Transformative Aeronautics Concepts Program

Atoms to Aircraft to Spacecraft

Active Technology Project (2020 - 2024)

Project Introduction

The next generation of aerospace systems requires materials and structures that combine high performance at high utilization in short missions with the possibility of high rate production, without excessive non-recurring cost, to allow for rate flexibility and shorter structural life cycles. The development of materials and structures that offer this flexibility in rate without negatively influencing performance and economic viability will require a matching and overlapping experimental and computational design approach.

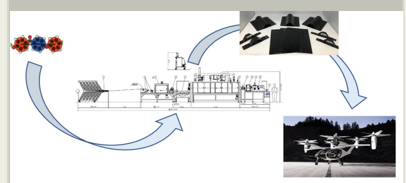
The objective is to go from Atom to Airframe to Spaceframe for thermoplastic unidirectional tape based fastener-free assemblies. Thermoplastic composites are chosen as the focus because these materials allow for reversible fusion bonding in every stage of their life cycle after synthesis. Our strategy is to combine multi-scale computational approaches with multi-scale experimental activities to develop an understanding of and capabilities to manufacture custom unidirectional thermoplastic tape. This tape will be the basis for our high-rate multiple-technology manufacturing approach validated by the production of two representative demonstrators for urban air mobility vehicle structures. The multi-disciplinary team will work in an integrated manner to effectively combine computational approaches with experimental approaches at each stage of characteristic manufacturing flows.

The team aims for tools and technology to quantify the thermo-rheological aspects of unidirectional tape-based production and assembly of aerospace quality thermoplastic components as well as for validated tools for unidirectional tape-based thermoplastic preform and part design and manufacture. The work will be used to design and build two demonstration structural parts characteristic for urban air mobility vehicles.

Anticipated Benefits

The development of electric lift and related propulsion technology is rapidly enabling urban air mobility that has long been desired but never materialized due to the complexity of power distribution in a traditional liquid fuel based, combustion powered air vehicle. Urban air mobility vehicles will be required in quantities that general aviation has never seen before. At the same time, the expected utilization and required reliability of such vehicles is beyond anything achieved for traditional general aviation aircraft. This will require airframe technology to be developed that can support agile industrial development of new affordable and reliable vehicles that are series manufacturable without excessive non-recurring cost and with shorter life cycles. These vehicles also need to be able to benefit from new developments in propulsion technology and evolving customer demands.

The team brings together universities and a consortium of companies which can bring the change required to compete in this field and assure that the United States can lead the development of this new industry and profit of the

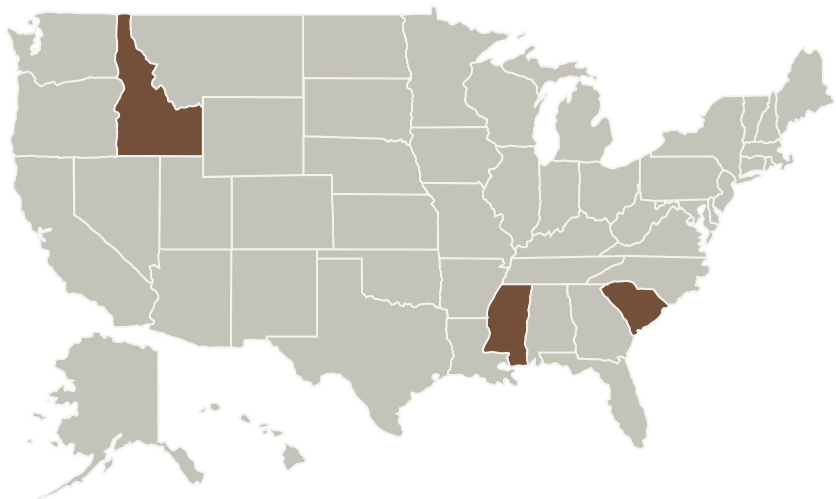


Designing from Atoms-to-Aircraft for Fastener-Free Assembly

Table of Contents

world-wide introduction of these vehicles in the decades to come. The results may be transitioned to develop space-based manufacturing of composite structures for lunar base development.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
University of South Carolina	Lead Organization	Academic	Columbia, SC
Benedict College	Supporting Organization	Academic	
Boise State University	Supporting Organization	Academic	Boise, ID
The University of Southern Mississippi	Supporting Organization	Academic	Hattiesburg, MS

Primary U.S. Work Locations	
Idaho	Mississippi
South Carolina	

Organizational Responsibility

Responsible Mission Directorate:

Aeronautics Research Mission Directorate (ARMD)

Lead Organization:

University of South Carolina

Responsible Program:

Transformative Aeronautics Concepts Program

Project Management

Program Director:

John A Cavolowsky

Project Manager:

Koushik Datta

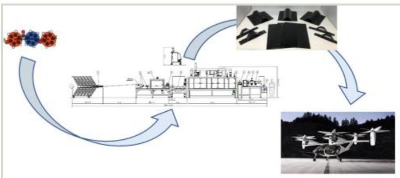
Principal Investigator:

Paul Ziehl

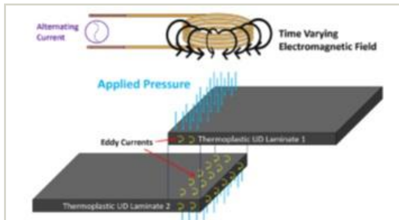
Co-Investigators:

Wout De Backer
Darun Barazanchy
Jaspreet Pandher
Jeffrey Wiggins
James Rawlins
Eric Jankowski
Gurcan Comert
Negash Begashaw
Balaji Iyangar

Images



Designing from Atoms-to-Aircraft for Fastener-Free Assembly
Designing from Atoms-to-Aircraft for Fastener-Free Assembly
(https://techport.nasa.gov/image/40778)



Induction welding diagram for thermoplastic unidirectional laminates
Induction welding diagram for thermoplastic unidirectional laminates
(https://techport.nasa.gov/image/40779)

Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **5**

1 2 3 4 5 6 7 8 9

Applied Research | Development | Demo & Test

Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  └ TX12.4 Manufacturing
    └ TX12.4.2 Intelligent Integrated Manufacturing

Target Destination

Foundational Knowledge

Supported Mission Type

Push