National Aeronautics and Space Administration

NASA Aeronautics Engaging with Academia: the University Innovation Project

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NASA Aeronautics
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University Innovation (UI) Project

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University Leadership Initiative (ULI)

Faculty led teams provide high impact aviation outcomes

University Student Research Challenge (USRC)

Students propose own concepts and need to crowdfund

Gateways to Blue Skies Competition

Student teams work on a future aviation concept paper

Future Aviation Maintenance

Propose in collaboration with Aviation Maintenance Schools

ULI Engaging the University Community

- 30 awards in 7 rounds
- 88 universities (39 non-R1 Universities; 32 Minority Serving Institutions)
- More than 500 students

ULI Targets Faculty Proposals

- Solve major, system-level technical challenges in aeronautics
- Annual solicitation, typically opens in March
- Two-step proposal submission and evaluation process
- Receive up to $2M / year for 3-4 years
- 3 ULI awards / year
- Opportunities for graduate, undergraduate and community college students to participate in aeronautics research
- Promote diversity in aeronautics with inclusion of underrepresented universities and faculties

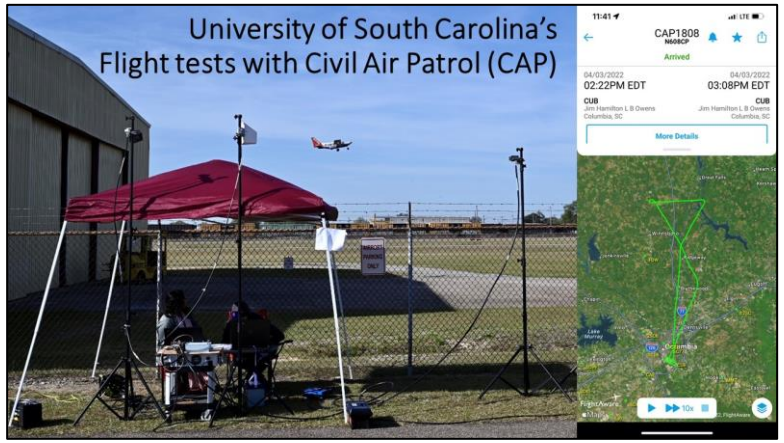
ULI Portfolio Spans All NASA Aero Strategic Thrusts

Air Traffic Operations (Thrust 1)	High-Speed (Thrust 2)	Subsonic Transports, including Zero Emission Aviation (Thrust 3)		Vertical Lift (Thrust 4)	Materials & Structures (Thrust 4)	Aviation Manufacturing (Thrust 3, 4)	System-wide Safety (Thrust 5)	Autonomy (Thrust 6)	Hypersonic
University of South Carolina: Increase communication capabilities in the National Airspace System	**Texas A&M University:** Reduce supersonic noise for various atmospheric conditions (Extended for potential flight experiments)	**Ohio State University:** Develop electrical propulsion technologies for a 1-Megawatt aircraft	**University of Illinois:** Develop cryogenic & hydrogen technologies for a hydrogen aircraft (Extended for additional development)	**University of California, San Diego:** Design tools to rapidly develop electric vertical takeoff and landing vehicles	**University of Delaware:** Part/process design methodology for TuFF composites for high-rate manufacturing	**Carnegie Mellon University:** Improve Additive Manufacturing (AM) certification process and build an AM ecosystem	**Arizona State University:** Improve risk prediction NAS-wide with information fusion and prognostics	**Stanford University:** Develop techniques to enable trusted AI-based aviation systems	**Purdue University:** Optical and laser sensors for hypersonic flight control
University of Texas, Austin: Theory and concept of autonomous cargo operation	**Georgia Tech:** Co-optimally develop lower emission engine technologies and aviation systems for supersonic transport	**University of Tennessee:** Improve aerodynamic efficiency of slotted natural laminar flow aircraft	**Florida State University:** Hydrogen powered hybrid electric power system that uses turboelectric generators and fuel cells	**Georgia Tech:** Advanced materials, tools and processes for Urban Air Mobility (UAM) vehicles	**University of South Carolina:** Unidirectional tape-based thermoplastic part design and manufacture	**University of Wisconsin:** Improve safety and efficiency of manufacturing with human-robot teaming	**Oklahoma State University:** Prediction of low-level winds in both natural and urban environments	**North Carolina A&T University:** Integrate secure, coordination and control algorithms for certification of UAS/UAM	**University of Texas, Austin:** Vehicle as aero-dynamic sensor for hypersonic flight control **(AFOSR funded)**
New Mexico State University: Safe and efficient UAM operational strategies to meet flight demand from an electric grid perspective		**Penn State University:** Optimal design of a gas turbine engine for short-haul aircraft	**University of Central Florida:** Technologies for using ammonia for a hydrogen powered aircraft	**Boston University:** Safe, low-noise operation of UAM in urban canyons by integrating gust and trim optimization			**University of Notre Dame:** Enhance sUAS traffic management based on safety, readiness, operator preparedness, and maintenance	**University of Illinois:** Autonomy tools to help UAM aircraft fly safely through dense urban environments	
Univ of California, Berkeley: Stress testing and hardening the National Airspace System			**Tennessee Tech. University:** Propulsion and power for ammonia-based aircraft				**George Wash-ington University:** Securing high-density urban airspaces against cyberattacks		
Ohio University: Address challenges with automatic UAS surface operations									

Awards in performance

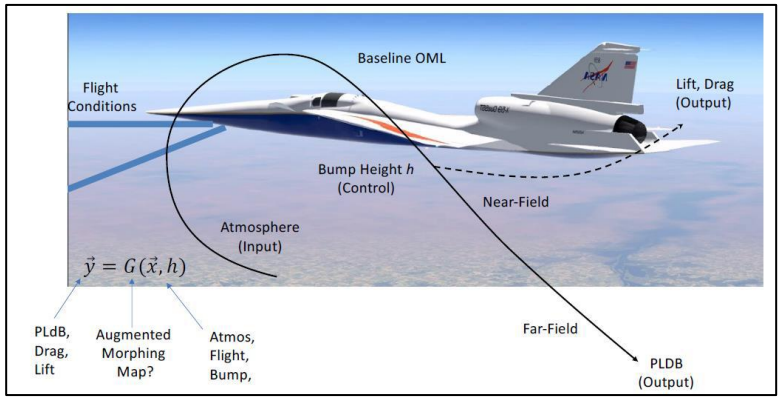
Closed or in process of closing

Technical Impact of ULI Research (examples)



University of South Carolina led

- Filter bank multi-carrier for L and C band aviation networking that can be part of LDACS 3 standard. Would improve aviation datalink communication robustness and efficiency
- Deployed mmWave airport networks to increase communication capacity and security for wide range of applications
- **What's Next:** NSF and industry funded $24M infrastructure project at NC State to support experiments related to sUAS detection, 5G, UTM, and AAM



Texas A&M University led

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- "Morphing map" relates flight conditions (Mach number, Angle of attack) to conformal adaptive outer mold line shape
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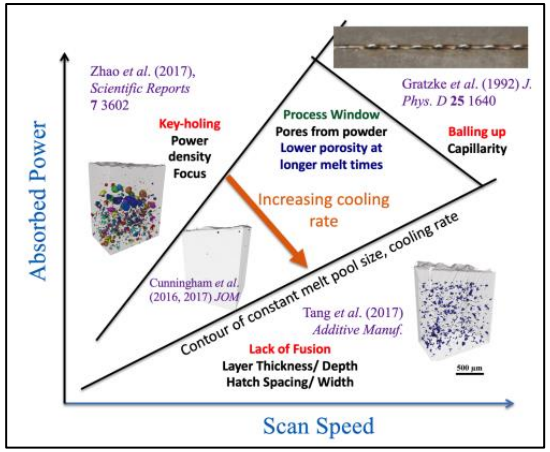


Carnegie Mellon University led

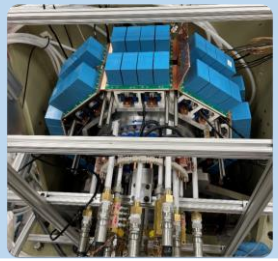
- Connection between Additive Manufacturing printing process parameters (laser power, scan speed, …) and fatigue (a key mechanical property)
- Project data is curated and will be made publicly available to provide a large amount of process-microstructure-properties data for others to use and investigate.
- **What's Next:** A CMU-led NASA Space Technology Research Institute award ($15M).

Enabling Non-CO_2 Technologies for 2050s and Beyond

Electric Propulsion

Ohio State University (1 MW motor)

- Developed 9 kW/kg, 95.8% efficient integrated modular motor drive
- No partial discharge observed at 50,000 ft in NASA NEAT facility



Hydrogen

University of Illinois, Urbana-Champaign
(Cryogenic hydrogen electric aircraft)

- Superconducting motors and power transfer, Liquid hydrogen tanks
- Hydrogen fuel cell, Cryogenically-cooled power electronics

Florida State University
(Hydrogen powered hybrid electric aircraft)

- Combination of turboelectric generators and fuel cells
- Develop power electronics, power distribution, and manage thermal loads

Ammonia

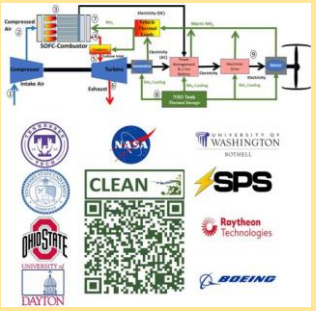
University of Central Florida
(Cracking ammonia for hydrogen propulsion)

- Ammonia as a hydrogen carrier, NOx control, and thermal management
- Supercritical carbon dioxide waste heat recovery system

LFA
Ammonia as a Liquid for the Future of Aviation

Tennessee Technological University
(Ammonia based power generation)

- Integrate an ammonia-based Solid Oxide Fuel Cell-Combustor and a turbogenerator
- Distributed electric propulsion



USRC Inspiring Next Generation of Aviation Entrepreneurs

USRC Seeks Student Ideas

- Students propose their novel, entrepreneurial aviation ideas
- 3 proposal cycles per/year, proposals due around February, June, November
- 3-page technical proposal
- Receive up to $80K for 1 year
- 5 USRC awards / year

- Gain technical and entrepreneurial skills
- Teams use crowdfunding
- Interface with NASA experts
- Open to all majors and interdisciplinary teams

USRC
UNIVERSITY STUDENT RESEARCH CHALLENGE

29 awards total,
11 funded by OSTEM
Space Grant Office

Virginia Tech team acquired $40k+ in industry support (Northrop, Boeing, etc.). Won top prize at the Student Manufacturing Design Competition

Michigan State University
Recognized at MSUxRutgers game
Presented at International Auto Show

ERAU team lead worked with ArduPilot.
10 companies interested in technologies for UAS reliability and failure diagnosis

Using Gateway to Blue Skies Competition to Crowdsource New Ideas

Student Group Competitions

- New competition theme each year
- As a team work on a future aviation concept

- Competition opened July 25, 2023, finished May 30-31, 2024

- A 5-to-7-page paper/design study and an infographic
- Top 8 teams present to NASA

- Winning team receives NASA internships

- 1 competition / year

- Increase college students' interest in climate friendly aviation research
- Gain systems-level thinking
- Open to all majors and interdisciplinary teams

GATEWAYS TO BLUESKIES
Student Competition

2022: Airports of Tomorrow

- Ohio State students briefed Las Vegas airport executives on carbon capture and carbon reducing options
- U Penn students briefed Houston airport executives on their ideas for a new airport terminal design

2023: Clean Aviation Energy

- Boston U students proposed Aluminum Powder Combustion
- Directed Energy Beam Propulsion from UC San Diego

2024: Advancing Aviation for Natural Disasters

- For earthquake response, Cal Poly Pomona students proposed using airship, small and micro drones
- Columbia U students proposed a tail sitter drone to measure snowpack conditions used to predict avalanche risk

Developing Aviation Maintenance for Advanced Aviation Concepts

Targets Advanced Air Mobility, Electric and Hydrogen Propulsion

- Research future aviation maintenance technical challenges not yet addressed in current Aircraft Maintenance Technician Schools (AMTS) curricula
- 2-year duration, up to $300k/year, $50k of which goes to AMTS
- Pathfinder, potentially every 2 years
- Universities partnering with AMTS and the aviation industry
- Engaging undergraduate, graduate, and AMTS students

LEADERSHIP TEAM

PI Anand K. Gramopadhye, Dean of Engineering, Computing and Applied Sciences, Clemson University

Co-I Kapil Chalil Madathil, Industrial Engineering

Co-I Crystal Maguire, Executive Director, ATEC

Co-I Jonathan Beck, Executive Director, NCAT

Co-I Zack Nicklin, Uncrewed Aerial Systems Instructor

COLLABORATORS / CONSULTANTS

Stephen Ley, School of Aviation Sciences, UVU

Karen Johnson, Aviation Technologies, SIU Carbondale

Ryan Goertzen, President, Choose Aerospace

Rebecca Short, Internal Evaluation, CUCWD

INDUSTRY STAKEHOLDERS AND PARTNERS

AAR, AIAA, EP Systems, GAMA, Zipline, ASA, FlexJet, RoboticSkies, United, SAE International, supernal

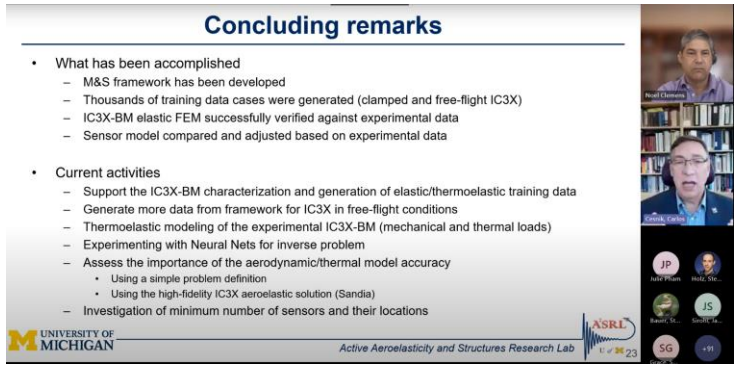
UC Davis University of California; Ampaire; Solano Community College; RoboticSkies

NIAR Wichita State University National Institute for Aviation Research; WSU Tech

Disseminating Research through Tech Talks

ULI Tech Talks

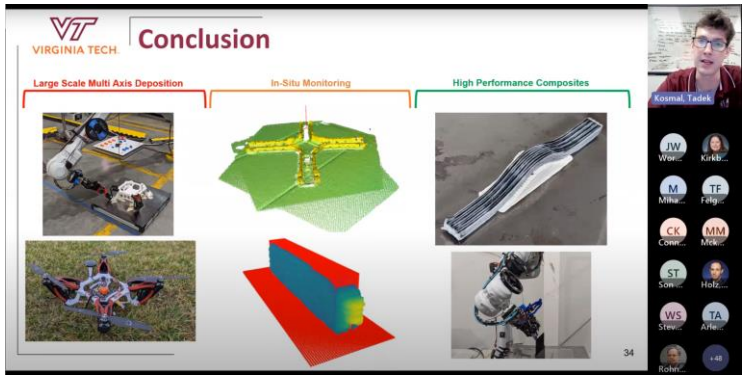
- ULI research dissemination to NASA, industry, and academia
- Catalyzing research collaborations



9-14-23 ULI Tech Talk: FAST Full Airframe Sensing Technology for Hypersonic Aerodynamics Measurements

USRC Tech Talks

- Awareness and subject matter expert connections for USRC student research within NASA, industry, and academia



7-24-23 USRC Tech Talk: Robotic Aerial Vehicle Fabricator

- https://uli.arc.nasa.gov/talks/
- Previous Tech Talks available to stream
- 450+ on invite list between NASA, Academia, and Industry

University innovation of today influencing aviation of tomorrow

Increased Participation of Universities in Aeronautics Research

Achieving Aviation Outcomes

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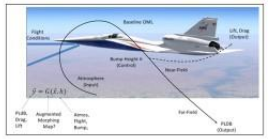

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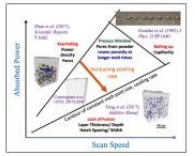

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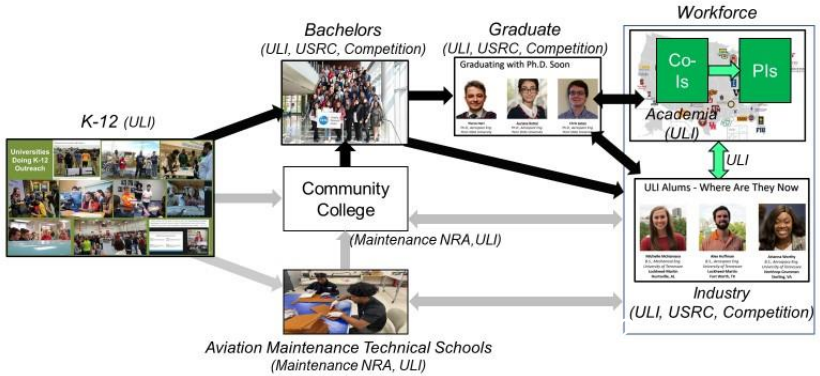
Impacting Workforce Pipeline




NASA