Special Notice 12-SN-0028
Office of Naval Research
Special Program Announcement
"2012 Basic and Applied Research in Sea-Based Aviation Aircraft Science and Technology"

I. INTRODUCTION:

This announcement describes a research thrust entitled "Basic and Applied Research in Sea-Based Aviation Aircraft Science and Technology," to be launched under the ONR BAA 13-001, "Long Range Broad Agency Announcement (BAA) for Navy and Marine Corps Science and Technology" which can be found at http://www.onr.navy.mil/Contracts-Grants/Funding-Opportunities/Broad-Agency-Announcements.aspx. The research opportunity described in this announcement specifically falls under numbered paragraph 1 of the "Naval Air Warfare and Weapons (Code 35)" sub-section of BAA 13-001, Section I, item 6, Research Opportunity.

The purpose of this announcement is to focus attention of the scientific community on (1) the area to be studied, (2) opportunities for dialogue among those interested in this arena, and (3) the planned timetable for the submission of white papers and proposals.

II. TOPIC DESCRIPTION: BASIC AND APPLIED RESEARCH IN SEA-BASED AVIATION AIRCRAFT SCIENCE AND TECHNOLOGY

Background:

ONR established National Naval Responsibilities (NNRs) to highlight S&T areas where the Navy and Marine Corps depend primarily on Department of Navy-funded research products. The Sea-Based Aviation (SBA) NNR was initiated in 2011 to maintain the health, currency, and technical superiority of Sea-based Aviation S&T. Three focus areas have been identified under the SBA NNR and are: 1) Aircraft Research, 2) Structures and 3) Propulsion. The Aircraft Research Focus area of the SBA NNR will provide innovative research and technology in five research thrust areas: Virtual Dynamic Interface, Advanced Handling Qualities and Control, Improved Fixed-Wing High Lift Aerodynamics, Enhanced Fixed Wing V/STOL Operations, and Autonomous Deck Operations. This Special Notice addresses the Aircraft Research Focus Area. ONR seeks to initiate 6.1 Basic Research and 6.2 Applied Research efforts beginning Government Fiscal Year 2014.

Objective:

The Office of Naval Research (ONR) is interested in receiving initially white papers and eventually proposals from selected Offerors for the Sea-Based Aviation National Naval Responsibility (SBA NNR) Aircraft Research Focus Area.

Projects should advance fundamental understanding and the state of the art, and should align with and produce measurable progress towards the long range S&T goals that support SBA, as outlined below. Research projects should comprise either Basic or Applied Research only. Interaction and collaboration among Industry, Universities, and Government Labs is encouraged.

White papers and proposals should identify a technical baseline representative of the current State of the Art (SOA) and explain how the proposed research will advance the technology. Projects aimed at developing high-fidelity physics-based models should include validation of analytical methods using new or existing experimental data.

The five research thrust areas are:

Virtual Dynamic Interface (VDI)

The Virtual Dynamic Interface research thrust area addresses the coupled interactions between ship and aircraft.

The Navy seeks to develop physical and numerical modeling capabilities that will lead ultimately to fast, full-fidelity ship/aircraft Dynamic Interface (DI) simulations. This thrust area envisions long-range S&T goals of

1. Real-time piloted simulation of fidelity sufficient to permit initial and recurrent pilot training, initial evaluations of evolving aircraft and/or ships, determination of shipboard operating limitations to augment flight testing, and evaluation of new automatic guidance and control systems and displays
2. non-piloted simulations running in real-time or faster in support of ship and air vehicle system design optimization, flight testing and evaluation of autoland systems and landing aids.

"Full-fidelity" in this context means that all physical phenomena of potential significance to the outcome of the simulation are included to a consistently high level of fidelity. At a minimum, this implies that simulations capture the following in physics-based models:

- fully-coupled, unsteady, and nonlinear aerodynamic interaction between ship airwake and aircraft
- flight mechanics of aircraft including control laws, handling qualities, pilot workload
- for helicopters, coupled rotor/fuselage dynamics
- deck motion, nonlinear contact dynamics, and limiting events (hard landings, sliding, rollover).
- propulsion system dynamics

The VDI research thrust seeks proposals in research topic areas that are expected to provide incremental progress towards the ultimate goal outlined above. The specific topic areas of interest are:

1. Fast, high-fidelity physics-based simulation of coupled aerodynamics of moving ship and maneuvering rotorcraft. Progress in this area is expected to derive from (1) innovative numerical methods and (2) novel approaches to massively parallel computing.

2. Fixed wing vehicle / ship airwake coupled dynamics simulation and experimentation with the goal of accurate prediction of aircraft controllability and recovery success rate.

3. Fast, moderate fidelity methods – innovative reduced order computational techniques that capture essential physics while executing much faster than high-fidelity methods. This topic area includes for example reduced order post-execution representation of CFD results (Proper Orthogonal Decomposition, surrogate modeling, etc.) and reduced-order physical models (free wake, finite state inflow, etc.)

4. Adaptive gridding of computational fields – computational methods for capturing, resolving, and propagating ship airwake flow features downstream into the aircraft approach path, and resolving unsteady airloads of aircraft maneuvering in ship airwake for approach.

5. Rotor wake modeling – fast, high fidelity tools to support complete analysis of rotor wake properties over a non-uniform moving ground plane representing major ship features.

Proposals in other research topic areas that support VDI thrust area goals will be considered as time and funding permit.

Advanced Handling Qualities (HQ) and Control

The Advanced HQ & Control research thrust area is intended to develop enabling S&T for highly effective control systems for shipboard operations in degraded weather and in the presence of significant deck motion, as well as other maritime operations.

This area supports the following long-range S&T goals:

- Efficient, precise UAV launch and recovery requiring little or no human intervention
- Reduced-workload launch and recovery of piloted aircraft. Improved operations with towed minesweeping systems.

Proposals are sought in the following topic areas.

1. Maritime rotary wing control laws – control laws for precision landing and reduced pilot workload in turbulent airwakes and with large ship motions, with associated verification / validation tools. Advanced control systems that use relative position sensors and advanced pilot-vehicle interfaces to enable carefree handling in shipboard operations,

with greatly reduced workload and improved safety (note, however, that this topic does not include sensor development).

While signficant progress in this area relies on effective modeling and simulation (M&S), improved M&S is not a direct goal of this research topic. Rather, state-of-the art models of appropriate fidelity may be used, augmented as appropriate with improved modeling capabilities developed under other SBA efforts, or elsewhere.

Mission Task Elements (MTEs) may be used to support research in this topic area, in which event existing MTEs may be used or new ones proposed. White papers and proposals should identify and describe any MTEs to be used.

2. Dynamics of towed systems – modeling and testing of rotorcraft towing submerged vehicles. Control strategies for low-workload handling and precise sweep pattern.

Improved Fixed-Wing (FW) High Lift Aerodynamics

The Improved Fixed-Wing High Lift Aerodynamics thrust area seeks to improve the Navy's understanding in the area of aerodynamics of fixed-wing vehicles in approach configuration (flaps and landing gear extended) and airspeeds. Long-range S&T goals include

- Reduced approach speed and high precision flight control during fixed wing aircraft approach to and landing on aircraft carriers
- Direct Lift Control and reduced control surface area with current levels of pitch/roll/yaw control.

As with the VDI thrust area, this area is aimed in part at the development of fast, high-fidelity simulation capabilities. However, it differs from VDI in its specific focus on S&T issues related to low-speed aerodynamics of fixed-wing vehicles, with less emphasis on ship airwake/vehicle coupling issues. Both existing aircraft and advanced concepts (for example, flying wing configurations) are of interest. Proposals are sought in the following topic areas:

1. Thrust vectoring for recovery operations - combined and/or partitioned thrust vectoring and flap systems for control authority with reduced control area, and direct lift control.
2. Innovative approaches to passive and/or active flow control systems to provide high lift and control at low speeds. In particular, designs and modeling techniques for advanced tailless configuration effectors and active adaptive systems.
3. CFD methods enabling robust prediction of highly nonlinear and unsteady aerodynamic behavior in approach, for example stability derivatives, pitchup, wing drop, and separation over highly deflected and/or moving control surfaces.

Enhanced Fixed Wing V/STOL Operations

A theme that emerges frequently in advanced vertical lift concepts intended for Naval use is the desire to combine the speed and cruise efficiency of a fixed-wing aircraft with the hovering capability of a helicopter. Aircraft capable of vertical takeoff and landing typically incur

significant performance compromises at either end of their operational range. Helicopters set the standard for hover capability, but are limited in cruise speed; direct-lift and lift-fan aircraft, on the other hand, excel in forward flight but are limited in their hover performance.

The Enhanced Fixed Wing V/STOL Operations thrust area seeks to develop technologies that ultimately enable V/STOL aircraft, for example jet lift (direct lift) and lifting fan aircraft, that combine

1. Extended hover performance adequate for launch and recovery on large- and small-deck ships and mission-specific hover operations (e.g. ASW, ASUW, or shore reconaissance)
2. hover handling qualities (agility, gust response) suitable for shipboard operations in the ship's airwake and in the presence of significant deck motion
3. significant high-speed performance and cruise efficiency
4. payload adequate for mission-specific equipment

The Navy is interested in research projects that will enable advancement of the state of the art in V/STOL technology and improve understanding of the aeromechanics of these concepts. Long-term S&T goals include

- Improved V/STOL, transition, and cruise aerodynamics for lift-fan and direct-lift aircraft
- Robust, high-fidelity M&S for ship/aircraft flowfield interaction

Proposals are sought in the following research areas:

1. Innovative computational and experimental methodologies for prediction and analysis of V/STOL vehicle aerodynamics in hover, transition, and forward flight. Specific topics of interest include for example lifting fan inlet, duct and blade aerodynamics, powered lift nozzles, fuselage interactions, dynamic jet/wake evolution, gust and control response, downwash/outwash flow field dynamics, wake reingestion and thermal profiles
2. High-fidelity predictive capability for V/STOL shipboard operations, including simulation of multiple jet mixing, aircraft/flow field interaction (reingestion, suckdown, control authority, etc.), deck heating, outwash, vehicle and ship dynamics, and airwakes.

Autonomous Deck Operations

Aircraft aboard the flight and hangar decks of aircraft carriers are handled in a series of complex processes involving aircraft, people, and equipment in a constrained, chaotic, loud, and hazardous environment with significant RF limitations. Deck operations include arresting gear exit after recovery, taxi to parking after landing, refueling, payload handling, movement from pre-launch spot to the catapult for launch, and catapult hookup. Continually evolving deck space constraints, environmental conditions (lighting, wind, rain, deck motion etc.), safety issues, time-critical contingencies, and constraints on resources all combine to present significant challenges to efficient flow of aircraft through these deck handling processes.

Long range S&T goals in Autonomous Deck Operations research thrust area are:

1. Reduce manpower on the flight deck for both cost savings and safety/health purposes
2. Support seamless integration of increasing numbers of autonomous systems into mixed manned/unmanned carrier operations with minimal need for special procedures or training different from that required for manned aviation
3. Support efficient high operations tempo/sortie rates with mixed manned/unmanned aviation.

For purposes of this notice, the research focus is automated deck operations system capabilities used for safe and efficient movement of UAV's from their prelaunch parking spots to the catapult, and postflight, from the landing area to their final shutdown spot. Particular research efforts should assume a future objective of an overall system that would have the following attributes:

1. Includes a local segment that is mounted in, on, or near the UAV and provides local situational awareness only to the degree necessary to supplement the global segment
2. the local segment, if on-board an aircraft, has minimal impact on aircraft aerodynamics, flight control, signature, and maintainability, and have minimal size, weight, and power needs. If off-board the aircraft, it has appropriate characteristics for operations on a carrier deck (e.g., using large numbers of small ground systems would not be practical since they might be blown off the carrier deck and/or create a hazard in adverse weather).
3. Includes a global navigation, tracking, and command & control capability such that UAV position and status are known to some reasonable degree of precision for carrier decks and shared with other networked aircraft and supervisory controllers.
4. Includes provisions for supervisory control such that the vehicle and its moving parts, engine, and critical functions can be directly commanded in a contingency situation.
5. Has autonomous decision making capability based on local and global situational awareness and authorized decision authority.
6. Is capable of safe, efficient, and reliable operation
7. Is capable of operating in all naval environmental, electromagnetic emissions, and deck motion limits under which manned flight operations can be conducted.

Specific focus areas include:

1. Improved deck operations leveraging an affordable tracking system so that position/orientation/status of aircraft, equipment, and personnel is known. Leverage passive sensors such as vision and RF ID tags to greatest extent possible. Increasingly shift flight deck functions to central coordinators with flight deck personnel remaining in more of a supervisory role in the event of contingencies. Support rapid planning changes when necessary due to contingencies. Consider new ways to aid interaction between deck crew and autonomous deck systems (e.g., useful cues that deck crew are walking too close to a prop/rotor/intake). Eliminate the need for humans to perform specific carrier deck tasks via automation.

2. Autonomous control for direction and movement of aircraft and ground equipment on the carrier deck including validation of algorithms for safety purposes and leveraging of off-board tracking systems where feasible. Applied research for networked and/or central autonomous control concepts and enabling technologies to support direction of systems on the decks. Applied research for precision autonomous control tasks such as parking and final launch positioning after the deck crew brings the aircraft near the location with an appropriate mix of on-board and/or off-board sensing. Basic research to support perception-based control of UAS and ground equipment operations on the carrier deck under high-level human direction and supervision. Note that perception for this task could be based on sensors on the aircraft, sensors on the ship, or sensors on ground robotic equipment (e.g., ground robot leader, robot for nose wheel steering, etc). Autonomy for movement of deck equipment might support both regular operations and emergencies such as firefighting.

Research in this area should support unique aspects of operations in chaotic and constrained carrier decks and not general research in unmanned ground vehicle autonomy and tracking. Note that the focus of this effort is not on the development of new sensing, mobility, or human interaction hardware, but should consider how the existing/emerging state of the art in these areas could be leveraged.

III. Proposer Workshop

ONR will hold a web-based workshop approximately three weeks from the date of this Special Notice for those interested in proposing projects under this Special Notice. Registration is required. An amendment to this notice will be posted with scheduling, registration and other logistic information. Participation in the Proposer Workshop is not mandatory for either White Paper or Proposal submission.

IV. WHITE PAPER SUBMISSION

White papers are desired and strongly encouraged for all offerors seeking funding. White papers should be submitted according to the format requirements found in Section IV, item 2a, of BAA 13-001.

White paper requirements for both Basic and Applied research are identical. The requirements for white paper format outlined in ONR BAA 13-001 apply. White papers should not exceed 4 single-sided pages, exclusive of cover page and resume of principal investigator. The cover page should be labeled "2012 Basic and Applied Research in Sea-Based Aviation Aircraft Science and Technology" and include the following information: title of the proposed effort, technical point of contact, telephone number, fax number, and e-mail address. The 4-page body of the white paper should include the following information: (1) Principal Investigator; (2) Relevance of the proposed effort to the relevant research area(s) described in Section II; (3) Technical baseline, objective of the proposed effort, and expected advancement in the technology; (4) Technical approach that will be pursued to meet the objective; (5) A summary of recent relevant technical breakthroughs; and (6) A funding plan showing requested funding per fiscal year. A resume of

the principal investigator, not to exceed 1 page, should also be included after the 4-page body of the white paper.

White papers should be submitted electronically to the program technical points of contact listed below. Files exceeding 10MB in size should not be emailed, but instead transmitted via a file transfer service, for example AMRDEC Safesite, https://safe.amrdec.army.mil, or mailed on CDROM or DVD. White papers shall be in Adobe PDF format (preferred) or in a Microsoft Word format compatible with MS Office 2007.

To ensure full, timely consideration for funding, white papers are encouraged by the date specified below in Section VII, Significant Dates and Times. White papers received after that date will be considered as time and availability of funding permit.

Each white paper will be evaluated by the Government to determine whether the technology advancement proposed appears to be of particular value to the Department of the Navy. Initial Government evaluations and feedback will be issued via e-mail notification from the Technical Point of Contact. Only authors of white papers that appear to be of particular value to the Department of the Navy will be invited to submit full proposals.

Detailed Full Proposals will be subsequently encouraged from those Offerors whose proposed technologies have been identified through the above referenced e-mail as being of "particular value" to the Government. However, any such encouragement does not assure a subsequent award. Full Proposals may also be submitted by any offeror whose white paper was not identified as being of particular value to the Government or any offeror who did not submit a white paper.

For white papers that propose efforts that are considered of particular value to the Navy but either exceed available budgets or contain certain tasks or applications that are not desired by the Navy, ONR may suggest a full proposal with reduced effort to fit within expected available budgets or an effort that refocuses the tasks or application of the technology to maximize the benefit to the Navy.

V. FULL PROPOSAL SUBMISSION AND AWARD INFORMATION

Full proposals should be submitted under ONR BAA13-001 by the date identified below in Section VII, "Significant Dates and Times." Full Proposals received after that date will be considered as time and availability of funding permit. ONR anticipates that both grants and contracts will be issued for this effort. Full proposals for contracts, cooperative agreements, and/or other transaction agreements should be submitted in accordance with the instructions in BAA 13-001, Section IV, Application and Submission Information, item 2.b, Full Proposals. Full proposals for grants should be submitted in accordance with the instructions in BAA 13-001, Section IV, Application and Submission Information, item 5, Submission of Grant Proposals through Grants.gov. All full proposals for grants must be submitted through www.grants.gov. The following information must be completed as follows in the SF 424 to ensure that the application is directed to the correct individual for review: Block 4a, Federal Identifier: Enter N00014; Block 4b, Agency Routing Number, Enter the three (3) digit Program Office Code (351) and the Program Officer's name, last name first, in brackets (John Kinzer). All attachments

to the application should also include this identifier to ensure the proposal and its attachments are received by the appropriate Program Office.

ONR plans to fund multiple individual awards with nominal duration of two years plus a one-year option. For planning purposes, the scope of 6.1 Basic Research efforts submitted under this BAA Special Notice is expected to be equivalent to the scope of a single investigator grant. It is anticipated that the scope of 6.2 Applied Research efforts will be approximately one to three full-time equivalents per year. Although ONR expects the above described program plan to be executed, ONR reserves the right to make changes including the right to make no awards.

Anticipated dates for funding decisions and award dates are identified below in Section VII, "Significant Dates and Times."

Proposals should address all of the technical and programmatic considerations necessary for project execution and timely preparation of deliverables. Deliverables shall include, at a minimum, quarterly financial and technical progress reports, and a final report. In addition, where projects involve development of analytical methodologies implemented in software, a complete description of the methods including theory manual, user documentation, and source code should be provided to the Government under license with Unlimited Rights.

ONR anticipates that grants, contracts, cooperative agreements, and/or other transaction agreements will be issued for this effort.

VI. POINTS OF CONTACT

In addition to the points of contact listed in BAA 13-001, the specific points of contact for this announcement are listed below:

Technical Points of Contact:

John Kinzer, Program Officer, john.kinzer@navy.mil (Air Vehicle Technology)
Judah Milgram, Program Officer, judah.milgram@navy.mil (Air Vehicle Technology)

Marc Steinberg, Program Officer, marc.steinberg@navy.mil (Autonomous Deck Operations)

Business Point of Contact:

Lynnette Desorcie, Contracting Officer, lynnette.desorcie@navy.mil

VII. SIGNIFICANT DATES and TIMES

Event	Date
White Paper Submission Date	01 Nov 2012
Notification of White Paper Evaluation	03 Dec 2012
Full Proposal Submission Date	17 Jan 2013
Funding decision notification	20 Feb 2013
Grants in place *	20 Apr 2013
Contracts in place *	21 Jun 2013

* These are approximate dates

VIII. Submission of Questions

Any questions regarding this announcement must be provided to the Technical Points of Contact and/or Business Point of Contact listed above. All questions shall be submitted in writing by electronic mail.

Answers to questions submitted in response to this Special Notice will be addressed in the form of an Amendment and will be posted to the following web pages:

- Federal Business Opportunities (FEDBIZOPPS): https://www.fbo.gov/
- Grants.gov: http://www.grants.gov
- ONR Broad Agency Announcement (BAA) Webpage: http://www.onr.navy.mil/Contracts/Funding-Opportunities/Special-Notices.aspx

Questions regarding White Papers should be submitted no later than two weeks before the recommended date for receipt of White Papers. Questions regarding Full Proposals should be submitted after submission of White Papers and no later than two weeks before the recommended due date for receipt of Full Proposals. Questions received after the dates indicated will not be acknowledged and will be answered only as time permits.