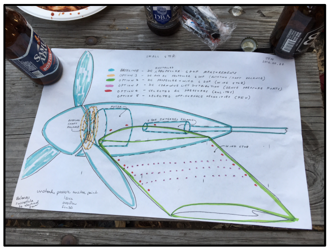
Convergent Aeronautics Solutions (CAS) Project
Transformative Aeronautics Concepts Program
NASA Aeronautics Research Mission Directorate



Fostering Innovation - Pushing Boundaries & Overcoming Barriers

NASA wants to change the way airplanes fly and the aviation industry along with it. The CAS Project invests in seemingly improbable ideas that might lead to solutions to the problems that plague aviation with respect to safety, environmental and community impact, and the global growth in air traffic.

The goal of CAS is to rapidly assess the feasibility of novel concepts to determine whether additional investment is warranted. Those that prove feasible are expected to transition into more focused technology development projects to mature the technologies.

CAS concepts must demonstrate five key attributes:

- Convergent – exploit the benefits of combining multiple disciplines and multiple partners (both within and external to NASA)
- Transformative – exhibit the potential for substantially greater impact than current approaches
- Targeted – address challenges and opportunities relevant to NASA's strategic objectives and outcomes reflected in the ARMD Strategic Investment Plan
- Feasibility Focused – determine whether and the degree to which the concept is feasible using existing technologies or requiring minimal development
- Rapidly Executed – complete feasibility assessments in less than 2.5 years

Project investment decisions are made using a Venture Capital-inspired approach including an annual "shark-tank" competition called CASTInG (CAS Teams Investment Gateway) that is used to select the next round of feasibility studies.

Prior to CASTInG NASA researchers have access to a variety of services to help them "incubate" and accelerate formulation of their concepts to more effectively address the CAS attributes.

Concepts that are selected at CASTInG are given management support under an agile "light management" approach that minimizes administrative burden on the innovators and emphasizes outcomes over excessive tracking activity and reporting.

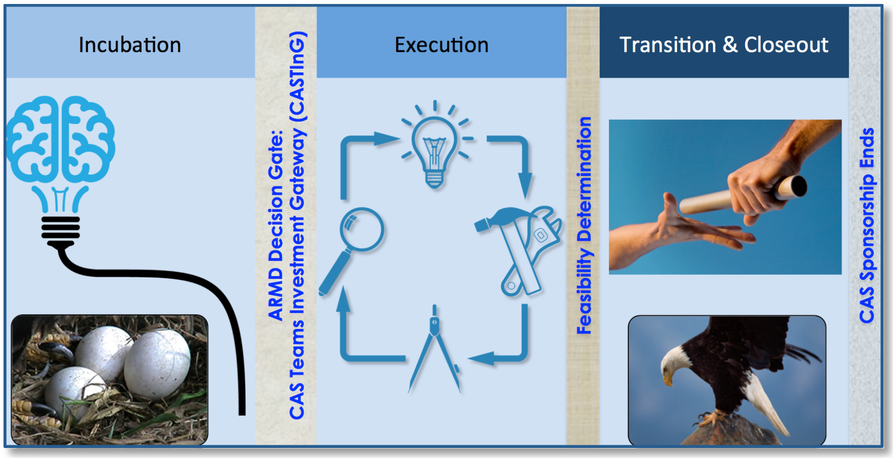


Figure 1 - CAS Project Phases

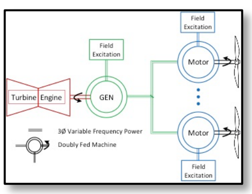
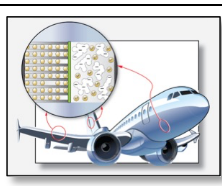
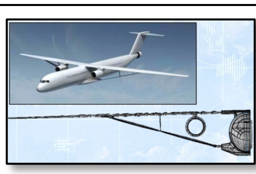
CAS holds an annual Showcase at one of the NASA research centers to share the status of the feasibility studies with the NASA community to broaden awareness, increase the potential to transition concepts that prove feasible, and inspire new ideas and concepts.

The CAS portfolio consists of a collection of activities that strive to span all of the six ARMD Strategic Thrusts. The activities are phased to support the sustainable transition of ideas/concepts into and out of the Project. Below are the description of the feasibility assessments conducted since CAS inception per fiscal year.

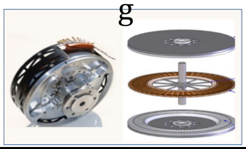
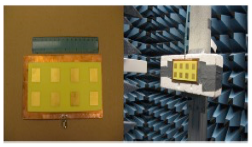
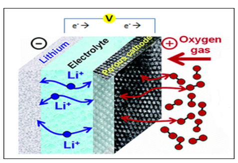
Round 1 – FY16-FY17

AATC	Aeronautics Autonomy Testbed Capability (AATC) – Investigates new approaches for developing a UAS testbed capability that can address a variety of autonomy research questions.
	X-Plane – Develops a cost-effective approach to accomplishing flight research with large-scale experimental airplanes to test solutions to technical challenges associated with ultra-efficient, future aircraft designs.
	Scalable Convergent Electric Propulsion Technology Operations Research (SCEPTOR) – Evaluates the impacts of using distributed electric propulsion through a rapid concept-to-flight demonstration to enhance safety while also reducing costs, noise, and emissions.

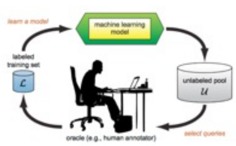
Round 1 – FY16-18

	Autonomy Operating System for Unmanned Aerial Vehicles (AOS4UAVs) – Developing an autonomous pilot that can fly in the National Air Space and in UAS air space, using an open flight software framework that expands capabilities through *apps* from multiple parties.
	Design Environment for Novel Vertical Lift Vehicles (DELIVER) – Demonstrates whether it's possible to apply current conceptual design tools to small and novel vertical lift vehicle designs, and to improve these tools with new technologies for usability, operability, and community acceptance.
	Mission Adaptive Digital Composite Aerostructure Technologies (MADCAT) – Exploring the idea of using emerging digital composite manufacturing methods to build an ultra-lightweight, adaptable wing.
	High Voltage Hybrid Electric Propulsion (HVHEP) – Studies whether lightweight, efficient power distribution systems could replace petroleum fueled aircraft propulsion systems.
	Multifunctional Structures for High Energy Lightweight Load-Bearing Storage (M-SHELLS) – Evaluates whether it's possible to use nanotechnology to create aircraft structures that can also store electrical power.
	Digital Twin – Explores developing a computer model that can more accurately predict how a future aircraft will perform over time and accelerate certification while still assuring safety and reliability.
	Learn to Fly (L2F) – Explores whether aerodynamics modeling, adaptive controls, computers and sensors can shave years and dollars off designing, building, testing and certifying new aircraft.

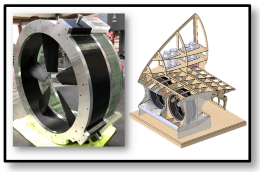
Round 2 – FY17-19

g 	Compact Additively Manufactured Innovative Electric Motor (CAMIEM) – Developing new innovative electric motor topologies enabled by additive manufacturing that significantly increase the state-of-the-art in electric motor power densities.
	Conformal Lightweight Antenna Structures for Aeronautical Communication Technologies (CLAS-ACT) – Developing a conformal microwave antenna based on an ultralight and thin aerogel that can conform to the aircraft's contours—avoiding interference, reducing drag, fuel burn and emissions.
	Fostering Ultra-Efficient, Low-Emitting Aviation Power (FUELEAP) – Leveraging technology convergence in high-efficiency Solid Oxide Fuel Cells (SOFC), high-yield fuel reformers, and hybrid-electric aircraft architectures to develop tightly integrated power system producing electricity from hydrocarbon fuels at twice the combustion efficiencies.
	Lithium Oxygen Batteries for NASA Electric Aircraft (LION) – Investigating feasibility of designing ultra-stable electrolytes that are resistant to decomposition so that batteries last longer, allowing electric-powered aircraft to fly farther.
	Spanwise Adaptive Wing (SAW) – Increasing aircraft efficiency by articulating outboard portions of the wing using shape memory actuators to allow the size of the rudder to be reduced while maintaining stability.

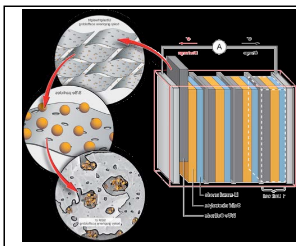
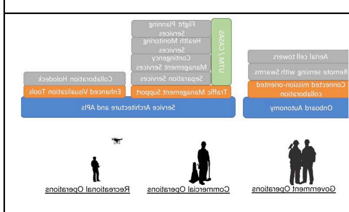
Round 3 – FY18-20

	Autonomy Teaming & TRAnsparency for Complex Trusted Operational Reliability (ATTRACTOR) – Building a basis for certification of trustworthy multi-agent autonomous systems based on explainable AI (XAI), persistent modeling, and simulation, and mission planning and execution with analyzable trajectories.
	Fit to Fly (F2F) – How will operators of commercial drone fleets know, *for sure*, that their vehicles are Fit2Fly? Automated inspection and live digital airworthiness certificates are parts of the answer. Using a combination of automated monitoring, inspection, and testing to create an auditable system to determine whether aircraft have sufficient airworthiness to perform their intended missions.
	Toward a Safe and Secure Future of Aviation through Quantum Communication and Computation (QTech) – Harnessing the power of quantum computing for optimization and key distribution to assure reliability of communications needed for traffic management of autonomous aircraft networks.

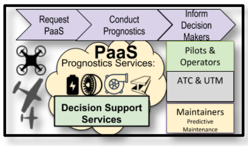
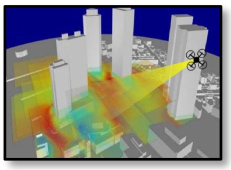
Round 4 – FY19-20

	AdhEsive fRee BONDing of Complex Composite Structures (AERoBOND) - Seeking to increase manufacturing rate of composite airframes using a joining method with reduced dependence on redundant mechanical fasteners and improved *reliability* and *manufacturability* over currently available methods.
	Aqueous, QUick-charging battery Integration For Electric flight Research (AQUIFER) - Exploring a novel integration concept using nano-electrofuel (NEF) aqueous batteries and rim-driven motors (RDM) to retire fire and explosion hazards, decouple power and energy, and reduce EMI and noise for multiple electrified aircraft configurations.
	High-Efficiency Electrified Aircraft Thermal Research (HEATheR) - Exploring the feasibility of managing the waste heat on a megawatt-level electric aircraft propulsion system while achieving performance and operational cost benefits.

Round 5 – FY20-21

	Solid-state Additively-manufactured Batteries for enhanced Energy, Recharging, and Safety (SABERS) – Exploring how to enable energy intensive Urban Air Mobility (UAM) and all electric aerovehicle designs through new battery technology that intrinsically meets rigorous aerospace safety and performance criteria
	Sensor-based Prognostics to Avoid Runaway Reactions & Catastrophic Ignition (SPARRCI) – Eploring how catastrophic battery failures can be avoided to enable safe next-generation ultra-high energy batteries for propulsive aircraft power
	Scalable Traffic Management for Emergency Response Operations (STEReO) – Exploring to what extent can a UTM ecosystem reduce response times, scale aircraft operations, and provide operational resiliency to dynamic changes during a disaster event

Incubation Activities (sample) – FY18-19

	TAiloRing Materials and Manufacturing AutomatiCally (TARMMAC) - Exploring the use of clear box data science and high-performance computing to streamline the development of additively manufactured aeronautics structures.
	Prognostics as a Service (PaaS) – Exploring the idea of leveraging cloud resources to provide wide access to precise and timely system failure prediction (prognostics) information to improve decision-making capabilities.
	MAchine learning ESTimations for uRban Operations (MAESTRO) - Enhancing the safety and efficiency of urban UAS operations by providing onboard estimation of urban winds through machine learning and commodity airborne sensors without requiring GPS.