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Funding and Strategic Alignment Guidance for Infusing Small Business Innovation Research Technology Into NASA Programs Associated With the Aeronautics Research Mission Directorate

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September 2015

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Abstract

This report is intended to help NASA program and project managers incorporate Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) technologies that have gone through Phase II of the SBIR program into NASA Aeronautics and Mission Directorate (ARMD) programs. Other Government and commercial program managers can also find this information useful.

Introduction

Incorporating Small Business Innovation Research (SBIR)-developed technology into NASA programs is important, especially given the Agency's limited resources for technology development. The SBIR program's original intention was for technologies that had completed Phase II to be ready for integration into NASA programs, however, in many cases there is a gap between Technology Readiness Levels (TRLs) 5 and 6 that needs to be closed.

After Phase II projects are completed, the technology is evaluated against various parameters and a TRL rating is assigned. Most programs tend to adopt more mature technologies—at least TRL 6, to reduce the risk to the mission rather than adopt TRLs between 3 and 5 because those technologies are perceived as too risky. The gap between TRLs 5 and 6 is often called the "Valley of Death" (Fig. 1) and historically it has been difficult to close because of a lack of funding support from programs. Several papers already have suggested remedies on how to close the gap (Refs. 1 to 4).

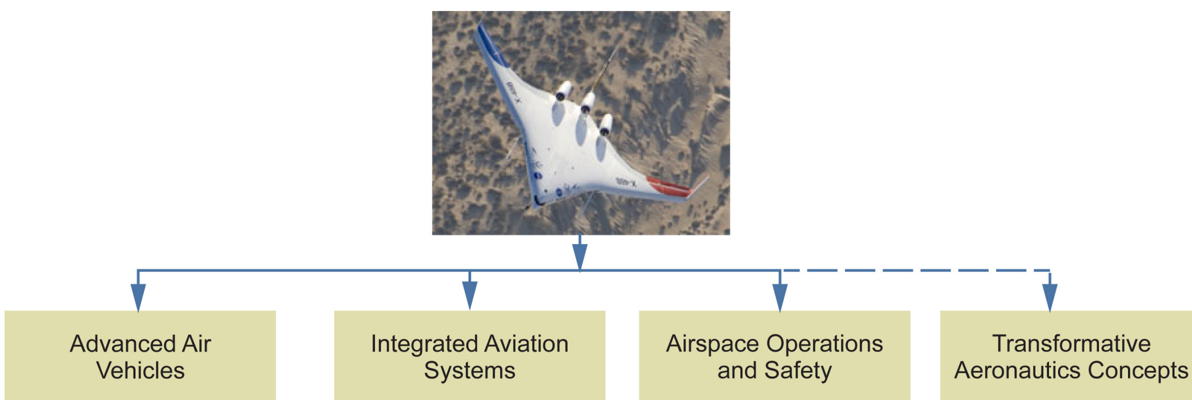
To address the TRL gap, NASA's SBIR program has made a considerable effort to strengthen the critical connection between SBIR and NASA programs through post-Phase II initiatives. As a result, NASA SBIR now supports its small business partners with three post-Phase II options that focus on creating opportunities for technology infusion and commercialization. The Phase II Enhancement (Phase II-E), Phase II Expanded (Phase II-X), and the Commercialization Readiness Program (CRP) options provide opportunities for Phase II technologies to be integrated and tested in the NASA system platform or in the space environment.

Aligning SBIR Technologies Into Aeronautics Research Mission Directorate Programs

This section discusses how NASA program managers can incorporate SBIR technologies into Aeronautics Research Mission Directorate (ARMD) programs by showing where there is relevant alignment. This information will also help other Government agencies or commercial entities that pursue related fields.

		TRL	Description
SBIR Phases I and II	Basic research	1	Basic scientific/engineering principles observed and reported
	Feasibility research	2	Technology concept, application, and potential benefits formulated (candidate system selected)
	Feasibility research	3	Analytic and/or experimental proof-of-concept completed (breadboard test)
	Technology development	4	System concept observed in laboratory environment (candidate system selected)
Technology demonstration "Valley of Death"	Technology development	5	System concept tested and potential benefits substantiated in a controlled relevant environment
	System development	6	Prototype of system concept is demonstrated in a relevant environment
System development	System development	7	System prototype is tested and potential benefits substantiated more broadly in a relevant environment
	Operational verification	8	Actual system constructed and demonstrated with benefits substantiated in a relevant environment
	Operational verification	9	Operational use of actual system tested with benefits proven

Figure 1.—Technology Readiness Levels (TRLs).



- Ultra-efficient commercial vehicles
- Innovation in commercial supersonic aircraft
- Transition to low-carbon propulsion
- Assured autonomy for aviation transformation

- Flight research-oriented, integrated, system-level R&T that supports all six thrusts
- X-planes/test environment

- Safe efficient growth in global operations
- Real-time system-wide safety assurance
- Assured autonomy for aviation transformation

- Seedling program

Figure 2.—Aeronautics Research Mission Directorate (ARMD) programs and research thrusts.

ARMD research focuses on traditional aeronautic disciplines and emerging fields, helping to make the Nation's air transportation system and future air and space vehicles more efficient. ARMD programs and research activities (Fig. 2) are as follows:

(1) Advanced Air Vehicles Program (AAVP): supports advanced air transport technology, revolutionary vertical-lift technology, commercial supersonic technology, advanced composites, and aeronautics evaluation and testing capabilities

(2) Integrated Aviation Systems Program (IASP): focuses on environmentally responsible aviation, unmanned aerial system integration in the NAS, and flight demonstrations and capabilities
(3) Airspace Operations and Safety Program (AOSP): develops and demonstrates airspace technology, assesses shadow modes using realistic technologies for the National Airspace System (NAS) for safe trajectory-based operations, and operates safe autonomous systems
(4) Transformative Aeronautics Concepts Program (TACP): this seedling program focuses on leading-edge aeronautic research, transformational tools and technologies, and convergent aeronautics solutions

Each program focuses on several research thrusts. The goal of these thrusts is to solve the air traffic congestion, safety, and environmental impact challenges that exist in air transportation systems today. These thrusts enable ARMD to be responsive to the growing demand for mobility; challenges to energy and the environmental sustainability; and technology advances in information, communications, and automation technologies.

ARMD Programs Overview

Beginning in fiscal year (FY) 2015, NASA's Aeronautics programs were restructured into four programs to focus on achieving timely and compelling impacts to the six strategic thrust areas. NASA funding requests for FYs 2015 to 2019 associated with ARMD operation programs is shown in Table 1.

Fiscal Year 2015 Solicitation Topics and Subtopics Related to ARMD

The annual NASA-wide SBIR solicitation contains topics and subtopics that are developed to strategically align with ARMD programs, ultimately supporting the directorate's current needs and objectives. To help small business principal investigators (PIs) and ARMD project managers, it is important to understand how the SBIR topics and subtopics are mapped to ARMD programs. Figure 3 shows the FY 2015 solicitation topics and subtopics mapped to ARMD programs.

TABLE 1.—FISCAL YEAR (FY) BUDGET REQUEST SUMMARIES FOR ARMD PROGRAMS (IN MILLIONS OF DOLLARS) (REF. 5)

Program	Actual	Projected			
	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019
Airspace Operations and Safety	151	132	134	135	137
Advanced Air Vehicles	213	211	205	203	205
Integrated Aviation Systems	127	125	128	133	134
Transformative Aeronautics Concepts[a]	79	86	93	95	96

[a]Seedling program.

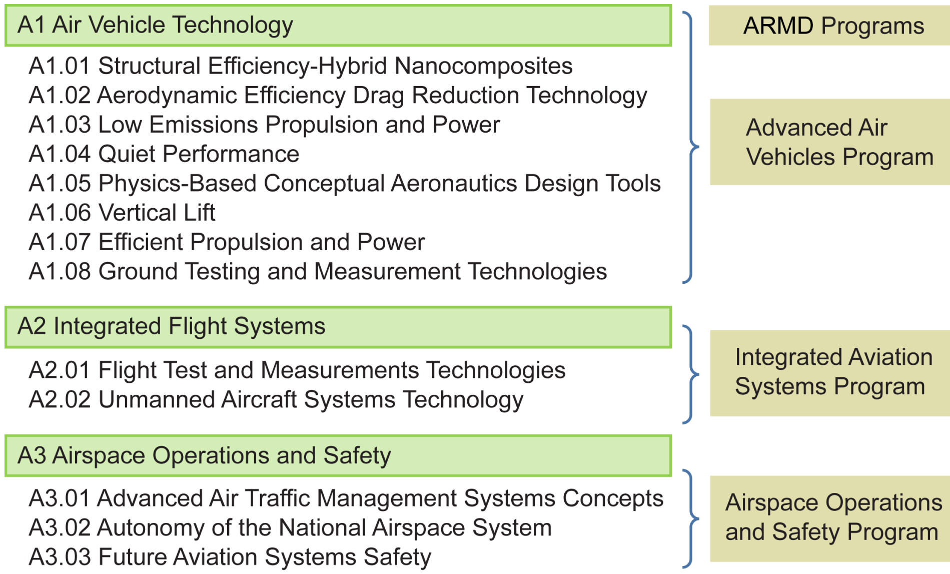


Figure 3.— Fiscal year 2015 SBIR subtopics mapped to ARMD programs.

SBIR Solicitation Process

Understanding how the SBIR solicitation process works should help small businesses and ARMD project managers form partnerships to incorporate SBIR technologies into NASA programs and projects. For example, when ARMD program managers identify specific SBIR subtopics that are likely to generate technologies that could apply to their programs or projects, the SBIR office would provide information about previously developed technologies that could be incorporated into their work. Small business PIs would also benefit from understanding NASA program and project needs, thus increasing the likelihood that the technologies they developed will be infused into ARMD projects. FY 2015 solicitations are posted at http://sbir.gsfc.nasa.gov/solicitations.

Fiscal Year 2015 ARMD SBIR Topic and Subtopic Summaries

Topics and subtopics for all directorates are listed in Chapter 9 of the FY 2015 SBIR solicitation. Topics and subtopics related to the ARMD directorate follow.

Topic A1 Air Vehicle Technology

A1.01 Structural Efficiency-Hybrid Nanocomposites

Take advantage of the multifunctionality offered by carbon nanotubes (CNTs) through the use of hybrid composites, where CNTs are integrated into conventional carbon fiber reinforced composite structures, for reduced weight and enhanced safety performance

A1.02 Aerodynamic Efficiency Drag Reduction Technology

Because viscous skin friction stands out as particularly significant across most classes of flight vehicles—and effective measures for its control would have a major impact on flight efficiency—identify and verify key relationships between wall layer and outer layer dynamics for a full understanding of turbulent boundary layer physics

A1.03 Low Emissions Propulsion and Power

Supports electric propulsion of transport aircraft, including turboelectric propulsion (turbine prime mover with electric distribution of power to propulsors) and various hybrid electric concepts, such as gas turbine engine and battery combinations. Turboelectric propulsion for transport aircraft applications will require components with high specific power (hp/lb or kW/kg) and high efficiency, and cryogenic and superconducting components will likely be required. The cryogenic components of interest include fully superconducting generators and motors (i.e., superconducting stators as well as rotors), cryogenic inverters and active rectifiers, and cryocoolers.

A1.04 Quiet Performance

Improve noise prediction, acoustic and relevant flow field measurement methods, noise propagation, and noise control for subsonic, transonic, and supersonic vehicles, specifically targeting airframe noise sources and the noise sources due to the aerodynamic and acoustic interaction of the airframe and engines

A1.05 Physics-Based Conceptual Aeronautics Design Tools

Investigate the potential of advanced, innovative propulsion and aircraft concepts to improve fuel efficiency and reduce the environmental footprint of future commercial transports across flight speed regimes, providing the best conceptual design/analysis tools possible

A1.06 Vertical Lift

Develop tools for the modeling and prediction of the high-frequency acoustics for small vertical-lift unmanned aerial vehicles (UAVs), such as quadcopters, coaxials, ducted fan rotors, etc.; develop and demonstrate hybrid/electric technologies for full-scale rotorcraft drive and propulsions systems that show benefits in terms of weight, efficiency, emissions, and fuel consumption

A1.07 Efficient Propulsion and Power

Develop propulsion controls and dynamics technologies that help achieve the goals of three strategic thrusts: Innovation in Commercial Supersonic Aircraft, Ultra-Efficient Commercial Vehicles, and Assured Autonomy for Aviation Transformation

A1.08 Ground Testing and Measurement Technologies

Develop innovative tools/technologies that enhance testing and measurement capabilities, improve ground test resource utilization and efficiency, and provide capability sustainment
Integrated Flight Systems

Topic A2 Integrated Flight Systems

A2.01 Flight Test and Measurements Technologies

Develop test techniques that improve the control of in-flight test conditions; expand measurement and analysis methodologies; improve test data acquisition and management with sensors and systems that have fast response, low volume, minimal intrusion, and high accuracy and reliability

A2.02 Unmanned Aircraft Systems Technology

Develop the ability of UAS teams to cooperate and interact while making real-time decisions based upon sensor data with little human oversight

Topic A3 Airspace Operations and Safety

A3.01 Advanced Air Traffic Management Systems Concepts

Address user needs and performance capabilities, trajectory-based operations, and the optimal assignment of humans and automation to air transportation system functions, gate-to-gate concepts, and technologies to increase capacity and throughput of the National Airspace System (NAS), achieving high efficiency in using aircraft, airports, and en-route and terminal airspace resources while accommodating an increasing variety of missions and vehicle types, including full integration of Unmanned Aerial Systems (UAS) operations

A3.02 Autonomy of the National Airspace System (NAS)

Develop concepts/technologies to increase the efficiency of the air transportation system within the midterm operational paradigm (2025 to 2035 time frame), in areas that would culminate in autonomy products to improve mobility, scalability, efficiency, safety, and cost-competitiveness

A3.03 Future Aviation Systems Safety

Focus toward a future NAS where a gate-to-gate trajectory-based system capability exists that satisfies a full vision for NextGen and beyond, ultimately enabling the delivery of a progression of capabilities that accelerate the detection, prognosis, and resolution of system-wide threats

References

1. Anderson GA, Iacomini C. "Paragon's experience in successful technology development and infusion within the SBIR program," 2009 IEEE Aerospace Conference, pp. 1–9.
2. Zacny K, et al. "Honeybee Robotics approach to technology development and infusion," 2010 IEEE Aerospace Conference, pp. 1–7.
3. Kiefer KF. "Case study: Small business technology infusion," *Aerospace and Electronic Systems Magazine*, IEEE, 25(10):4–9.
4. Comstock DA. "Technology development and infusion from NASA's Innovative Partnerships Program," 2008 IEEE Aerospace Conference, pp.1–11.
5. FY 2015 President's Budget Request Summary.