Topic: N17B-T034

Barron Associates, Inc.

Risk-Based Unmanned Air System (UAS) Mission Path Planning Capability

The Autonomous Planning and Replanning (AutoPRep) tool plans safe and efficient routes by considering risk instead of treating airspace volumes as binary (okay/not-okay). AutoPRep weighs routing advantages and disadvantages by factoring population, land use, airspace, vehicle performance, failure modes and emergency procedures to estimate risk imposed by occupying any location in 3D airspace, resulting in safer and more efficient flight paths. Barron Associates is a research and development firm with nearly 40 years of experience developing intelligent modeling and control approaches for complex, safety-critical, and autonomous systems, and a history of successfully transitioning advanced technologies. Targeted platforms include MQ-4 Triton, MQ-25 Stingray, and MQ-8 Fire Scout. The goal is to produce as a stand-alone tool or integrate into government or prime contractor mission planning tools.

Technology Category Alignment:

Autonomy
Air Platforms
Command, Control, Communications, Computers, & Intelligence (C4I)

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SYSCOM: NAVAIR
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Corporate Brochure: https://navystp.com/vtm/open_file?type=brochure&id=N68335-19-C-0141

Department of the Navy SBIR/STTR Transition Program

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NAVAIR 2020-838

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Barron Associates, Inc.

WHO

SYSCOM: NAVAIR

Sponsoring Program: PMA-263

Transition Target: Navy and Marine Corp Unmanned Air Systems

TPOC:
(301)995-2038

Other transition opportunities: MQ-4 Triton, MQ-25 Stingray, MQ-8 Fire Scout, RQ-7 Shadow, RQ-23 TigerShark, DoD UAS, and civilian UAS.

Notes: The Autonomous Planning and Replanning (AutoPRep) tool enables Air Vehicle Operators (AVOs) to efficiently plan routes that meet all mission objectives while also minimizing the hazard imposed on people and property on the ground. AutoPRep considers population and land use, performance, failures, and emergency procedures to estimate the risk and provide a minimum risk plan. Further, the AutoPRep planning tool considers hazardous weather (AIRMET/SIGMET) and airspace restrictions during mission planning. The Autonomous Divert Point Identification component is a freestanding tool that locates suitable emergency divert points (airports and open/unpopulated locations). Another freestanding component, The Impact Cost Map Construction tool, generates data maps that represent the cost (injury and/or damage) of impacting the ground at any given location. Both components are included in the complete AutoPRep toolset.

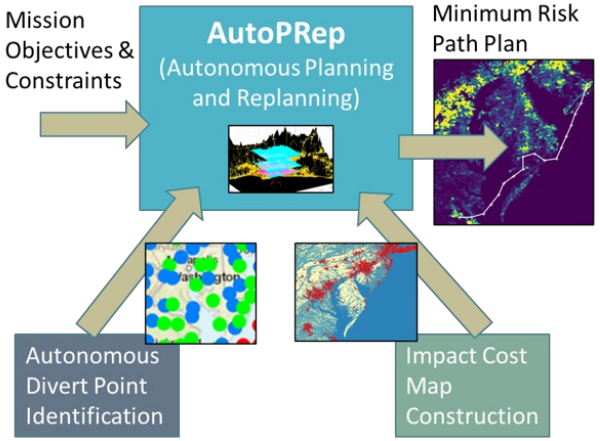

Image courtesy of Barron Associates, Inc., 2020.

WHAT

Operational Need and Improvement: Navy UAS operations are currently much more heavily constrained than operations of manned aircraft. The Navy needs enhanced mission planning tools to improve the flexibility and efficiency of UAS operations, with a goal of approaching the relatively unconstrained operations of manned vehicles. These enhanced tools will allow missions to be rapidly and efficiently planned in a way that mitigates the hazards imposed by UAS, which do not meet the same airworthiness standards that allow manned aircraft to fly relatively freely within the National Airspace. The enhanced mission planning capabilities are a key technology needed to enable UAS to move beyond the current paradigm of operating primarily in very limited areas where the hazards of the operations, particularly the risk to personnel and property on the ground, are known to be very low.

Specifications Required: Mission path planning capabilities and algorithms are needed to enhance the efficiency of the Navy's UAS mission planning process, especially to minimize the risk to personnel and property that is independent of, and dependent on, the air vehicle. Potential technologies exist that can reduce the complexity of AVO path planning tasks. The risk-based algorithms need to be scalable to multidimensional optimization problems that handle mission/vehicle constraints (e.g. weight, size, maneuvering capabilities) and risk-based information uncertainties (e.g. inferring population densities from FAA Sectionals). The algorithm(s) will address flight path safety during normal flight and during contingency operations, including robustness to air vehicle failures.

Technology Developed: The AutoPRep tool generates flight routes that meet all mission objectives while also minimizing risk to people and property on the ground. AutoPRep weighs routing advantages and disadvantages by factoring population and land use as well as vehicle failure modes and emergency procedures to estimate risk imposed by occupying any location in the overlying airspace. In addition to meeting mission objectives (required waypoints) and minimizing risk, AutoPRep also considers hazardous weather (AIRMET/SIGMET) and airspace restrictions during planning.

Warfighter Value: AutoPRep drastically reduces the time required to generate a safe and effective initial plan (as well as any required plan updates) thereby increasing AVO efficiency and readiness. AutoPRep is designed to rapidly plan efficient low risk flight routes, allowing the warfighter to launch sooner, meet objectives more quickly, and reduce the required fuel and flight hours.

WHEN

Contract Number: N68335-19-C-0141 **Ending on:** March 29, 2021

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Autonomous planning of minimum risk mission paths	N/A	Autonomously planned path incurs lowest risk among path options	4	April 2018
Optimized C++ Implementation	N/A	Two order of magnitude reduction in required computational time.	5	June 2020
Evaluation via surrogate AVOs at National Test Pilot School	Med	Improved efficiency over prior methods.	6	December 2020
If Option exercised, evaluation with flight hardware (ground based)	Med	Transmission and simulated flight of safe/efficient plan.	7	February 2022

HOW

Projected Business Model: AutoPRep is a software package that enables AVOs to rapidly plan flight routes that meet all mission objectives while also minimizing risk to people and property on the ground. It is intended to be distributed as a standalone toolset with a Right-to-Use License and a Maintenance Agreement or for integration into an existing planning software package. Use of the software will be supported with Engineering Services to assist with initial integration and tool customization. Barron Associates will offer services directly to the Navy and to prime contractors.

Company Objectives: Company objectives are to transition the AutoPRep software package to the Navy directly or though a prime contractor as part of a Phase III effort, working with PMA and RT&E groups. Barron Associates will seek licensing and engineering support contracts.

Potential Commercial Applications: AutoPRep is applicable to all (DoD and non-DoD) flight planning in which minimizing risk to people and property on the ground is a concern. Potential Navy applications include MQ-4 Triton, MQ-25 Stingray, MQ-8 Fire Scout, RQ-7 Shadow, RQ-23 TigerShark, and RQ-21 Blackjack and is applicable to manned aircraft planning as well. Potential private sector applications include personal transport, package delivery, entertainment industry, news, sporting events, recreational and business video recording, and weather monitoring. With an understanding that UAS have safety shortcomings in comparison with manned aircraft, the resulting risk to the population may be mitigated through path planning that minimizes exposure. Barron Associates envisions selling software licenses and engineering services to the DoD, manufacturers of UAS aircraft, airframers, and guidance, navigation and control (GNC) systems.

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