHASE I: Determine the feasibility of an affordable NDE/NDI technology or method to evaluate the heat transfer and structural characteristics of current and advance cooled hot section parts.

PHASE II: Design and demonstrate a full-scale prototype system for an existing turbine hot section component or production line.

PHASE III: Define a transition plan to insert the inspection technology into casting vendor, engine manufacturer or engine depot production and inspection processes.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Successful development and transition of a new inspection technology into the military fleet has direct application to engines in commercial air fleets and on land-based power gas turbines. Accurate and economical inspection of complicated air-cooled gas turbine hot section parts is as important to the US commercial aircraft market as it is to the DoD. For example, the commercial gas turbine industry would benefit from the reduction of inspection costs and unscheduled removals as well. Both commercial and military users will also save maintenance costs by not scrapping costly hot section parts that are actually flight worthy and acceptable for additional use.

REFERENCES:
1. Additional details for this topic are available on the SITIS website. http://www.dodsbir.net/sitis/

2. ASM Handbook Volume 17: Nondestructive Evaluation and Quality Control, ASM International, 1989.

KEYWORDS: Gas turbines; Non-destructive evaluation; Non-destructive inspection; Airfoil cooling passage blockage; Turbine coatings; Turbine airfoil castings

TPOC: (301)757-0492
2nd TPOC: (301)757-0465

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N06-T012 TITLE: High Speed, Precision Machining of Silicon Carbide Ceramic Matrix Composites

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: F-35/Joint Strike Fighter

OBJECTIVE: Develop and demonstrate high speed, precision, machining processes and/or tooling for silicon carbide based ceramic matrix composites (CMCs).

DESCRIPTION: Engine and exhaust washed aircraft structures require highly efficient CMC designs to minimize weight and withstand severe environmental conditions. These components are time consuming and expensive to fabricate and require post-fabrication machining to precise dimensions. The machining process is made very difficult due to the low thermal conductivity and hard, brittle, abrasive nature of CMCs. As a result of these unique characteristics of CMCs, existing methods of machining and drilling processes are inefficient and expensive. Machining tools are easily damaged and require frequent replacement due to over-heating and repeated contact with the hard and abrasive material. In addition, the CMC components are prone to damage from improper machining. A high-speed machining process or method for silicon carbide CMC design is anticipated to eliminate many of the major cost and risk impediments for transitioning these materials in aircraft production.

Innovative, scalable, high-speed, and precise process(es) are sought to fabricate and machine silicon carbide CMC components for engine and exhaust washed aircraft structures. In particular, precision drilling, countersinking, counter-boring, slotting and milling processes should be developed and demonstrated. Possible approaches may explore the use of contact and/or non-contact tools and methods for CMC material removal. Proposed processes should be designed to minimize damage and replacement of machining tools. It is anticipated that the results of this work will lead to process guidelines and tooling designs that allow a 10 fold reduction in time and cost to machine these components, a significant reduction in part rejection/rework, and decreased maintenance costs of machining tools.

PHASE I: Demonstrate scientific merit and feasibility of the proposed high speed machining processes and tooling concepts for various precision CMC machining process/material removal operations for typical contours and shapes. Prototype machined samples should be characterized micro-structurally, and mechanically tested per accepted ASTM methods for strength and fatigue durability.

PHASE II: Develop the prototype machining process based on the Phase I work. Fabricate prototype-machined samples, and eventually a full-scale component, to be characterized micro-structurally and mechanically tested per accepted American Society for Testing and Materials (ASTM) methods for strength and fatigue durability.

PHASE III: Generate generic process guidelines and contact/non-contact machine tools for use in fabricating high temperature silicon carbide CMC components. Produce and qualify components using the high speed machining process and transition to current and emerging aircraft production.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: More widespread usage of CMC components using high speed machining processes is expected for the aerospace, power generation and automotive industries.

REFERENCES:
1. Lopez de lacalle, L.N. Perez, J., Liorente, J.I. Sanchez, J.A., "Advanced cutting conditions for the milling of aeronautical alloys", J.Matls. Proc. Tech., 100 (2000) 1-11

2. Ezugwu, E.O. "High Speed Machining of Aero-Engine Alloys", J. of the Braz. Soc. of Mech. Sci & Eng., January-March 2004, Vol XXVI, No. 1, 1-11

KEYWORDS: Silicon carbide matrix composites; High-speed machining; Ceramic matrix composites (CMC); Nozzles; Machine tools; High temperature structure

TPOC: (301)342-9343
2nd TPOC: (301)342-9355

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N06-T013 TITLE: Polymer Based, Thermally Conductive and Erosion Resistant Boot Materials/Concepts for Rotor Blade Leading Edge Protection

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: V-22

OBJECTIVE: Develop an easy to apply, high-strain, lightweight, thermally conductive and conformable boot to improve the durability of the leading edges of composite rotor blades.

DESCRIPTION: Naval aircraft often operate in hostile environments that include sandy or dusty landing zones and/or severe sand, rain, or ice storms. Helicopters and other vertical/short take-off and landing (VTOL/STOL) aircraft such as the V-22 Osprey are expected to endure these severe environments without rapid erosion to the leading edge of their rotor blade. To avoid rapid deterioration of the rotor blade and potentially irreparable damage, the leading edge is typically protected with erosion resistant materials.

For example, the leading edge of the V-22 rotor blade is currently made of titanium and nickel abrasion strips bonded to the composite substrate (blade). Although this bonded metal-composite hybrid is effective for erosion protection and supports the deicing capability of the leading edge, this current configuration limits working strain and fatigue life of the blade. This hybrid concept necessitates frequent inspection to detect incipient fatigue cracks in the metal to ensure flight safety. Due to the bonded application, field removal and maintenance is unfeasible,

increasing operating and support costs of the rotor blade. In addition, leading edge concepts must not deteriorate the deicing capability of the rotor blade.

The Navy is interested in replacing the metallic leading edge strip with a polymer based, field serviceable and thermally conductive erosion resistant boot materials/concepts directly over the existing composite substrate of the rotor blade. This proposed concept should reduce the overall blade weight and ensure uniform working strain and satisfactory fatigue life in the rotor blade. Reduced maintenance requirements and costs could be achieved by simplifying and allowing for repair and reapplication of the leading edge in the field. In the case of the V-22, the proposed coating materials/concepts will need to meet the requirement for 250 flight hours continuous operation in rain, dust and sand. Specifically, the proposed boot materials/concepts need to demonstrate (via testing in a nationally recognized erosion test facility) a superior resistance to surface abrasion and spallation caused by high velocity impact of sand particles and raindrops respectively. Furthermore, the contractor will need to demonstrate sufficient thermal conductivity through the boot to deice the blade in a wintry environment and demonstrate the efficacy and field serviceability of the proposed boot materials/concepts in hostile fleet environments.

PHASE I: Provide an initial development effort that demonstrates scientific merit and feasibility of an erosion resistant boot for an existing composite rotor blade leading edge without degrading current performance requirements including deicing capabilities. Demonstration should include erosion resistance and thermal conductivity measurements. A minimum of 10 gm/cm2 of sand erodent followed by a minimum of 120 minutes of rain erosion at 1 inch/hour are desired at an impact velocity of 550mph (rotor tip speed of the V-22). Independent verification of test results by a recognized test lab is desired.

PHASE II: Optimize the proposed boot materials/concepts and fabricate a prototype based on Phase I efforts. Conduct appropriate coupon and component level experiments that mimic typical severe sand and rain erosion requirements; teaming with a rotor blade manufacturer and an erosion test facility is recommended. Demonstrate satisfactory thermal conductivity for deicing, field serviceability and ease of application and removal. Demonstrate producibility and cost-effectiveness of the proposed concept.

PHASE III: Implement full-scale production of the proposed boot materials/concepts for the rotor blade, and in concert with a major Navy rotor blade manufacturer, qualify and transition this technology to a rotary wing platform.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Successful development of this technology can be transitioned to any commercial application requiring improved erosion resistant surfaces and simplified field serviceability. Any surface that is exposed to severe erosion environments will benefit from technologies developed under this effort. Examples include ship propellers and rudders along with transport piping found within the chemical industry.

REFERENCES:
1. S. C. Hong and T. J. Wiggins; Advanced Rain and Sand Erosion Resistance Elastomers; Proceedings for the American Helicopter Society 57th Annual Forum

KEYWORDS: Coatings, Erosion, Nano-Powders, Leading Edge, Rotor Blade, Composites

TPOC: (301)342-9343
2nd TPOC: (301)757-9506

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N06-T014 TITLE: Delamination Resistant Coating System for Zinc Sulfide Domes and Windows, Utilizing a Compliant Layer.

TECHNOLOGY AREAS: Materials/Processes, Weapons

OBJECTIVE: The objective of this topic is to dramatically increase the protection afforded infrared transparent Zinc Sulfide (ZnS) domes and Forward-Looking Infrared (Radar) (FLIR) windows from rain impact damage and lower life cycle costs for ZnS domes and windows in currently deployed systems. Innovative research in materials properties is needed to develop an infrared transparent, compliant layer that can absorb and redirect the force of rain impact away from the fragile Zinc Sulfide substrate, and prevent delamination of the coating system.

DESCRIPTION: The production of infrared transparent domes and windows from zinc sulfide is a mature technology offering many advantages (e.g. ZnS is the most practical material for long wave infrared transparency). A coating is applied to Zinc Sulfide domes and windows to protect them from rain and sand erosion and to provide an anti-reflection layer. Reported delamination of these coatings degrades performance and may lead to excessive replacement of windows. For missile domes, the possibility of catastrophic failure is a serious concern. Theoretical analysis of multi-layer coatings suggests that a compliant layer, perhaps of a polymeric material, between the hard outer coating and the zinc sulfide surface may improve resistance to rain impact damage. By chemically modifying the ZnS surface and matching the interfacial chemistry of the compliant layer(s) with both the ZnS substrate and the hard outer coating it may be possible to have surfaces that re-bind if flexure of the outer layer separates the layers. Regardless of the mechanism, strong adhesion of the coating over a useful temperature range, under adverse weather conditions, is essential. The compliant layer may also serve to minimize the amount of impact force transmitted through the rigid outer protective layer into the ZnS substrate, thus offering additional protection. It is desirable, but not required, that the proposed coating system transmit both mid wave (3-5 micron) and long wave (8-14 micron) infrared radiation. The long wave region is especially desirable because this region is not covered by alternative oxide dome and window materials and allows for the use of uncooled infrared seekers. Optimizing the mechanical protection offered by the coating system and achieving an optical performance of >90% transmission in either (or both) the 3-5 micron or the 8-12 micron region of the infrared spectrum (transmittance in the 0.5-1.1 micron region is also desirable.

PHASE I: Develop a proof-of-concept coating system that includes a hard/compliant/ZnS layer structure. The thickness of each layer should be comparable to that of an optical window system, although transmission properties need not be optimized for Phase I. Coupon testing of the proof of concept design is desired. Test conditions such as those offered by the Whirling Arm Rain Rig (e.g. 20 minutes of 1 inch per hour, 2-mm-diameter drops, at 470 mph, normal incidence) would be acceptable.[4] The coating system should protect the coupons from mechanical damage and the coating should show no evidence of delamination.

PHASE II: Develop a prototype with the focus on optimizing the mechanical protection offered by the coating system and achieving an appropriate optical performance). Optical performance can be measured on coupons of a thickness reasonable for dome and window applications and it is expected that anti-reflection layers will be included in the design. Thermal testing to find the operational temperature range for coating, sand erosion experiments, water jet or single drop water impact experiments will determine a threshold damage velocity will be necessary to prove resistance properties of the coating. Control samples may be required to validate characterization procedures. Use the data collected in to determine the best application(s) for the coating and prepare either a demonstration dome or window for evaluation in an existing system.

PHASE III: Qualify the coating for insertion into a new or existing system (e.g. missile dome or FLIR window) and transition the technology.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Infrared sensors are increasingly important in the private sector, including the automotive industry and commercial aviation.

REFERENCES:
[1] D. C. Harris, Materials for Infrared Windows and Domes, SPIE Press, Bellingham WA, 1999.
[2] W. F. Adler and D. J. Mihora “Analysis of Waterdrop Impacts on Layered Window Constructions” Proc. SPIE Vol. 2286, Window and Dome Technologies and Materials IV; Paul Klocek; Ed., 1994, 264.
[3] N. Brette and P. Klocek “Engineered Polymeric IR-Transparent Protective Coatings” Proc. SPIE Vol. 2286, Window and Dome Technologies and Materials IV; Paul Klocek; Ed., 1994, 325.
[4] L. M. Goldman and R. W. Tustison “High Durability Infrared Transparent Coatings” Proc. SPIE Vol. 2286, Window and Dome Technologies and Materials IV; Paul Klocek; Ed., 1994, 316.

KEYWORDS: infrared dome; IR window; infrared coating; long wave infrared seeker; rain erosion; coating delamination

TPOC: (760)939-1629
2nd TPOC: (760)939-1649

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N06-T015 TITLE: High Cycle Fatigue (HCF) Prediction, Detection, and Prognosis for Gas Turbine Integrally Bladed Rotors (IBR, Blisks)

TECHNOLOGY AREAS: Air Platform, Ground/Sea Vehicles, Materials/Processes, Space Platforms

OBJECTIVE: Develop advanced modeling methods or technologies to predict and analyze the effects of aero-elastic forces on integrally bladed rotors (IBRs) or blisks to assess remaining fatigue life of in-service IBRs and more effectively design future IBRs.

DESCRIPTION: IBRs are widely used in modern military and commercial aircraft engines for their cost, weight and performance benefits. IBRs are designed without joints and have low inherent structural damping and high-levels of structural and aerodynamic coupling. For this reason, IBRs are prone to complex aero-elastic excitation that is difficult to predict and mitigate. Fan and compressor rotors are also susceptible to wear, erosion and foreign object damage that change their mistuning characteristics while in service.

To improve naval aircraft propulsion safety and affordable readiness, innovative prediction, detection, and prognosis methods or technologies are needed to accurately depict complex relationships between measured response and high cycle fatigue (HCF) damage. The prediction and measurement techniques developed should improve damage tolerance and increase repair limits on current IBR designs. In addition, the proposed techniques are expected to establish more accurate relationships between measured response and HCF damage enabling more robust future IBR designs. Coordination of this effort with separately funded DoD Science and Technology activities, e.g., Versatile Affordable Advanced Turbine Engine program (VAATE), is recommended.

PHASE I: Determine the feasibility of modeling methods or technologies to predict and analyze effects of aero-elastic forces on integrally bladed rotors.

PHASE II: Develop the proposed prototype methodology or tool(s). Demonstrate and validate the methods or tool(s) to a production, developmental, or research IBR. It is recommended that this demonstration be a coordinated effort with the corporation or institution owning the design.

PHASE III: Continue Phase II research and development in concert with an engine manufacturer in the definition, development, and manufacture of advanced IBR designs for gas turbine engines. Transitioning this technology to Naval depots, O-level maintenance, and industrial maintenance facilities will guide refurbishment and enhance the reuse of IBRs.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology will rapidly transition to the development and support of gas turbine IBRs in commercial aviation, industrial, and marine uses (taking advantage of cost savings, reduced parts, and decreased maintenance).

REFERENCES:
1. Griffin, J. and Yang, M.-T., “A Reduced Order Model of Mistuning Using a Subset of Nominal System Modes,” Presented at the 1999 International Gas Turbine and Aeroengine Congress and Exposition, June 1999, Indianapolis, IN, Paper No. 99-GT-288.

2. Petrov, E. and Ewins, D.; “Analysis of the Worst Mistuning Patterns in Bladed Disk Assemblies,” Proceedings of ASME Turbo Expo 2001, New Orleans, LA, June 2001.

3. Bladh, R. and Pierre, C., “Component-Mode-Based Reduced Order Modeling Techniques for Mistuned Bladed Disks--Part I: Theoretical Models,” J. Eng. Gas Turbines Power (ASME Paper 2003-GT-0360), vol. 123, no. 1, 2001, pp. 89-99.

4. Choi, Yoon S., et al, "Resonant Response of Mistuned Bladed Disks Including Aerodynamic Damping Effects", 39th AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit, July 2003, AIAA Paper 2003-4977

5. Feiner, D. and Griffin, J., “Identification of Damping Variations in Mistuned Bladed Disks,” Carnegie Mellon University, 10th National Turbine Engine High Cycle Fatigue (HCF) Conference, 8-10 March 2005.

KEYWORDS: integrally bladed rotor (IBR); blisk; compressor; fan; blading; mistuning; aero-elastic; high cycle fatigue (HCF)

TPOC: (301)757-0473
2nd TPOC: (301)757-0517

Questions may also be submitted through DoD SBIR/STTR SITIS website.

N06-T016 TITLE: Advanced System of Systems Design Capability

TECHNOLOGY AREAS: Information Systems, Ground/Sea Vehicles

ACQUISITION PROGRAM: DD(X)

OBJECTIVE: Develop an advanced ship design tool set to support capability-based acquisition and planning.

DESCRIPTION: The design and engineering of complex systems based on rapidly changing technologies continues to be a challenge. Future Naval systems architectures must be designed with a “system-of-systems” focus to take into account the complex interaction of the heterogeneous systems comprising these architectures. As such, reduced cost and design times will be required to make capability-focused decisions on future early-stage naval platforms. Current design tools lack adequate flexibility and fidelity to accurately model large architectures and optimize the design of individual platforms and sub-systems for multiple missions.

A flexible, object-oriented framework is desired that would allow a ship-centric capability analysis early in the systems engineering and analysis ship design process. This would allow for early stage evaluation of ship capabilities against mission needs with the ship as an agent in a larger world-view that encompasses future Naval operations. A design tool to rapidly explore the design space, examine the interactions between capabilities and technologies, evaluate technology refresh and obsolescence, and optimize this “system-of-systems” is seen as a key enabler for capability-based acquisition and planning.

PHASE I: Demonstrate the feasibility of an advanced system of systems design tool set that can be applied to support ship centric, capability based acquisition and planning. Develop validation criteria and approach, as well as milestones, for Phase II.

PHASE II: Design, develop and test a prototype tool set as identified in Phase I. Through laboratory characterization experiments, demonstrate the utility of the system and compare the results to representative modeling and simulation frameworks and environments. Address the multivariate tradeoffs applicable to simultaneous considerations of performance, dependability, and cost parameters for a complex system of systems. Demonstrate how the tool set can be applied to rapid execution of analyses of early stage ship designs' performance in Naval warfare scenarios.

PHASE III: Working with the Navy and industry, as applicable, implement on a major navy initiative program and perform demonstration/validation exercises.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Design tools for complex "system-of-systems" have a broad applicability to the early stage design of systems within both the defense and commercial sectors, including aeronautics, space, and the commercial shipbuilding industry. The tool set to be developed can be applied to any complex system early stage design, for which domain specific models are available. For example, the methodology can be applied to early stage fast-ferry design, if fast-ferry models are available.

REFERENCES:
1. Meyers, Richard, B., “Operation of the Joint Capabilities Integration and Development System,” Chairman of the Joint Chiefs of Staff Manual, CJCSM 3170.01A, March 12, 2004.
2. Ilachinski, A., “Irreducible Semi-Autonomous Adaptive Combat (ISAAC): An Artificial-Life Approach to Land Warfare (U)”, CRM 97-61.1, Center for Naval Analyses, August 1997.
3. Baker, A.P., Mavris, D.N., "Assessing the Simultaneous Impacts of Requirements, Vehicle Characteristics, and Technologies During Aircraft Design," AIAA-2001-0533, Presented at the 39th AIAA, Aerospace Sciences Meeting and Exhibit, Reno, NV, January 9-11, 2001.
4. Padmanabhan, D. and Batill, S.M., "An Interactive Concurrent Subspace Robust Design Framework," AIAA Paper 2000-4841, AIAA Multidisciplinary Analysis and Optimization Conference and Exhibit, Long Beach, California, September, 2000.

KEYWORDS: System of systems; ship design; naval platforms; modeling and simulation; acquisition; planning

TPOC: Scott Littlefield
Phone: (703)588-2358
Fax: (703)696-0001
Email: scott.littlefield@navy.mil
2nd TPOC: Katherine Drew
Phone: (703)696-5992
Fax: (703)696-6887
Email: drewk@onr.navy.mil

N06-T017 TITLE: Advanced Composites Research to Reduce Cost

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: DD(X)

OBJECTIVE: With the growing use of composites in the marine environment, there is a need for more cost effective ways to produce, test, and outfit composite materials.

DESCRIPTION: While their has been a growing interest in the use of composite materials in naval applications over the last several years, there are still some barriers limiting the acceptance and as a result a more widespread use in current naval shipbuilding programs. The topic seeks to remove these barriers by applying innovative scientific and engineering solutions as a means of reducing the costs driven by acquisition, manufacturing, materials, qualification and maintenance of composite materials on board naval vessels. Portability, adaptability, precision and automation will be important attributes to consider in developing solutions. Of particular interest are initiatives with a clear business case. Proposals should describe the technology that will be applied in order to solve the problem, along with its development, specific benefit and how it might be transitioned into the shipbuilding industry.

Efforts cited within each research area are illustrative only and proposals dealing with other efforts within the described area of interest are also solicited. The research areas include:
- Low cost, room temperature cured structural composites
- Analytical method for determining expected service life of organic materials (resins, etc.)

PHASE I: Demonstrate feasibility for enhancements being developed and identify the impacts upon shipbuilding affordability. Include a first order Return-On-Investment (ROI) analysis and estimate the potential Total Ownership Cost (TOC) reduction. Establish Phase II performance goals and key developmental milestones.

PHASE II: Finalize the design, as appropriate, develop and demonstrate a working prototype of the concept(s) proposed in Phase I. Perform laboratory tests to validate the performance characteristics established in Phase I. Develop a detailed plan and method of implementation into a full-scale application.

PHASE III: Utilizing the concept developed during Phase I and II, work with the Navy and industry to approve and certify the proposed concept for use in Navy applications and transitoin this technology to existing and future surface combatant systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Composites are widely used in the construction of advanced air, ground, and sea vehicles. Any industry associated with the development, design, and construction of these vehicles would benefit, typically the transportation industry. Composities are also gaining favor in the road and bridge building industry due to the very low maintnenance requirements inherent to composites.

REFERENCES:
1. The Composites Material Handbook—Mil-17, CRC Press, 1999.
2. Sorathia, U. and C.P. Beck, "Fire-Screening Results of Polymers and Composites," Proceedings of Improved Fire and Smoke Resistant Materials for Commercial Aircraft Interiors, National Research Council, Publication NMAB-477-2, National Academy Press, Washington, DC (1995).

KEYWORDS: composite; material; process; marine; ship; maintenance

TPOC: Bill Bell
Phone: (301)227-1448
Fax: (301)227-2138
Email: william.b.bell@navy.mil
2nd TPOC: Robert Matteson
Phone: (310)227-5088
Fax: (310)227-5548
Email: robert.matteson@navy.mil

N06-T018 TITLE: Automation of Analysis Model Creation

TECHNOLOGY AREAS: Information Systems, Ground/Sea Vehicles

ACQUISITION PROGRAM: DD(X)

OBJECTIVE: Develop analytical methods and a tool suite that will facilitate analysis model creation.

DESCRIPTION: As modeling and simulation (M&S) increasingly become drivers in the design process, institutions ranging from DOE, to DOD, to the aerospace and automobile industries are finding that the limiting factor in the utilization of M&S is the magnitude of the analysis set-up time. Typically the diverse information comprising the product model, for example, CAD or solid geometry data, material information, subsystems properties, etc. must be abstracted or supplemented into a form amenable to meshing and then analysis. This process involves, for example, correction of geometric inaccuracies, dimensional reduction or enhancement (for example, from solid to shell geometry, or vice versa), intelligent de-featuring, and other geometric approximations. It has proved very difficult to automate, and is still done manually in most industries. The result is that currently approximately 80% of the time devoted to M&S is spent setting up the problem, only 20% in analysis. Furthermore, the process must be repeated for analyses in different disciplines, since the requirements for each discipline are different. For example, a hydrodynamic analysis might require only surface data, whereas a structural analysis depends on geometric details of the interior, but requires simplification of the geometry. The time-consuming nature of this process often limits the degree to which M&S can impact the design spiral, since analyses cannot be conducted quickly enough.

PHASE I: Demonstrate the feasibility of tool suite that will facilitate analysis model creation. Develop validation criteria and approach, as well as milestones, for Phase II.

PHASE II: Design, develop and fabricate a prototype tool set as identified in Phase I. Through laboratory characterization experiments, demonstrate the utility of the system and compare the results to representative modeling and simulation frameworks and environments. Address the applicable performance, human factors analysis, dependability, and cost measurements of the technology. Demonstrate how various scenarios can be analyzed quickly and that various capabilities trade-offs can be performed.

PHASE III: Working with the participating members of the navy design or acquisition community, as applicable, evaluate the design tool's performance against actual design problems.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This capability would have a broad range of modling and simulation applications for use within the automotive industry, commercial aircraft industry, and in marine shipbuilding and construction.

REFERENCES:
1. Post, Douglass E. and Votta, Lawrence G., "Computational Science Demands a New Paradigm", Physics Today, Pages 35-41, January 2005. www.physicstoday.org
2. Post, Douglass, "The Coming Crisis in Computational Science", LA-UR-04-0388, Presented at the IEEE International Conference on High Performance Computer Architecture: Workshop on Productivity and Performance in High-End Computing, Madrid, Spain, 14 February, 2004.

KEYWORDS: modeling and simulation; computational design tools; finite element analysis; CAD to CAE; meshing;

TPOC: Glen Sturtevant
Phone: (202) 781-2245
Fax:
Email: glen.sturtevant@navy.mil
2nd TPOC: Luise Couchman
Phone: (703) 696-0786
Fax: (703) 696-0308
Email: couchml@onr.navy.mil

N06-T019 TITLE: Research 3-D Screen Technology Utilizing Autostereographics and the impacts on Tactical Operartors in the Command and Control Center.

TECHNOLOGY AREAS: Information Systems, Human Systems

OBJECTIVE: The objective of this effort is to understand the impacts on operator performance, qualification certification, and on-board training associated with Autostereographics. In addition understand the human factors impacts of the resultant increased visual stimuli associated with this technology on the operators within a cramped low lighting submarine command and control center environment.

DESCRIPTION: Recent advances in Computer Flat-Panels have enabled the display of 3-D images visible to the human eye, that give the user a more complete visual picture of the image. These images have the potential to provide a far more realistic depiction of objects relative to an operator's point of view in three-dimensional space, such as is found in tactical situations and for navigation. Submarine tactical operators traditional have had issues with visual depth perception after deployments and long-term careers as operators. It is unknown how these images could benefit/impact the overall performance of operators and the human factors for use in a cramped low light submarine environment.

PHASE I: Research the impacts of autostereographics stimulation on operator object recognition and the impacts of this technology in a cramped visual environment. Develop a HSI white paper that identifies the visual stimulation impacts within in this environment, and the benefits/impacts on operator performance.

PHASE II: Determine, which tactical displays where this technology could be utilize and develop the tools to integrate this technology with existing command and control displays. Develop test plans, procedures and conduct evaluation testing; and access implementation costs respective to the Government and contractor approved alternatives.

PHASE III: Install and test prototype display within the Government approved tactical system on board a designated SSN Class submarine.

KEYWORDS: 3-D Screen Technology; Operator Performance; Human Factor Visual impacts, increased visual stimuli, low light, cramped submarine environment.

TPOC:	Masco Settles
Phone:	(202)781-2206
Fax:	
Email:	masco.settles@navy.mil
2nd TPOC:	Nickolas Guertin
Phone:	(202)781-3426
Fax:	(202)781-4683
Email:	nickolas.guertin@navy.mil

N06-T020 TITLE: Power Harvesting for Encrypted Wireless Sensor Clusters

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes, Sensors, Electronics

OBJECTIVE: Develop and commercialize a device for harvesting energy from interior shipboard environments to power wireless sensor cluster systems. The sensor system includes a sensor cluster of two or more sensor elements, integrated electronics, and integrated wireless communications elements that meet the requirements for FIPS 140-2 certification and future US Navy commercial wireless communications security requirements.

DESCRIPTION: Several exploratory research studies have been conducted showing the feasibility of extracting power from environmental sources such as tides, wind, sunlight, vibration, shock, heat, and animal life to either replace or augment batteries as electrical power sources. The use and life-cycle-cost of integrating smart and/or wireless sensors in system health monitoring applications has been severely limited by current battery life. A concept for harvesting energy from internal shipboard environments to provide low level electrical power has been demonstrated recently the Navy's Reduced Ship's crew by Virtual Presence (RSVP) Advance Technology Demonstration (ATD). However, the RSVP demonstration components were not adequately scaled in size and electrical energy capacity to support the small one cubic inch volume targeted for integrated condition health monitoring sensor systems that have emerged into commercial markets.

PHASE I: Develop and demonstrate a design concept for one or a family of electrical power harvesting modules. The module concept(s) shall be demonstrated to physically and electrically integrate with the current state-of-the-art wireless sensors designed for shipboard monitoring of machinery health condition and meet the Navy's requirement for shipboard wireless security listed in Phase II. The concept shall demonstrate the conversion of environmentally produced power into electrical power sufficient to eliminate the tethered wires that provide external electrical power to the wireless sensor systems. Concepts for direct supply of power to sensor electronics as well as concepts for significantly extending the replacement life of small volume batteries will be addressed. The concept should also incorporate the capability to operate the wireless sensor cluster for extended periods of time when no ambient energy is available for harvest. The technology proposed in the conceptual design shall not require any special material handling requirements during storage, handling, installation or use. The power harvester should be designed to have an operational lifetime that meets or exceeds the lifetime of the wireless sensor cluster it is designed to provide power to. A concept demonstration of the most promising electrical power harvesting design

will be provided. Produce preliminary design documentation sufficient to design and demonstrate a prototype power harvesting system.

PHASE II: Design and demonstrate a prototype power harvesting system, based on the Phase I concept, in an integrated wireless sensor used for assessing condition of a submarine system (i.e.: propulsion system, communications system, electrical power generating and distribution system, environmental and electronic cooling system, etc.) and a comparable commercial system. Develop design documents and drawings sufficient to support the design, manufacture, test and evaluation of a first production model power harvesting system. The wireless link shall meet the Navy's commercial wireless security requirements for shipboard use in place at the time of the demonstration (currently FIPS 140-2 certification).

PHASE III: Design, produce, test and evaluate the first production model of a fully integrated, complete power harvesting system for a full suite of machinery condition assessment wireless sensors and demonstrate the performance of the power harvesting system in a shipboard and commercial machinery CBM application. Complete the design documentation and drawings sufficient to support full scale manufacturing production of power harvesting systems/modules. The wireless link shall meet the Navy's commercial wireless security requirements for shipboard use in place at the time of the demonstration (currently FIPS 140-2 certification)

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Electrical power harvesting for extending small volume battery life has commercial potential in the consumer appliance industry, security and surveillance industry, transportation industry, aerospace industry, and maritime industry.

REFERENCES:
1. RSVP ATD Final Technical Report, OPNAVINST 4700.7J, "Policies and Procedures for Maintenance of Ships
2. "Applying RCM Principles in the Selection of CBM-Enabling Technologies", Kenneth S. Jacobs, presented at ASNE Conference, Norfolk, October 1999
3. "US Navy Lessons Learned in SMART Ships and Related Technology Initiatives", NSWCCD Tech Report, T. R. Galie and M. Greenberg, June 2000
4. "Intelligent Sensor Nodes Enable a New Generation of Machinery Diagnostics and Prognostics," F. M. Discenzo, K. A. Loparo, D. Chung, and A. Twarowski, New Frontiers in Integrated Diagnostics and Prognostics, 55th Meeting of the Society for Machinery Failure Prevention Technology, April, 2001, Virginia Beach
5. "Federal Information Processing Standards Publication (FIPS) 140-2, Security Requirements For Cryptographic Modules"; U.S. Department if Commerce, National Institute of Standards and Technology (NIST); May 2001.

KEYWORDS: Sensors, Power Harvesting, Condition Based Maintenance, Wireless

TPOC: Masco Settles
Phone: (202) 781-2206
Fax:
Email: masco.settles@navy.mil
2nd TPOC: Michael Donnelly, P.E.
Phone: (215) 897-1274
Fax: (215) 897-1582
Email: michael.e.donnelly@navy.mil

N06-T021 TITLE: Development of Lightweight and Low Cost Advanced Structural Materials for Off-board Surface Vessels (OBVs)

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: LCS

OBJECTIVE: Development of innovative, lightweight, high-performance advanced structural materials that can be used in the construction and/or optimization of manned and unmanned surface vessels operating in harsh marine surface and sub-surface environments.

DESCRIPTION: New US Navy surface combatants such as the Littoral Combat Ship (LCS) are employing growing numbers of unmanned and manned Off-Board Vessels (OBVs) that provide important tactical capabilities that are critical to the ship's overall mission capability. These OBVs are designed to support such littoral missions as mine hunting, surface warfare against asymmetrical small boat threats, and anti-submarine warfare against shallow water submarines. Broader applications such as the routine protection of Navy capital assets, commercial shipping, and structures at sea are also contemplated for future use. OBVs are usually hosted aboard a transport ship which then launches and remotely operates the OBV. OBVs are routinely subject to heavy abrasion and collision with waterborne obstacles or the host ship's recovery apparatus. The weight and physical dimensions of the OBVs are critical as the on-deck operations and launch and recovery systems are all weight limited

This topic seeks innovative solutions that address the application and/or optimization of advanced structural materials in a harsh marine environment while 1) not decreasing the payload capacity of the OBVs and 2) fitting within the allotted storage foot print onboard the host/transport vessel. Solutions that address protection against ballistic damage and/or improve OBV payload capacities will be given additional consideration.

Design solution validation will necessitate the use of equally innovative modeling and simulation approaches and tools to optimize composite designs and accurately predict the response of complex composite structures in dynamic maritime environments.
Areas of interest include, but are not limited to:

- Bulbous and sharp leading edges of hulls and control planes
- High-load junctures between hulls, structural members, and control planes
- Formation of flat or curvilinear structural panels
- Formation of variable shaped fuel and ballast tanks

PHASE I: Demonstrate the feasibility of advanced structural materials as a means of improving or optimizing manned and unmanned OBVs operating in harsh marine environments. Conduct cost, weight, and performance trade-off analyses to determine the best candidate materials. Establish Phase II performance goals and key developmental milestones.

PHASE II: Finalize the Phase I design, as appropriate, fabricate and demonstrate a working prototype(s). Perform laboratory tests to validate the performance characteristics established in Phase I. Develop a detailed plan and method of implementation into a full-scale application.

PHASE III: Working with Navy and/or industry, as applicable, develop a full-scale prototype of an Unmanned Surface Vessel capable of operating from the Littoral Combat Ship (LCS).

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The advanced materials developed would have direct application for commercial manned and unmanned surface vessels used in oceanographic surveying, off-shore oil exploration and on salvage ships. Additionally, high-performance marine composite materials have nearly unlimited applications in ship building.

REFERENCES:
(1) LCS Program Seaframe Overview Presentation, RADM Charles Hamilton, PEO Ships, Naval Sea Systems Command, 14 June04.

KEYWORDS: Low Cost, marine structures, composite materials, Unmanned Surface Vessels (USVs), Off-Board Vessels (OBVs).

TPOC: Glen Sturtevant
Phone: (202) 781-2245
Fax:
Email: glen.sturtevant@navy.mil

2nd TPOC: Scott Littlefield
Phone: (703)588-2358
Fax: (703)696-0001
Email: scott.littlefield@navy.mil

N06-T022 TITLE: Waterjet Wake Characterization Suite

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: LCS

OBJECTIVE: Develop analytical methods and tool suite to predict ship bubbly wake acoustic signatures for waterjet propelled surface ships such as the Littoral Combat Ship (LCS).

DESCRIPTION: Ship wake characteristics are a significant contributor to overall ship signature, and are especially important to the performance of wake homing torpedo threats. While wake features from traditional propeller driven ships are well studied, the ability to perform predictive analysis and design optimization of bubbly wakes from waterjet driven advanced hull forms such as LCS do not currently exist. Effective capability for this application will require computational methods to perform analysis and predictive modeling of bubbly flow in the wake arising from wave and propulsor (including waterjet turbulence and cavitation inception), acoustic analysis to provide sound speed attenuation relevant to wake homing threats, and engagement simulation for threat performance assessment.

PHASE I: Demonstrate the feasibility of the proposed concept(s) to predict bubbly wake signatures for surface ships. Define a proposed concept and provide a Phase II development approach and shedule that contains discrete milestones for product development.

PHASE II: Finalize the design and fabricate a prototype of the concept proposed in Phase I. Through laboratory characterization experiments, demonstrate the utility of this system and compare the results to representative data. Testing may consist of laboratory testing, at-sea testing and/or analysis of previously collected data. Develop a Phase III test plan to validate the toolset's capabilities.

PHASE III: Working iwth the Navy and industry, as applicable, expand waterjet wake characterization tool suite for generic application to a broad range of waterjet propelled craft.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The acoustic computational methods and propagation modeling methods will have direct application to flow quieting problems ranging from helicopter rotor quieting to plumbing flow noise reduction to high-speed ferries, which also utilize waterjet propulsion technology.

REFERENCES:
1.) “Vibration monitoring of a ship waterjet with fiber Bragg gratings,” Johnson, G.A., Vohra, S.T.; Danver, B.A.; Pran, K.; Havsgard, G.B.; Wang, G., Proceedings of SPIE The International Society for Optical Engineering, v 3746, 1999, p 616-619.

2.) “US study advocates axial flow waterjets for high speed craft,” Source: Warship Technology, JANUARY, January, 2004, p 16-17.

3.) “Noise and Vibration Control Techniques for the U. S. Navy 3000-LT Surface Effect Ship,” Fox, Gary L., Marine Technology, v 17, n 1, Jan, 1980, p 16-28.

4.) “Unsteady thrust of a water jet vane-axial pump,” Weston, A., Mongeau, L., Proceedings - National Conference on Noise Control Engineering, v 1, 1997, p 393-398.

KEYWORDS: LCS; bubbly wake; waterjet; wake homing; threat assessment; CFD; acoustic attenuation

TPOC: Warren Goldman
Phone: (401) 832-8742
Fax:
Email: warren.goldman@navy.mil
2nd TPOC: Thomas Owen
Phone: (540) 653-7614
Fax: (540) 653-7193
Email: thomas.f.owen1@navy.mil

N06-T023 TITLE: High Power Density Swaging Device

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: CVN 21

OBJECTIVE: Develop a high capacity swaging press that is lightweight and portable for use on the aircraft carrier.

DESCRIPTION: The arresting gear system aboard aircraft carriers relies on a purchase cable to transfer the energy from the landing aircraft to the arresting gear engines located below the deck. Each end of the purchase cable is fitted with a terminal. The purchase cable terminal on the top, deck end connects to the cross deck pendant, which is engaged by the landing aircraft's tailhook. On the opposite end, the terminal connects the purchase cable to the arresting engine. The purchase cable terminal is considered a critical safety item. The failure of a terminal during an aircraft arrestment could result in the loss of life, the loss of an aircraft, or both. After replacement (or "rereeve") of the purchase cable, the sailors need to attach the terminal on the flight deck in order to connect the purchase cable with the cross deck pendant. The current process, which requires the sailor to pour molten zinc into the socket terminal, is toxic, hazardous and time consuming.

The Navy is interested in a portable swaging tool that could be used to attach the terminal to the purchase cable. It is important that the swaging device be able to apply enough force for a secure attachment that survives continuous arrestments throughout the cable's service life, and yet be lightweight and small enough to fit within available spaces aboard the carrier (maximum size: 5 feet by 8 feet footprint, 6 feet high). Maximum force required is 2200 tons, and the user should be able to gradually regulate the force applied from a minimum of 700 tons to 2200 tons. The wire arresting gear rope is 1 7/8 inch diameter, lang lay steel with a polyester core. Breaking strength is 215,000 lbs, and operational life is 3000 cycles.

PHASE I: Develop a conceptual design and prove the feasibility of the concept to meet the requirements with thorough analysis and/or simulation. Include defendable estimates for cost and reliability and maintainability.

PHASE II: Develop a prototype and demonstrate in a lab setting using a section of Navy arresting gear cable and terminal. Pull test the tensile strength of a cable with a termination resulting from use of the prototype swaging unit at 215,000 lbs for 3000 cycles.

PHASE III: Produce units for delivery to CVN-78, in-service carrier fleet and shore sites.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Wire rope has a wide range of applications in industry, including bridges, construction equipment, ship moorings and off-shore oil rigs. A portable, lightweight swaging press would benefit these and any other applications that require machining steel or swaging onto pipe or hose, where space is constrained or operations require frequent movement (as is found at construction sites).

REFERENCES:
1. Drawing of Terminal, Swaged Type, 627369
2. Procedure for Swaging 1 7/16" Cable, 218333

KEYWORDS: Swaging; wire rope; machine tools; cable termination

TPOC: Mark Husni
Phone: (732)323-4081
Fax: (732)323-7219
Email: mark.husni@navy.mil
2nd TPOC: Lonnie White
Phone: (732)323-4260
Fax: (732)323-2884
Email: Lonnie.white@navy.mil

N06-T024 TITLE: Viscous Drag Reduction Using Hydrophobic Surface

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: NAVSEA PMS 325; Rapid Sea Lift Ships R&D Program

OBJECTIVE: Develop and demonstrate a hydrophobic surface that will have significant effects on skin-friction drag and/or transition delay in boundary layers present in naval and commercial ships and submarines. Innovations in design and fabrication technique for manufacturing a large hydrophobic surface will be essential. A hydrophobic surface should meet the following notional design and performance requirements at a minimum:

a. Skin-friction drag reduction >20% at the nominal Reynolds number ranges for commercial and military vessels,
b. Capable of long-life operation in seawater,
c. Final design suitable for a test in a water tunnel.

DESCRIPTION: It has been shown that certain hydrophobic surfaces can reduce skin-friction drag in micro-fluidic devices. The effects of such hydrophobic surfaces on skin-friction drag in large-scale flow devices have not been demonstrated. The U.S. Navy is interested in innovative design and fabrication technique for manufacturing super hydrophobic surfaces that can be used in military and commercial vessels and weapons for the purpose of skin-friction drag reduction and/or delay of transition to turbulence. Such a hydrophobic surface on these vessels is envisioned as an enabler of significantly reduced cost of operation and increased performance.

PHASE I: Estimate and characterize the required properties, such as the slip length, of a hydrophobic surface through preliminary analysis. Develop an innovative design of a hydrophobic surface with the required properties. Demonstrate the desired effect through numerical simulations and through small-scale laboratory experiments. Performance should include the percentage of drag reduction achieved and/or delayed transition. Document the design and performance analyses.

PHASE II: Based on the design developed in Phase I, fabricate a hydrophobic surface large enough to cover a substantial part of the model vessel (surface ships or submersibles) to be tested in tow tank and/or water-tunnel experiments; demonstrate the performance of the hydrophobic surface attached to a model vessel through numerical simulations and tow tank and/or water-tunnel experiments.

PHASE III: If this technology is proven to meet the requirements specified above at the end of Phase II, it will be considered for further evaluation on a large-scale demonstrator (TBD) under the ONR Skin-Friction Drag Reduction Seabasing FNC (FY07-start) program. This ONR FNC program will evaluate different skin-friction drag reduction technologies, including polymer and microbubble, gas cavity, paints and coatings. The promising technologies will then be transitioned to ships being considered by the PMS 325, including RSLS (Rapid Sea Lift Ships).

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This skin-friction reduction technology, if successful, will have a paramount impact on a wide spectrum of industry, including micro-fluidics, piping, fluid machinery, and shipbuilding industry in terms of operating cost and/or fuel savings. With soaring fuel cost, the shipping and shipbuilding industry are looking into energy saving technologies, including skin-friction drag reduction technology.

REFERENCES:
1. "Apparent fluid slip at hydrophobic micro-channel walls," by D. Tretheway and C. Meinhart, Phys. Fluids, vol. 14 2002.
2. “Apparent slip flows in hydrophilic and hydrophobic micro-channel," by C.-H. Choi, K. J. A. Westin, and K. S. Breuer, Phys. Fluids, vol. 15, 2003.
3. "Effects of hydrophobic surface on skin-friction drag," by T. Min and J. Kim, Phys. Fluids, vol 16, 2004.

KEYWORDS: Skin-Friction Drag Reduction; Hydrophobic Surface; slip length;

TPOC: Ki-Han Kim
Phone: (703)696-4305
Fax: (703)696-2558
Email: kimk@onr.navy.mil

N06-T025 TITLE: Decision Making Constructs for a Distributed Environment (DCODE)

TECHNOLOGY AREAS: Information Systems, Human Systems

ACQUISITION PROGRAM: None

OBJECTIVE: Enable quick-response knowledge interoperability in coalition operations decision making.

DESCRIPTION: Communication technology has flattened war fighting organizations, making the common operational picture and commander’s intent available throughout the chain of command. Simultaneously, defense transformation has put a new emphasis on the use of quick-response, agile, coalition or joint force response teams. Team knowledge processing has not kept pace with the cognitive overload created by massive sensor and tactical information distribution. This solicitation seeks innovative new human-centric knowledge processing tools to collect, fuse and analyze uncertain and often subjective multi-source information and present it in a quickly usable visual and digital format. The proposed product will improve decision time by reducing the time and effort devoted to conflict resolution and consensus building for tactical course of action selection. The architecture and human-computer interface for the DCODE tool has been prototyped by MIT and the Space and Naval Warfare Systems Command (SPAWAR) and has demonstrated improved team performance in lab experiments. A focused initiative is needed to further validate this concept and test it in simulation and field experiments.

PHASE I: Develop a cognitive processing-based concept, tool or methodology to improve the ability of both individual and distributed group decision makers to evaluate, share, and integrate decision-relevant information items and to improve decision time by reducing the time and effort devoted to conflict resolution and consensus building in reaching an overall group decision.

PHASE II: Develop and demonstrate a prototype tool or model for supporting consensus development. Conduct one or more lab or controlled experiments to validate the tool and quantifiably demonstrate its benefit in improved team decision-making performance. Develop a usability-qualified interface for the tool and validate performance in an experimental or simulated operational environment. Prepare guidelines and documentation for tool transition to an operational setting. Validate, standardize and document underlying software for application purposes and implement in a field experiment.

PHASE III: Coordinate with user subject matter experts to instantiate a working model with actual data, get user commitment for training and maintenance of the application. Field test tool in an operational setting and produce improved performance measures. Implement the tool in a comprehensive package that would include an intuitive graphical user interlace (GUI).

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology product could be applied to any collaborative or team problem solving situation where it is necessary to develop a team consensus on an issue or product

REFERENCES:
1. "Information Exchange and Display in Asynchronous C2 Group Decision Making"; Robert A. Fleming SPAWAR Systems Center, San Diego; The 8th International Command and Control Research and Technology Symposium (ICCRTS), 17 Jun, 2003
2. EWALL – Electronic Card Wall: http://ewall.mit.edu/abstract/

KEYWORDS: Decision-making; knowledge; interoperability; distributed; cognition

TPOC: Mike Letsky
Phone: (703)696-4251
Fax: (703)696-1212
Email: letskym@onr.navy.mil
2nd TPOC: Michael Cowen
Phone: (619)553-8004
Fax:
Email: mike.cowen@navy.mil

N06-T026 TITLE: Harvesting Electric Power from Walking

TECHNOLOGY AREAS: Ground/Sea Vehicles, Human Systems

ACQUISITION PROGRAM: MARCORSYSCOM, PM Marine Expeditionary Rifle Squad

OBJECTIVE: This effort would develop a practical backpack harness capable of generating several watts of electrical power when walking with a 50 lb backpack The concept would exploit the differential forces between human and backpack that occur during walking. It would seek to minimize the parasitic weight of such a generating device while also providing for electrical power storage and utilization. In addition the effort would seek to optimize the effects of the backpack suspension on human load carrying efficiency.

DESCRIPTION: Combat units operating on foot in remote regions are highly dependent on electrical energy for communications, navigation and sensing. As the use of electronic devices on the battlefield increases, so will the need for energy self sufficiency. Recent developments, published in the references below, show that it may be possible to construct a practical device that generates several watts while simultaneously increasing the efficiency of human motion associated with carrying a backpack.

PHASE I: Phase I would conclude with completion of a preliminary system design and breadboard level demonstration of representative components for electrical power generation, power conditioning and energy storage.

PHASE II: At the completion of Phase II, the design of the prototype backpack generator system will be developed to the point where it is ready for preliminary field evaluation and experimentation. Phase II will be concluded with a prototype demonstration conducted by the vendor.

PHASE III: This phase would likely begin with the fabrication and delivery of a small number of representative backpack generator systems to the Marine Corps for experimentation and operational assessment prior to a possible decision to proceed with Engineering and Manufacturing Development.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The device may also be of interest to recreational hikers and climbers requiring the capability to recharge batteries in remote locations.

REFERENCES:
1) L.C. Rome et al, Science Vol. 309, 1725, Sep 9, 2005
2) A.D. Kuo, Science Vol. 309, 1686, Sep 9, 2005

KEYWORDS: Energy Harvesting;Electric Power;Biomechanics;Generator;Backpack

TPOC: Clifford Anderson
Phone: (703)696-4485
Fax: (703)696-4274
Email: anderscw@onr.navy.mil

N06-T027 TITLE: Binary Multi-Taggant System for Unique Target ID

TECHNOLOGY AREAS: Information Systems, Ground/Sea Vehicles, Materials/Processes, Sensors

ACQUISITION PROGRAM: PM Intel, MARCORSYSCOM

OBJECTIVE: Dust or dot-type taggants exist that can be easily and covertly applied to targets. However, these taggants produce limited numbers of signatures that can be used to distinguish one tagged entity from another. Currently, they are only useful for distinguishing tagged from untagged targets. This work will develop a system of multiple taggants that can be selectively applied to a target to produce a unique signature. If some number (N) of taggants are used, each of those N taggants can be either applied or not applied to a given target. Treating "applied" as a 1 and "not applied" as a 0, the pattern of taggants on a given target can be read as a binary number from 1 to 2N-1, allowing unique identification of up to 2N-1 different targets. This task will develop a prototype system consisting of the taggants themselves, the dispenser/delivery system, and the interrogator.

DESCRIPTION: Global War on Terrorism (GWOT) imposes upon our warfighter a requirement to be able to detect, classify, identify, geolocate and track entities of interest buried in large amounts of urban clutter. Optical taggant technology is potentially relevant to the capability gap given its potential to be used against uncooperative targets. Tags can also potentially be read from significant standoff distances. In the urban environment future forces would benefit from a capability to uniquely identify very large numbers of entities, something that is beyond the current state of easily applied optical tags.

PHASE I: Survey potential taggants and tag reader technologies. Downselect to the the optical taggant approach that shows the most promise for near term fielding. Develop a concept of operations (CONOPS) and preliminary design for tag delivery system/dispenser. Model and predict system performance.

PHASE II: Prototype the tag system, including taggant, delivery, and reader. Characterize performance and compare to Phase I predictions. Conduct a demonstration for users and gather feedback. During the demonstration prove the tactical feasibility of utilizing hundreds/thousands of unique identifiers and assert the operational feasibility of inserting into the battlespace the number of tag readers required for tract continuity.

PHASE III: Integrate a tag system into the persistent ISR program at ONR. Improve Phase II design for ruggedness and manufacturability and incorporate changes suggested by Phase II demonstration. Implement service-oriented interfaces for interoperability in a Distributed Common Ground/Surface Station (DCGS) environment. Support a Field User Evaluation in an operational environment. Emphasize the delivery of knowledge vice sensor data to the warfighter.

This capability will transition to the Marine Corps via the Tactical Persistent Surveillance Enabling Capability at ONR as part of the Tagging, Tracking, and Locating product. This EC will in turn transition technology to the Marine Corps Intellligence Surveillance and Reconnaissance Enterprise Services (MCISR-ES) program. MCISR-ES will fulfill for the Marine Corps the OSD mandate for all services to adopt a service-based, interoperable intelligence architecture based on the Distributed Common Ground/Surface Station (DCGS). MCISR-ED has a stated requirement for TTL.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology would have direct application to civilian law enforcement and security, especially for tracking of organized or recurring criminal activity and for detecting threats to large public events.

REFERENCES:
1. http://www.darpa.mil/ato/programs/dots.htm
2. http://www.esi-topics.com/quantumdots/
3. http://www.nanotech-now.com/

KEYWORDS: tagging, tracking, and locating (TTL); taggants; tag readers; optical tags; unique identifiers; tracking

TPOC: Martin Kruger
Phone: (703) 696-5349
Fax: (703) 588-2438
Email: krugerm@onr.navy.mil
2nd TPOC: Clifford Anderson
Phone: (703) 696-4485
Fax:
Email: anderscw@onr.navy.mil

N06-T028 TITLE: Affordable Monolithic Power Digital to Analog Conversion for Radar, Electronic Warfare, and Communications

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: IWS2.0

OBJECTIVE: To develop the ability to digitally and affordably generate high power (e.g., 10 watts) S-band microwave analog signals with high efficiency and linearity (i.e. 50 dBc or better).

DESCRIPTION: Available "real estate" on ships limits the number of antennas permitted and therefore the ability of the ship to optimally accomplish its mission. In addition, electromagnetic interference (EMI) among the various antennae is difficult to control. An expedient way addressing this problem is to enable each antenna aperture to perform more than one function (e.g., radar, communications, electronic warfare, digital beamforming). A problem with this approach is that conventional analog microwave amplifiers experience significant reductions in efficiency when simultaneously amplifying more than one signal. The more efficient analog amplifiers also create unwanted intermodulation distortion. Theoretically, digital power amplifiers are immune to both of these problems and represent an expedient solution to technology problems anticipated in implementing fully integrated topside systems and systems expected to use ultra broadband and complex signaling. Solutions that are scalable in frequency and bandwidth and with a path to monolithic integration are required.

PHASE I: Investigate, model, and design new digital approaches to the efficient generation of multiple simultaneous 10 watt S-Band signals in the 3.0 – 3.5 GHz spectrum and further characterized by intermod products at least 50 dBc down. Digital implementations need not necessarily be limited to binary logic. Approaches may include, but are not limited to distributed architectures, switching amplifiers, sigma-delta, and noise shaped approaches.

PHASE II: Demonstrate that digitally derived, 10 watt minimum S-band microwave signals can be generated efficiently (e.g., >70% efficiency) and that this efficiency is not seriously degraded when two or more signals are simultaneously generated. This demonstration shall be devoid of any analog signal amplification.

PHASE III: The general circuit architecture developed in phase II shall be reduced to not more than three monolithic chips and the spectrum of signals shall be increased to an octave of instantaneous bandwidth.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This technology would be especially pertinent to 3rd and 4th generation cell phone base station usage. (The operating efficiency of current cell phone base stations is generally less than 5%.) It is also applicable to transmitters employing wide bandwidth complex signals such as HDTV transmitters.

REFERENCES:
1. "Critical DAC Parameters for Multi-Carrier GSM/EDGE Transmitters"; http://www.maxim-ic.com/appnotes.cfm/appnote_number/1886
2. "Power Digital to Analog Conversion Using Sigma-Delta and Pulse Width Modulations", by Jorge Varona; http://www.eecg.toronto.edu/~kphang/ece1371/pwrdac.pdf#search='digital%20power%20DAC'
3. Keyzer J, Hinrichs J, Metzger A, Iwamoto M, Galton I, Asbeck P. "Digital generation of RF signals for wireless communications with band-pass delta-sigma modulation." 2001 IEEE MTT-S International Microwave Symp. pp.2127-30 vol.3
4. Kobayashi H, Hinrichs JM, Asbeck PM. "Current-mode class-D power amplifiers for high-efficiency RF applications." IEEE Transactions on Microwave Theory & Techniques, vol.49, Dec. 2001, pp.2480-5
5. Brett Forejt,, Vijay Rentala, Jose Duilio Arteaga, and Gangadhar Burra, "A 700+-mW Class D Design With Direct Battery Hookup in a 90-nm Process." IEEE JOURNAL OF SOLID-STATE CIRCUITS, VOL. 40, NO. 9, SEPTEMBER 2005
6. Scholnik D.P., Coleman J.O., Bowling D., Neel M., "Spatio-temporal delta-sigma modulation for shared wideband transmit arrays. Radar Conference, 2004. Proceedings of the IEEE 26-29 April 2004 Page(s):85 - 90

KEYWORDS: microwave; efficient; amplifiers; direct digital conversion; digital beamforming;

TPOC: Paul Maki
Phone: (703)696-3060
Fax: (703)696-8496
Email: Paul_Maki@onr.navy.mil
2nd TPOC: Dan Purdy
Phone: (703)588-1920
Fax: (703)696-1331
Email: purdyd@onr.navy.mil

N06-T029 TITLE: RF Waveform Library Reader

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: Radio Frequency Antennas & Topside Program PMW180

OBJECTIVE: Integrate COTS parts into a box capable of delivering stored digital representations of hundreds of RF waveforms to a cross-correlation based, direct from RF receiver.

DESCRIPTION: Digital cross correlation represents the ideal method of realizing the optimal (matched) filtering of the wide variety of time dependent waveforms used by the DoD and thereby the maximum probability of reception in high EMI/dense signal environments. Direct from RF, digital reception is increasingly feasible as fast clocking digital technologies such as SiGe, III-V semiconductors, and superconducting electronics mature. Combining direct reception and digital cross-correlation on the RF waveform seems the ideal performance path to software defined radios. The digital reference waveform must, however, be delivered at a high clock speed if the subtleties of the waveform are to be reproduced. Unfortunately, the speed of cheap mass memory seems destined to lag behind high speed logic by at least 10X. Thus a new, affordable arbitrary bit stream generator box that muxes large COTS memories to high output speed is needed.

PHASE I: Locate candidate components emphasizing COTS, creatively design the desired circuit, and demonstrate by simulation that it ought to function as desired.

PHASE II: Demonstrate a preproduction unit capable of dumping 10 Gbits of data at 10 Gbps from a RAM memory. Output pulses must have <25 ps rise and fall times. Design must build in possibility to cascade boxes to provide continuous data streams, stable relative phasing of time bases of multiple boxes to drive multi-bit words at 10Gword/s, and a path toward future units outputting at 40 Gbps per line. If funding allows, demonstration of these functional enhancements or the circuit to accept 10 Gbps per line at data input and rewrite the data in the RAM is desirable.

PHASE III: Such units will find application in software defined radio programs where they will be useful on receive as a source of cross-correlation templates and on transmit as substitutes for expensive analog frequency synthesizers and as sources for waveforms in sigma-delta based waveform generators. Applications in both single antenna and active arrays are foreseeable.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The product will have application at the outer edge of the fiber optic telecommunication network where digital data (especially of differing data rates) needs to be compressed in time and transmitted as bursts rather than time interleaved bit or wordwise with other traffic. Such networks are increasingly used to move data around on military platforms and bursted data may be significantly easier to handle than interleaved in multi-level security and priority networks such as are essential during battle. In the instrumentation market, the unit will be useful in testing cutting edge digital circuits and providing easily transported frequency standards. If Si computer CPUs continue to move toward intense parallelization and optical interconnects, these units will also be useful in uploading data from mass memory.

REFERENCES:
Numerous are available at http://qdev.boulder.nist.gov/ by following links: What We Do; Quantum Voltage; Josephson Arbitrary Waveform Synthesizer

KEYWORDS: pulse pattern generation; arbitrary waveform generation; multiplexing; high speed circuits; optical communications; sigma-delta waveform generation

TPOC:	Deborah Vechten
Phone:	(703)696-4219
Fax:	(703)696-8496
Email:	vanvecd@onr.navy.mil
2nd TPOC:	Anna Leese de Escobar
Phone:	(619)553-5987
Fax:	(619)553-1090
Email:	anna.leese@navy.mil

N06-T030 TITLE: Micro-factory for Miniaturization, Portability and Remote Production

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: None

OBJECTIVE: Develop an enabling technology for producing miniaturized components at remote locations with portable manufacturing machines. Design and build a micro-factory or “desktop” factory that is capable of manufacturing highly accurate micro-parts of a variety of materials with complex three-dimensional surface features.

DESCRIPTION: Micro-manufacturing [1] is a novel technology for making small things with small machines. The expectation is that the tools of production can be miniaturized, made portable and net-worked to compete against conventional production approaches to technologies as diverse as chem.-bio and IED detection sensors, which would benefit from miniaturization, and Navy-specific applications such as UUVs and UAVs, which would benefit from rapid insertion of precision micro-components. Today, conventional, large-scale manufacturing systems are used to fabricate parts of 100µm to 10mm (micro-meso) dimensions. This practice is energy inefficient and results in poor dimensional tolerance and accuracy due to inertial uncertainties. The need is to develop a miniaturized manufacturing system. The micro-factory [2] or “desktop” factory is a system that can be designed to carry out fabrication, cleaning and assembly operations in one location and have its own “life-support” system, e.g., de-ionized water for cleaning. The micro-factory can be portable so small parts and devices can be made at a remote location, which will eliminate the need to maintain costly inventory of parts and allow the production of parts on-demand. Cost savings are also achieved because of reduced material and energy consumption, reduced maintenance

and footprint and reduced environmental impact. With these benefits, the successful development of the micro-factory will be a true cost reduction initiative.

PHASE I: Develop proof-of-concept of a robust and realistic engineering design of a micro-factory or "desktop" factory and its components. The micro-factory system should be capable of micro-component production and assembly into any high value Navy-specific product. The micro-factory should have an interchangeable modular design with fully automated seamless conveyance and communication between the modules. It should have in situ metrology and a capability for mass production as well as mass customization. It should be portable and networked, yet rugged. The research plan should address methods to achieve cross-dimensional (micro-meso) integration.

PHASE II: Construct a micro-factory prototype and demonstrate the fabrication of simple micro-parts and their assembly into a working, testable product.

PHASE III: Transition the micro-factory technology to critical military use and the civilian sector. Build marketable manufacturing units and demonstrate the fabrication of parts for a variety of industries: defense, aerospace, health and energy.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: A successful micro-factory system would be useful for a variety of commercial applications. Its affordability, portability and versatility will result in new businesses and industries, and high value jobs.

REFERENCES:
1. K. P. Cooper, "Micro-manufacturing: Making Small Things with Small Machines", Frontiers in Materials Science 2005: Innovative Materials & Manufacturing Techniques, Eds. T. S. Srivatsan, R. A. Varin, R. Abbaschian and S. Viswanathan, MS&T'05, ASM International, Materials Park, OH, (2005), 183-195.
2. Microfactory Emerging in Asia – Summary of 4th International Workshop on Microfactories held on Oct. 15-17th, 2004, Shanghai, China, Asia Pacific Nanotech Weekly, Vol. 2, article #43 (2004).

KEYWORDS: Cost reduction; micro-factory; micro-manufacturing; micro-components; sensors.

TPOC: Khershed Cooper
Phone: (703)696-4304
Fax:
Email: cooperk@onr.navy.mil

N06-T031 TITLE: Functionalized Nanotubes for High Performance Composites

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMS 500 Destroyer Class Program Office

OBJECTIVE: To investigate new approaches to carbon nanotube functionalization and to understand its effects on the mechanical properties of the CNTs themselves and of the final composite materials.

DESCRIPTION: Carbon Nanotubes (CNTs), despite their extraordinary mechanical properties, have limited interfacial bonding to polymer resins. As a result, when incorporated into polymeric resin in their pristine form, they lack the ability to transfer loads across the structure. Recent research indicates that functionalized nanotubes in very small amounts can significantly enhance composite mechanical performance (example: enhance their interlaminar shear strength or blast resistance) and, in fact, lead to low costs materials particularly when they replace materials that have large Life Cycle Costs (such as structural steels and aluminums). Functionalization of CNTs has to be done in such a way that the CNTs mechanical properties are not significantly degraded. This is a scientific and technical challenge since CNTs are formed by a single graphene sheet and bonding anything to them will change their electronic structure (and therefore mechanical properties). This STTR requests proposals on new functionalization methods or approaches that provide improved bonding with common structural resins (such as vinyl esters or epoxies) to enable stiffer and tougher composites for Naval applications. It also requests an

understanding and characterization of the effects that the functional groups have on the mechanical and physical properties of CNTs themselves.

PHASE I: During the Phase I research effort the PI will demonstrate his ability to functionalize single wall carbon nanotubes (SWNT) (even though SWNTs are more expensive that MWNTs, it is anticipated that SWNTs will be easier to characterize than MWNTs due to their higher degree of crystallinity) with functional groups that provide improved bonding with structural resins. The PI will characterize the degree of functionalization of the SWNTs and correlate this with the mechanical performance of small nanocomposites. The objective of this phase is to find the best functional group compatible with structural resins (vinyl esters and epoxies) and the optimum degree of functionalization without deteriorating the mechanical characteristics of the SWNTs significantly.

PHASE II: The PI will characterize the mechanical properties of the functionalized SWNTs and proceed to fabricate coupons that incorporate these functionalized SWNTs in glass/vinyl ester composites; carbon/vinyl ester composites and carbon/epoxy composites. The PI will develop a complete characterization of the mechanical properties of these composites (e.g. compression, tension, shear, toughness, environmental durability, etc) to determine the effects of the functionalized SWNTs on structural performance of the composite materials. The samples that are to be tested should be manufactured using a Vacuum Assisted Resin Transfer Molding (VARTM) process.

PHASE III: This phase is not funded by the STTR program office. The PI will seek Navy program funding geared at demonstrating this technology in a larger scale.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The potential commercial applications for carbon nanotubes (CNTs) are enormous. These materials have 6x the strength of structural steels at 1/6 the density of them. The elongation to failure is 20%. The toughness of these materials is unsurpassed. Applications for bridge construction in the civil sector or wings and fuselage for commercial aviation are a near term reality. The results from initial testing indicate that the interlaminar shear strength (ILS) in these composites can be improved by 40% just by adding 0.014% (weight) of CNTs.

REFERENCES:
1) Odegard, G. M., Frankland, S. J. V., Gates T. S. "The Effect of Functionalization on the Elastic Properties of Polyethylene Nanotube Composites," AIAA Journal, 43, 1828-1835 (2005).
2) Frankland SJV, Caglar A, Brenner DW, Griebel M. “Molecular simulation of the influence of chemical cross-links on the shear strength of carbon nanotube-polymer interfaces”. J Phys Chem B 2002;106:3046-3048.
3) Brenner DW, Shenderova OA, Areshkin DA, Schall JD, Frankland SJV. “Atomic modeling of carbon-based nanostructures as a tool for developing new materials and technologies.” CMES 2002;3:643-673.
4) Krishnan A., Dujardin E., Ebbesen T.W.,”Young’s modulus of single–walled nanotubes”, Phys. Rev. B.58, No20, (1998-II), 14013-14019
5) Yu M.,Files,B.S., Arepalli S., Ruoff R.S., “Tensile Loading of Ropes of Single Wall Carbon Nanotubes and their Mechanical Properties”, Phys. Rev. Lett. 84, No 24, (2000) 5552-5555

KEYWORDS: nanotubes; CNT; SWNT; nanocomposites; composites; nanotechnology

TPOC: Ignacio Perez
Phone: (703)696-0688
Fax: (703)696-0934
Email: perezi@onr.navy.mil
2nd TPOC: Roger Crane
Phone: (301)227-5126
Fax: (301)227-5548
Email: roger.crane@navy.mil

N06-T032 TITLE: Compact High-Frequency Antennas

TECHNOLOGY AREAS: Information Systems, Electronics

ACQUISITION PROGRAM: Potential: MARCORSYSCOM/SPAWAR.

OBJECTIVE: Design, develop, test and demonstrate rugged, automatic-tuning, compact (less than 500 cubic centimeters; largest dimension <30 centimeters; weight <500 grams; transmit and receive performance equivalent to or exceeding the current whip and long antennas) high frequency (HF) antenna operating in frequency range of 2 to 30 MHz with instantaneous bandwidth of 3 kHz or more.

DESCRIPTION: High frequency communications is a vital resource to the Marine Corps for beyond-line-of-sight and over-the-horizon voice communications in both vertical incidence and ground-wave modes. Unfortunately, the same properties that allow such favorable propagation of radio frequency energy, also make communications greatly variable because of even minor environmental changes. In the past few years, automatic link-establishment radios have provided improved reliability by adapting to the changing propagation qualities to maintain a stable link.

Recent advances in processor capabilities and their enabling of improved algorithms in the areas of signal processing, channel definition, diversity (spatial, frequency, time, coding) and exploitation of environmental conditions may be applicable to high frequency communications for improving reliability and throughput. Assuming some success in applying this work to HF, the next technical challenge is reducing the size of the antennas from the current whips needed for HF communications.

The individual warfighter requires a man-portable HF antenna that will not significantly affect his endurance and agility. It must provide a reduced profile to opposing forces, while meeting or exceeding existing antenna performance for line-of-sight, ground-wave and near vertical-incidence sky-wave, and minimize visual signature for both and vehicle applications. The antenna must be compatible with existing and developmental radios with maximum transmitted power requirements of 150 watts in a vehicle-mounted configuration and 20 watts in a man-portable configuration. Human radiation exposure effects analysis at a power amplifier output of 150 watts and for 20 watts, respectively, must be included.

The research goal of this effort is to examine high-risk high-payoff technologies that go beyond current methods, such as stacked dipoles, and inductor-capacitor (LC) matching circuits, for producing electrically large, physically small antennas. Innovative solutions that enhance RF efficiency and performance while greatly reducing size and weight are of interest. Additionally, approaches that are adaptable to spectral efficiency such as time, space, frequency or coding agility are of particular interest.
Important technical challenges are expected in the areas of antenna matching, radiating structure and safety.

PHASE I: Contractor will provide technical report to discuss possible compact high-frequency antenna development approaches with proof of principle demonstration.

PHASE II: Prototype development, build, test and demonstrate compact high-frequency antenna (option period: engineering development model)

PHASE III: Engineering development for maturing of prototypes, relevant to use by USMC and/or naval forces.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: For use in high kilohertz/low megahertz public service bands. Also amateur radio 10-80 meter bands.

REFERENCES:
1. AN/PRC-150 radio:
http://64.233.161.104/search?q=cache:kPDlR4Rlm74J:www.rfcomm.harris.com/products/tactical-radio-communications/anprc-150c.pdf+PRC-150&hl=en.
http://64.233.161.104/search?q=cache:hs3nLRZPnjEJ:www.rfcomm.harris.com/products/tactical-radio-communications/ANPRC150-brochure.pdf+PRC-150&hl=en.
2. Falcon II/III tactical Radio: http://www.rfcomm.harris.com/products/tactical-radio-communications/.
3. AN/PRC-104 radio: e.g., http://www.columbiaelectronics.com/an_prc_104_hf_portable_radio_set.htm.
4. Distributed-loadmonoposes, e.g., http://www.scienceblog.com/community/article2865.html.
5. Testing, e.g., http://www.uri.edu/news/releases/?id=3126.

KEYWORDS: High Frequency; Antenna; RF Communications; RF propagation; RF materials; military communications; dipole, monopole, matching, loading.

TPOC: John Moniz
Phone: (703)696-2492
Fax: (703)696-2611
Email: monizj@onr.navy.mil
2nd TPOC: Nathan Smith
Phone: (540)653-5860
Fax:
Email: smithn@onr.navy.mil

N06-T033 TITLE: Fault Diagnostics, Prognostics, and Self-Healing Control of Navy Electric Machinery

TECHNOLOGY AREAS: Air Platform, Information Systems, Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: Naval Sea Systems Command; PMS 500: DD(X) Program. PMS 501: LCS Program

OBJECTIVE: The objective is to provide a capability for condition monitoring and fault diagnostics and prognostics for power electronic converters and electromechanical devices for both defense and commercial applications. Diagnostics and prognostics plays a key role in the proper operation of the power electronic converters and electromechanical devices. The power electronic converters can be ac/ac, dc/dc, ac/dc, or dc/ac converters, and the electromechanical devices can be an electric motor or generator, a transformer, a relay controlling a valve or a critical sensor.
Recent achievement in digital signal processors (DSPs) together with advanced algorithms and deep knowledge of power electronics converters and electromechanical devices provides a viable solution to the diagnostic problem. The objective of this topic submission is the development and demonstration of a capability to make repeatable decisions based on complex relationships between large amounts of measured and estimated data. The condition of the system will be available at all times, and the incipient detection and predictive maintenance unit will provide an accurate prediction of any potential failure on demand and will be used in "self-healing" strategies to improve reliability and availability of critical electrical systems including motors, drives, and generation and distribution equipment.

DESCRIPTION: The proposed work will provide an advanced fault diagnostics, prognostics, and self-healing control capability, ensuring cost effective and highly reliable electrical machinery systems to improve warfighting effectiveness and ensure a "limp home" capability. Systems currently exist in the navy that assesses the condition of engineering plant machinery, for example, ICAS (Integrated Condition Assessment System.) This system continuously assesses the engineering plant machinery and 1) notifies the watchstander of unusual or abnormal machinery conditions and 2) logs data on the machinery that can be used for trend analysis and the potential need for component replacement to prevent expensive catastrophic machinery failure. However, these systems are limited by the sensors that are employed and the scope of capability that the system provides. Existing sensor technology that is employed in the ICAS and similar systems lend themselves to single point failure. If the sensor fails, or even more costly, if the lead between the sensor and monitoring component fails, then there does not exist the redundancy needed to render the component operational. Advancements in smart sensor technology, such as WiFi (wireless fidelity) lend themselves as candidates to replace legacy, single point of failure sensors. A technological challenge, however associated with wireless sensor based systems is that they tend to be susceptible to Electromagnetic Interference (EMI), Radio Frequency Interference (RFI), susceptible to electronic attack, and establishing trust that the wireless smart sensors are relaying accurate and timely information. However, the payoff associated with improvements in sensor technology is the risk mitigation of potential sensor lead failures connecting the sensor to the monitoring and control system, and more rapid, real time assessment and reconfiguration capability. Should a lead be damaged, then information cannot be relayed from the component to the monitoring and control systems. Additionally, as the title implies, existing systems only assess conditions of machinery. They provide diagnostic information of machinery, but not prognositic information nor do they provide self healing capabilities. For example if a multi-phase motor has a fault that renders one or more phases incapable of carrying current to the

motor stator, then the motor will have to be shut down. However, if a smart sensor can be used in conjunction with machinery algorithms that can acknowledge the loss of one or more phases, respond to the fault by mathematically calculating what the current and appropriate phase angle needs to be in each of the remaining phases, then the machine can continue to be operated, albeit in a reduced capability mode resulting in reduced performance, vice unoperational which for military application, drastically reduces mission effectiveness, and for commercial application reduces throughput and therefore reduces profitability. From a system level perspective, smart sensors are needed to achieve future system reconfiguration response time goals. If demonstrated at the component level, then a level of confidence can be established that the sensors can be integrated at a system level to improve reconfiguration response times following weapon impacts and improve the warfighting effectiveness of the ship.

PHASE I: Based on characterization of potential faults and identification of new sensor technologies, establish a fault detection and reporting capability that can dynamically locate and identify faults. Design a diagnostic test bed to be used for making repeatable decisions based on relationships between measured and estimated data. Identify potential “Self Healing” Strategies that could prevent machinery from being taken off line. Describe “pros” and “cons” with each strategy and with sensor technologies identified. The deliverables will be monthly progress reports and a final report listing potential machinery and device faults, proposed new sensor technologies, description of the diagnostic test bed, and the listing of potential self healing strategies.
Additionally, perform evaluations to identify and characterize the incipient faults for different power electronic converters and various electromechanical devices.

PHASE II: Using results from Phase I, develop a diagnostic test bed and demonstrate its utility and accuracy to make repeatable decisions based on relationships between measured and estimated data. Down select from the collection of strategies identified in Phase I, and implement an optimized self healing strategy. Demonstrate the self healing capability through simulated and actual fault occurrences on a representative electrical system prototype. The final product will be a package which is capable of performing condition monitoring and fault diagnosis of electric and electromechanical machinery and systems, and perform “self-healing” functions to reduce down time of electrical machinery. A final report will be submitted that summarizes the methodologies developed and demonstrated and algorithms implemented during Phase II.

PHASE III: If this technology is proven to meet the requirements specified above at the end of Phase II, it will be transitioned to ONR’s Advanced Integrated Power System (AIPS) program under the Enterprise and Platform Enablers Future Naval Capability (FNC). This technology will be demonstrated 1) in simulation on ONR’s Virtual Test Bed (VTB) and 2) in a full scale medium voltage demonstrator (TBD) together with global power system management capabilities currently being developed under a FY05 initiated STTR that is progressing to Phase II in FY06.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Adjustable speed drives for AC motors are the backbone for industrial processes and applications that require rigorous torque and speed control. Premature failure of drives or motors may have a significant impact on industrial applications. Such impact could be an economic loss resulting from comprehensive breakdown for the whole system in an industrial setting. Consequently, the reliability and the continuous availability of motor-drive systems are of paramount importance. In many applications, engineers try to avoid such aforementioned failures through redundancy, which consequently and adversely increases the cost and size of the system.

REFERENCES:
1. Kwatny, H. G., J. Prosser, and M. Kam, "Security Supervisory Control in Electric Power Systems," Electric Power Research Institute, Palo Alto, Research Report EPRI TR-108327, June 1997.

2. Kwatny, H. G., X. M. Yu, and C. Nwankpa, "Local Bifurcation Analysis of Power Systems Using MATLAB," presented at 4th IEEE Conference on Control Applications, Albany, 1995.

3. Yaz, E.E., "Observer Design for Discrete-Time Stochastic Parameter Systems," Control and Dynamic Systems (ed. C.T. Leondes), Invited Chapter in the Special Volume on Digital Design and Control System Techniques and Applications, vol.73, pp. 121-158, Academic Press, San Diego, CA, 1995.

4. Yeh, C.-C., Mirafzal, Bl, Povinelli, R.J., and Demerdash, N.A.O., "A Condition Monitoring Vector Database Approach for Broken Bar Fault Diagnostics of Induction Machines," Proceedings in IEEE International Electric Machines and Drives Conference, IEMDC 2005, May 15-18, 2005.

KEYWORDS: Prognostics; Fault Diagnostics; Condition Monitoring; Self-Healing; Fault Mitigation; Electric Faults

TPOC: Lynn Petersen
Phone: (703)696-1291
Fax: (703)696-0308
Email: petersl@onr.navy.mil

N06-T034 TITLE: New Material Compositions That Expand the Operating Domain of Piezoelectric Single Crystals

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

ACQUISITION PROGRAM: Multiple: See acquisition interest section below.

OBJECTIVE: Synthesize new material composition of single crystal relaxor piezoelectrics (having the extraordinary electromechanical properties of high coupling: 90-95 %, and high strain: ~ 1 %) to operate at higher temperature, higher electric field and higher stress, than the current PMN-PT and PZN-PT single crystals. The broadened span of device operating domain will enable greater system design flexibility. These crystals shall be in the appropriate form (bulk, multilayer, fibers, thin films, etc.) for manufacturing into practical devices for defense and civilian applications.

DESCRIPTION: Near the onset of 1997 came the discovery that single crystals of certain relaxor ferroelectric materials (lead magnesium niobate – lead titanate, and lead zinc niobate – lead titanate) exhibit extraordinary piezoelectric properties, namely, strains exceeding 1%, and electromechanical coupling exceeding 90% (compared to 0.1% and 70-75 %, respectively, in state-of-the-art piezoceramics). Concerted efforts to grow these materials in a variety of forms (bulk, multilayer, fibers, thin films, etc.) now yield materials in quantities, and at a price, suitable for devices. Initial commercial devices have been marketed; development efforts are underway for a number of additional applications.

To facilitate a wider range of device application of these crystals, their operating domain (temperature, field, stress) must be enlarged. This topic aims to devise materials synthesis/growth technology that will produce new material compositions that allow these crystals to operate at higher temperature, higher electric field and higher stress than the currently available piezoelectric single crystals PMN-PT and PZN-PT. While the materials technology being developed should target an application arena, that application is only incidental to the work performed. Nevertheless, clearly establishing a linkage between the proposed materials development to a targeted application of importance to the Army, Navy, or Air Force would provide a plus.

PHASE I: Devise and demonstrate the feasibility of an innovative materials synthesis/growth methodology that substantially increases the operating domain (temperature-electric field-stress) of relaxor piezoelectric single crystals. Provide an analysis of the increase of the operating range in a production device.

PHASE II: Implement the innovative piezocrystal synthesis/growth technology and demonstrate “zero batch” production of a composition which targets a specific candidate application. Validate cost projections in detail. Survey potential markets and develop a pricing structure for production at various annual rates.

PHASE III: Manufacture materials for applications in the defense sector ranging from Navy sonar, through Army rotor blade control, to Air Force airfoil shape control. In the sonar arena, active development projects already target: torpedo countermeasures, torpedo homing sonar, supercavitating torpedoes, vector sensor line arrays, mine sonar, and towed torpedo defense projectors.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: In the civilian sector, applications targets for this materials technology include medical ultrasonic imaging transducers, actuators for active machine tool control, and sensors/actuators for vibration suppression in HVAC systems. Already accelerometers and medical ultrasonic imagers incorporating relaxor piezocrystals have been commercialized and development of actuators for hydraulic servo-valves is well underway.

REFERENCES:
1. S.-E Park and T.R. Shrout, "Ultrahigh Strain and Piezoelectric Behavior in Relaxor based Ferroelectric Single Crystals, " J. Appl. Phys., 82[4], 1804-1881 (1997).
2. S.-E Park and T.R. Shrout, "Characteristics of Relaxor-Based Piezoelectric Single Crystals for Ultrasonic Transducers," IEEE Trans. On Ultrasonic Ferroelectrics and Frequency Control, Vol. 44, No. 5, 1140-1147 (1997).

KEYWORDS: Materials Synthesis/Growth Technology; Electromechanical Sensors and Actuators; Piezoelectrics; Single Crystals; Lead Magnesium Niobate–Lead Titanate; Lead Zinc Niobate–Lead Titanate.

TPOC: Wallace Smith
Phone: (703)696-0284
Fax: (703)696-0934
Email: smithw@onr.navy.mil
2nd TPOC: Carl Wu
Phone: (703)696-0689
Fax: (703)696-0934
Email: wucarlc@onr.navy.mil

N06-T035 TITLE: Cryogenic Processing of Nano-Aluminum Powder and Consolidation of Armor Nano-Aluminum Composite Plates

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: DRPM AAAV & MARCOR PM Combat Tactical Vehicle (CTV)

OBJECTIVE: Develop a low cost process for cryogenic production of nano-micron-size blend aluminum powder suitable for bulk fabrication via conventional thermomechanical processing into armor plates.

DESCRIPTION: For their ballistic performance, environmental durability and weldability, wrought aluminum alloys (e.g. 5083 and 2519) have been the material of choice for a number of lightweight armored vehicles including the USMC Amphibious Assault Vehicle, the Expeditionary Fighting Vehicle, and numerous US Army platforms. Higher strength and better ballistic performance from this class of materials are necessary to meet requirements for future Marine Corps vehicles. The EFV is incorporating ballistic armor protection via an armor inserts within the space frame construction and the CTV will incorporate "A kit" (undercarriage armor to protect the crew from mine/IED blast) and "B kit" (add on armor to protect the crew from direct fire, indirect fire and IED attack) armor configuration with this approach. Both of these platforms offer the opportunity to integrate novel nano-micron grain size 5083 aluminum which has demonstrated 150-250% higher strength, without compromising ductility, and 30% improvement in ballistic performance compared to armor grade 5083-H131 aluminum. This effort will advance the Science and Technology involved in 5083 nano-micron aluminum powder mass production, which is a critical component to transition this material technology for armor vehicle application vs. the current laboratory scale cryogenic milling.

PHASE I: Demonstrate low cost processing cryogenic 50-50 blend of nano-micron grain size 5083 aluminum powder and consolidation of these powder into bulk plates (300mm x 300mm x 25mm).

PHASE II: Scale up the powder processing and consolidation methodology to fabricate a minimum of (1m x 1m x 25mm) plates with superior ballistic (>30%) and mechanical properties (>200%) than conventional 5083-H131 aluminum.

PHASE III: Transition technology to commercial military ground vehicle integrators, energetic materials and aerospace manufacturers.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Developing commercial powder processes capable of quantity production is necessary to lower the cost of this technology for military and commercial application such as the energetic materials and the aerospace structure communities.

REFERENCES:
1. Luton, M.J. et al., Cryomilling of nano-phase dispersion strengthened aluminum, in Mat Res. Soc. Symp. Proc. 1989. p. 79-86
2. Chin, E.S.C., Army focused research team on functionally graded armor composites. Materials Science and Engineering A, 1999. A259: p. 155-161.

KEYWORDS: aluminum; cryomilling; nano-technology; lightweight; materials; fabrication

TPOC: Rodney Peterson
Phone: (703)696-3632
Fax:
Email: petersr@onr.navy.mil
2nd TPOC: Ernest Chin
Phone: (410)306-0864
Fax: (410)306-0829
Email: echin@arl.army.mil

N06-T036 TITLE: Acoustic Pattern Recognition for Security Breaching Noise Detection

TECHNOLOGY AREAS: Information Systems, Sensors, Electronics, Battlespace

OBJECTIVE: An acoustic recognition platform that can be trained to identify and locate specific sounds amidst high noise serves as a foundation for non-line-of site detection and proactive alerts that can activate other verification and prevention technologies such as cameras and UAVs. Given that pattern recognition involves identification of a set of fundamental features, the essence of the sound recognition problem is the competing need for both high dimensionality representations (i.e. discrimination) and a reasonably limited feature space (i.e. rapid identification). Biological systems provide existence proofs of auditory recognition systems not currently matched by engineered systems. The objective of this topic is to go beyond currently demonstrated gun-shot detection systems to implement acoustic pattern recognition systems for security breaching noise detection. Examples of security breaching noises of interest include: assault rifles, RPG/mortar firings, sniper detection (e.g. chambering a round), etc.

DESCRIPTION: The field of terrestrial acoustic pattern recognition has seen dramatic new techniques and applications in the past two years, including the ability to recognize and locate gunfire. However, identification of acoustic signals in noisy environments remains one of the most difficult of signal processing problems. This STTR topic is searching for acoustic recognition platforms that can be trained to identify and locate sounds related to security breaching. It is well understood that the problem becomes even more difficult with a non-stationary device, and either approach could constitute a valid proposal. As with any "smart sensor", processing speed, computational requirements, power requirements, size, performance (e.g. rejection of false positives) are all important issues. This STTR topic is especially searching for novel solutions to these issues. The focus of this STTR would be to combine University-driven algorithm development with small business engineering and application "know-how".

PHASE I: Do a comprehensive survey of "state of the art" solutions. Develop a feasible concept. Develop a data base to test worthiness of concept. Build and subject software model to preliminary tests.

PHASE II: 1) laboratory refinement of first-generation acoustic recognition models formulated under Phase I. 2) a demonstration of the efficacy of the second-generation models with respect to false- positive rejection and noise robustness. 3) design and simulation of hardware implementation (FPGA or VLSI) of acoustic Phase II recognition

models. 4) design and simulation of a network structure within which multiple Phase II acoustic recognition units would function. 5) preliminary field-testing and evaluation of Phase ii acoustic recognition models.

PHASE III: 1) full-scale system design and prototyping of acoustic recognition system. 2) full-scale field-testing and evaluation of prototype acoustic recognition systems, including redesign according to field-testing results. 3) ruggedizing the field-tested systems, including additional field demonstration of the ruggedized system. 4) identification and cooperation in steps 1-3 of a sufficiently medium-to-large scale manufacturer that could support production of the final system. 5) productization and commercialization for delivery of an end user product designed to provide superior detection, recognition, and warning about suspicious or threatening event precursors before they become dangerous.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Private sector potential includes security at warehouses, manufacturing sites, refineries. It is possible that refinements of this technology can be used in forest/wilderness environments to detect "tree poaching". Other possible applications include external monitoring of oil pipes where sounds of hydraulic flow change as a function of tapping - either legal or illegal.

REFERENCES:
1. B. Gold, N. Morgan. Speech and audio signal processing: processing an perception of speech and music. Wiley, New York, 2000.
2. C. Kyriakakis, P. Tsakilides, T. Holman. Surrounded by sound. IEEE Signal Processing, Vol 16, 1, 1999: 55-66.
3. A. Harma, M. Juntunen. A method for parameterization of time-varying sounds. IEEE Signal Processing Letters, Vol 9:5, 2002, 151-153
4. M. Oud. Internal-state analysis in a layered artificial neural network trained to categorize lung sounds. IEEE Trans. Systems, Man and Cybernetics, Part A, Vol 32:6, 2002, 757-760.

KEYWORDS: acoustic recognition, temporal pattern identification, security, sound classification, perimeter protection

TPOC: Joel Davis
Phone: (703)696-4744
Fax: (703)696-8343
Email: davisjl@onr.navy.mil
2nd TPOC: Ray Perez
Phone: (703)696-4986
Fax:
Email: perezr@onr.navy.mil

N06-T037 TITLE: High Resolution Micro-meteorological Tools for Global War on Terrorism (GWOT) Contaminant Transport and Dispersal Predictions

TECHNOLOGY AREAS: Chemical/Bio Defense, Information Systems, Battlespace

OBJECTIVE: High resolution atmospheric modeling systems, including ensembles, are coming on line which are capable of providing quantitative and reliable probabilistic forecasts of meteorological parameters, such as temperature, wind direction and speed, precipitation, visibility, etc. These forecasts can be downscaled and used directly and/or to drive independent modeling systems for providing valuable guidance on problems relevant to the Global War on Terrorism (GWOT). Examples include contaminant transport and dispersion models run in simulation and/or actual occurrences of a "dirty bomb" attack or airborne release of chemical or biological agents. A key problem is translating the wealth data from these models into useful information, especially for risk analysis and decision making. The intent of this STTR is to develop products and decision aids that address this problem and which are "user friendly", timely, and reliable as tailored for sets of specific applications.

DESCRIPTION: Generic software and visualization systems are available that can be applied to this issue, but need to be structured to accommodate GWOT needs and requirements and, most importantly, be expanded to accommodate probabilistic information as derived from ensemble forecast systems. One particular system is being

targeted, namely, the Joint Ensemble Prediction System (JEFS) now being developed as a cooperative effort between NRL/MRY and AFWA. The problem is essentially two fold: 1) downscaling meteorological parameters from the relatively coarse deterministic and ensemble models with sufficient flexibility to drive contaminants transport and/or dispersion models of varying parameter dimensions, and 2) developing a "user friendly" information extraction and visualization system for display and interpretation of transport and/or dispersion model output required for risk analysis and decision making. Ultimately, this should be guidance probabilistic as a function of user specified exceedance thresholds.

PHASE I: Develop and Test:

1) a generic system for extracting sets of gridded meteorological data relevant to contaminant and dispersion forecasting (e.g., temperature, winds, humidity) from operational and/or experimental atmospheric prediction models;

2) given simulated or actual user specified geographical region of interest (~ city to state size) and critical threshold levels (e.g., T > Tcrit; V > Vcrit; T > Tcrit AND V>Vcrit), a system for displaying and highlighting warning areas where thresholds are exceeded over forecast period (e.g., 00, 03, 06 ... 72hr);

3) given generic and/or specific user specified input requirements, a system for pre-processing meteorological data for driving contaminant and/or dispersion models - to include sets of input derived individually from members of an ensemble forecast system.

PHASE II: Develop and Test:

1) using simulated and/or actual output from multiple runs of contaminant or dispersion models, system for deriving and displaying mean, standard deviation, and extremes of specified meteorological variables and/or derived parameters;

2) system for deriving and displaying probabilities of specified meteorological variables or derived parameters exceeding various threshold values over area of interest;

3) imaginative techniques for intuitive visualization and interpretation of uncertainties in contaminant, dispersion forecasts - as inferred from, but not necessarily limited to - items in "1" and "2" - in context of applications to decision making and risk analysis.

Demonstrate above in context of i) open, flexible, and extensible architecture, and ii) being "user friendly" for non technical individuals

PHASE III: The above is expected to transition through applications tying the NRL/AFWA Joint Ensemble Prediction System (JEFS) to not yet specified contaminant and dispersion modeling systems existing or under development for DOD and the Department of HomeLand Security in the context of the Global War on Terrorism (GWOT). The small business will work with individual agencies (e.g., DOD, Federal/local emergency managers) or user groups (e.g., staff pre-planners, first responders, consequence managers) in training and software/hardware issues.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: The above can be applied to any private industry or concern interested in security relating to transport of contaminants or dispersion of hazardous materials. Also, there are generic applications in many economic areas, such as energy and agriculture. In the former, for example, meteorological data from an ensemble of forecasts can be input to models governing heating oil usage as a function of "heating degree day" thresholds or models for electricity usage as related to variations in "heat index" potential. In the latter, for example, the meteorological data can be applied to systems designed to predict limits on aircraft release of pesticides or hydrological models for predicting drought indices. More generally, any industry or concern could employ the above in managing decisions depending upon vagaries in the weather.

REFERENCES:
Joint Ensemble Forecasting System
weather.afwa.af.mil/HOST_HOME/DNXM/JEFS/jefs.html

Ensemble Forecasting Explained
http://meted.ucar.edu/nwp/pcu1/ensemble/

NWS Support During Hazardous Materials Emergencies:
http://meted.ucar.edu/dispersion/disp_ops/txt/menu.htm

Emergency Response System: Real-Time Operational Models
http://narac.llnl.gov/modeling.html

LLNL and SNL Dispersion Modeling and Assessment Tools
http://eed.llnl.gov/ans/2002/nasstrom/nasstrom_ans_2002.pdf

KEYWORDS: GWOT; dispersion; contaminant; meteorolgical; ensemble; models

TPOC: Steven Tracton
Phone: (703)696-6598
Fax:
Email: tractos@onr.navy.mil
2nd TPOC: Ronald Ferek
Phone: (703)696-0518
Fax: (703)696-3390
Email: ferekr@onr.navy.mil

N06-T038 TITLE: STTR Friction Stir Processing for Superplastic Forming

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: TBD

OBJECTIVE: Solve technical hurdles (through modeling and experiment) and demonstrate the feasibility of Friction Stir Processing in combination with Superplastic Forming of high-strength, low-density alloys for the production of lightweight, geometrically complicated components avoiding design limitations, and labor and rework challenges and costs of welding multiple small sub-components.

DESCRIPTION: Complicated components, such as water tight doors for Navy ships and submarines or gun turrets for Marine Corps vehicles, are currently produced by joining multiple, straight subsections to form a more complicated three-dimensional architecture. In addition to the fabrication costs of labor intensive machining and welding operations, distortion generated during welding makes it difficult to control dimensions; and the added expenses of reworking must be considered in the final product cost. Superplastic forming (SPF) is a valuable tool for allowing the production of complicated forms from sheet product, often reducing the number of starting subcomponents a factor of 10. However, cost effective use of the technique is limited to a number of specially developed alloys processed to a narrow range of thicknesses. Friction Stir Processing (FSP) allows for the localized modification of traditional microstructures to very fine-scale structures that have been shown to be highly amenable to SPF. By combining the two technologies, the design space could be enlarged to include a number aluminum and titanium alloys, or even higher strength steel alloys, that without the constraints imposed by the need to limit welding distortion can have much thinner gauge section. The final components would be much more affordable (10X) and could be designed to be much lighter (2X).

Technical hurdles remaining are alloy- and design-requirement-specific. These issues are best solved by the concurrent engineering approach that is enabled by the STTR Program. University performers are most suited to develop the FSP processing-microstructure relationships that will allow the most affordable combination of high

strain rate forming at low pressures and temperatures for effective SPF for a given series of alloys. A small business with the capacity to FSP and SPF components of actual size would benefit immensely from the university led-research and would guide that research in a focused and productive manner, while simultaneously developing the tooling and process parameters to produce compelling demonstration articles.

PHASE I: Identification of a compelling demonstration article including design requirements (dimensional and mechanical property tolerances) and alloy selection will be part of a successful Phase I effort. Feasibility of using FSP combined with SPF for the class of alloys needed to meet design requirements must be demonstrated through experiment and modeling.

PHASE II: Relationships between processing parameters, mechanical properties and cost for the combined FSP and SPF of the alloy selected must be established. Success will be further defined by (1) production of a compelling demonstration article that is sufficiently complex to illustrate potential cost savings for the processing approach, and (2) representative mechanical property data for the material in the fully processed condition demonstrating that design criteria can be met.

PHASE III: Phase III will be marked by evaluation of the demonstration component in either sea or field trials. A business plan for full-scale production capability will be developed and initiated.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Private sector, commercial applications are numerous throughout the transportation industry. General principals developed in this project could be readily applied to components for civilian shipping, aerospace, train, automotive and public transport vehicles.

REFERENCES:
(1) Mishra, R.S., "Friction Stir Processing Technologies," Advanced Materials & Processes, October, p. 43, 2003.

(2) Ma, Z.Y., Mishra, R.S. and Mahoney, M.W., "Superplastic Deformation of Friction Stir Processed 7075Al Alloy," Acta Materialia, 50, p. 4419, 2002.

(3) Salem, H.G., Reynolds, A.P., and Lyons, J.S., "Structural Evolution and Superplastic Formability of Friction Stir Welded AA 2095 Sheets," Journal of Mat. Engineering and Performance, 13, p. 24, 2005.

KEYWORDS: superplastic forming, friction stir processing, light weight materials, aluminum alloys, titanium alloys

TPOC: Julie Christodoulou
Phone: (703)696-0953
Fax:
Email: christj@onr.navy.mil
2nd TPOC: Rodney Peterson
Phone: (703)696-3632
Fax:
Email: petersr@onr.navy.mil

N06-T039 TITLE: High-Power Fiber-Optical Switch for Infrared Countermeasure (IRCM) Laser Applications

TECHNOLOGY AREAS: Sensors, Electronics, Weapons

ACQUISITION PROGRAM: NAVAIR PMA-272 Tactical Aircraft Directed Infrared Countermeasures

OBJECTIVE: Develop a technology for switching (routing) multi-band IR power from an input port to any of several fiber-optic output ports. The switch must be low-loss and capable of transmitting high power while operating as part of an IRCM system within a military tactical aviation environment.

DESCRIPTION: The Navy has interest in IRCM systems that use lasers to protect aircraft from IR guided threats. Multiple system topologies are being considered, including those that utilize a single, centrally-installed laser, with its output being routed via fiber-optic cable to any of several tracker-pointer assemblies. These tracker-pointer assemblies then direct the laser power to the approaching threat. This arrangement can offer significant benefits, including reduced overall system volume, weight, and cost, when compared with other IRCM systems which use independent lasers for each tracker-pointer. A key technology for a central-laser design is a robust and rugged fiber-optic switch, to perform the function of routing the laser output to the appropriate tracker-pointer. Responders shall propose to develop and demonstrate a fiber-optic switch, which will operate with insertion loss of less than ~0.25dB while handling at least 2W of multi-band laser power over the spectral range between ˜ 2 and 5 µm. The proposed unit shall have switching times less than 0.5s, and shall work with chalcogenide glass fibers having core diameters within the range of 100µm-200µm, outer diameters (not counting buffer) within the range of 200µm-300µm, and numerical aperture (NA) ˜ 0.25. The proposals will be ranked based on the likelihood that the proposed device will meet the requirements for a fiber-optic switch, as outlined above, suitable for use in a military tactical aviation environment. Criteria such as performance, ruggedization, and cost will be considered.

PHASE I: Design, construct, and demonstrate a laboratory, proof-of-principle fiber-optic switch device. A clear development path toward militarization must be presented.

PHASE II: Produce and demonstrate via test a fiber-optic switch suitable for use in a military aviation environment. The test must demonstrate high power-handling capability, low insertion loss, and rapid fiber switching under vibration conditions representative of tactical aircraft.

PHASE III: Upon successful completion of the Phase II effort, the fiber-optic switch will transition to the Navy for integration into a defensive system being developed for tactical fixed- and rotary-wing aircraft.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: A fiber-optic switch as described should find uses in laser marking, laser machining, laser micromachining, and in the forensic sciences. Mid-wave infrared radiation is a valuable tool for spectroscopic investigations of organic compounds associated with oil exploration, and the use of fiber optics technology in this wavelength band allows spectroscopic measurements to be made in normally inaccessible locations, such as the bottom of an oil well bore-hole. These techniques can also be used to monitor oil properties inside engines and other machinery using in-situ sensors in order to monitor system performance and wear and diagnose and localize problems as they arise.

REFERENCES:
Discussion of optical fiber switching technology for conventional (short-wave infrared) multimode optical fibers:
Paper: MICROOPTICAL_MULTIMODE_SWITCH.PDF;
Abstract Link: http://www.opticsinfobase.org/abstract.cfm?id=78051
Paper Link: http://www.opticsinfobase.org/ViewMedia.cfm?id=78051&seq=0

Product data sheets for commercial optical fiber switcher:
Data Sheet: POLYSCI_FO4635.PDF
Web Link: http://www.polysci.com/FiberopticsandSecurity/foswitch.html
Data Sheet Link:http://www.polysci.com/docs/FO4635.pdf

Data Sheet:POLYSCI_FO4665DS.PDF;
Web Link: http://www.polysci.com/FiberopticsandSecurity/foswitch.html
Data Sheet Link:http://www.polysci.com/docs/FO4665DS.pdf

Discussions of mid-wave infrared transmitting optical fibers:
"Infrared Fiber Optics," http://irfibers.rutgers.edu/pdf_files/ir_fiber_review.pdf
"Fabrication of Single-Mode Chalcogenide Optical Fiber," Journal of LIghtwave Technology, Vol. 16, No. 2, February 1998.

KEYWORDS: Fiber optics; fiber optical switching; chalcogenide glass fibers

TPOC: Peter Craig

Phone: (703)696-0114
Fax: (703)595-1331
Email: craigp@onr.navy.mil
2nd TPOC: James Lynn
Phone: (202)767-3084
Fax: (202)767-3084
Email: greg.lynn@nrl.navy.mil

N06-T040 TITLE: Alternative Room Temperature Cure and VARTMable High Temperature Resin Systems for Large Scale Composite Ship Component Manufacturing

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

OBJECTIVE: Currently epoxy resins are not utilized in the VARTM process due to their higher viscosity and shorter cure times. In addition, normally an epoxy system will require a post cure in order to achieve the same glass transition temperature as a vinyl ester resin system such as Derakane 510A. This program would develop an epoxy system that would have the viscosity and cure characteristics of a vinyl ester and would not require post curing while achieving a glass transition temperature of at least 200 F, being compatable with both carbon and glass fibers. provide a high fracture toughness comparable to Derakane 8084, and have a low cure shrinkage. The use of epoxy resins would also eliminate the health risks currently associated with the styrene used in vinyl ester resins.

DESCRIPTION: Currently, the Navy uses vinyl ester resin as the matrix material for manufacturing composite ship structures. Vinyl esters have been used for all currently fielded composite components including the AEM/S mast, LPD-17 masts, DD(X), Composite Advanced Sail, and the Composite High Speed Vessel. As the Navy begins utilization of carbon fiber as the reinforcement, the use of vinyl ester as the matrix system is becoming less attractive. This is primarily due to the reduce interfacial properties that occurs between the carbon fiber and vinyl ester resin. Vinyl ester systems also typically have high cure shrinkage. An alternative polymer, like epoxy, that provides improved interfacial properties with carbon fiber, that has a high glass transition temperature (> 200 F) with room temperature cure, improved mechanical properties including hot/wet and fracture touchness, and can be manufactured using a Vacuum Assisted Resin Transfer Molding (VARTM) process would result in composite structures with improved performance. In addition, resin systems like epoxy have low cure shrinkage and will result in a structure that has minimal residual stresses.

PHASE I: The contractor will develop a room temperature cure epoxy based resin system that has a viscosity and cure kinetics that will allow VARTM processing of large area composite structures at room temperature and is compatible with both carbon and glass fibers. The epoxy based system shall have a glass transition temperture equivalent to or higher than a Derakane 510A vinyl ester and a fracture toughness in a carbon/epoxy laminate that is equivalent to or higher than a typical low temperature cure carbon/epoxy prepreg as well as composite mechanical properties for carbon/epoxy laminates that are equivalent to typical low temperature cure carbon/epoxy prepreg. The contractor shall manufacture carbon/epoxy panels and glass/epoxy panels that are at least 12 in x 12 in using a VARTM process with no post curing and determine G1c, transverse tension and short beam shear properties.

PHASE II: Manufacture composite panels using carbon fibers and glass fibers specified by the Navy to demonstrate large scale VARTM producibility of the resin system. Develop full B-basis allowable properties for both glass and carbon composite systems including hot/wet conditions. Demonstrate large scale manufacturing capability by VARTMing a composite cored structure with a shape and areal dimensions specified by the Navy but which will be at least 80 sq ft.

PHASE III: Work with a Navy shipyard in the manufacturing demonstration of a large scale composite structure such as DD(X) topside components or the Composite High Speed Vessel (HHSV) hull sections. Demonstrate the use of the material system for overplying composite stiffeners, i.e. tabbing regions of joints and stiffeners. Demonstrate a large vertical infusion using the VARTM process with a height of 20 ft or greater.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: Commercial aircraft companies have been hesitant to utilize the VARTM process for the manufacturing of carbon composite components

since vinyl ester resins are typically utilized. The vinyl ester systems do not provide the desired properties for these applications. Interest in reducing manufacturing costs utilizing an epoxy based resin with improved properties would be the segway for VARTM into the commercial aviation components.

REFERENCES:

1. Flores, F., J. W. Gillespie, Jr., T. A. Bogetti, "Experimental Investigation of the Cure-Dependent Response of Vinyl Ester Resin," Polymer Engineering and Science, Vol. 42, No. 3, pp. 582-590, March 2002.

2. Gao, S., R. E. Jensen, J. W. Gillespie, Jr., "A Study of the Mechanical Interlocking Effect on Polymer Composite Properties," Proceedings of the 28th Annual Meeting of Adhesion Society, February 13-16, 2005.

3. Gao, X., R. E. Jensen, J. W. Gillespie, Jr., "The Role of Fiber Sizing Incorporating Mechanical Interlocking on Polymer Composite Properties," submitted to SAMPE 2005 Symposium & Exhibition (50th ISSE), Long Beach, CA, May 1-5, 2005.

4. Chatterjee, A., M.S. Islam, J. W. Gillespie, Jr., R. Foedinger, C. Stager and R. Moulton "Room Temperature Curable Epoxy Resins: An Alternative to Vinyl Ester for VARTM Applications," submitted to SAMPE 2006 Symposium & Exhibition (50th ISSE), Long Beach, CA.

KEYWORDS: VARTM; carbon/epoxy composites; composite manufacturing; room temperature cure; carbon fiber; Navy composite structures

TPOC: Roger Crane
Phone: (301)227-5126
Fax: (301)227-5548
Email: roger.crane@navy.mil