NC STATE UNIVERSITY

Mechanical and Aerospace Engineering

Team Members:

- Brian Shi (Financial, Aerodynamics)
- Caleb Kebede (Communications, Propulsion)
- Jose Vizcarrondo (Systems, Payload & Avionics))
- Lucas Andrews (Manufacturing, CAD & Simulation)
- Sebastian Perna (Test & Safety, Stability & Control)
- Tobias Hullette (Project Manager, Structures)

REACHR Presents HERO 1

Aerospace Engineering Capstone Senior Design 2023-2024

GATEWAYS TO BLUESKIES

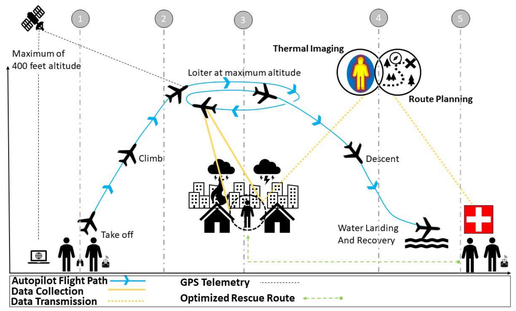
"NASA's gateways to Blue Skies Competition," *NASA's Gateways to Blue Skies Competition* Available: https://blueskies.nianet.org/

Course Instructor: Dr. Felix Ewere
Section Instructor: Joseph Deneke
Customers: Kevin Gitushi, Michael Hughes, Tom Freeman
Sponsor: Engineering Trust Fund

Mission

New Orleans, Louisiana in the aftermath of Hurricane Katrina taken by Mark Moran from NOAA

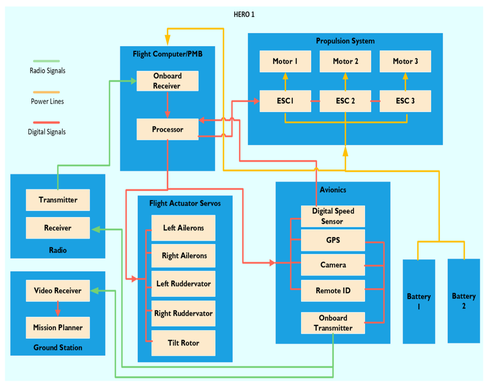
Concept of Operations



CONOPS: Remote operation by the pilot with observer support.
Stage 1: Observer hand-launches HERO 1 into hazard area post-hurricane.
Stage 2: Climbs to 400 feet and follows a planned path for 20 mins.
Stage 3: Gathers situational data using the avionics system and its known GPS location.
Stage 4: Data wirelessly transmitted to the ground crew for processing with AI.
Stage 5: Capable of VTOL landing on solid ground or water. The payload can be modified for specific mission criteria.

Functional Block Diagram

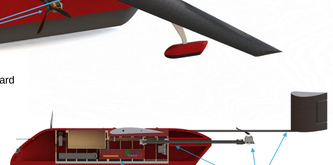
Functional block diagram: The flight computer serves as the central control unit for the aircraft, receiving inputs from various sensors such as GPS, altimeters, and pilot commands. It is connected to an avionics module, which facilitates data transmission to the ground station for monitoring and control by the crew. The avionics system includes cameras and sensors that are linked to the flight computer and an onboard transmitter for real-time data transmission. The power supply and propulsion systems are responsible for providing energy and thrust to the aircraft.

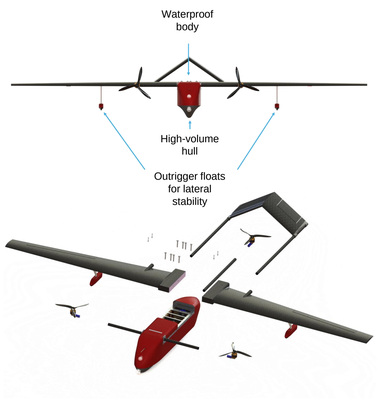


Design Solution

Design solution: A versatile UAV design featuring STOL, VTOL, and cruise flight capabilities. Constructed with carbon fiber, FORMULAR 150 foam, aluminum, and balsa wood for optimal strength-to-weight ratios. Capable of water landings for patrolling flooded areas. High endurance with high aspect ratio wing and dual batteries. Ideal for hurricane and flood response.

Subsystem	Component	Specifications
CAD	Full Assembly	Empty mass: 20 lb (target), 21.5 lb (actual)
		Volume: 1711.96 in^3
		Center of Mass: 25.16 in behind nose, 5.06 in vertically up from nose
Aerodynamics	Wing	Airfoil: NACA 4412
		Span: 10 ft
		Root Chord: 12 in
		Tip Chord: 6 in
		Taper Ratio: 0.5
		Aspect Ratio: 13.3
		Sweep: - 1.5 deg
		Dihedral: 0 deg
		Twist: 0 deg
		Incidence: 0 deg
	Tail	Airfoil: NACA 0012
		V-Tail: 110 deg
		Root Chord: 10 in
		Tip Chord: 10 in
		Taper Ratio: 1
		Sweep: 0 deg
		Twist: 0 deg
		Incidence: 0 deg
Propulsion	Motors	Thrust-to-Weight Ratio: 1.2
		3 x Spektrum Avian 5055-500Kv
	Propellers	13x8 3-Blade APC Propeller
Structures	Fuselage	Flying boat hull
		Aluminum frame, balsa ribs, foam body
	Wing	Foam core with carbon fiber skin and spars
	Tail	Foam core with carbon fiber skin and spars
	Rotor Spars	25x23mm carbon fiber spar
	Twin Booms	25x23mm carbon fiber spar
	Outrigger Floats	Attached just inboard of ailerons
		Foam core with carbon fiber skin and spars
Stability and Controls	Controls Software	ARDUPilot

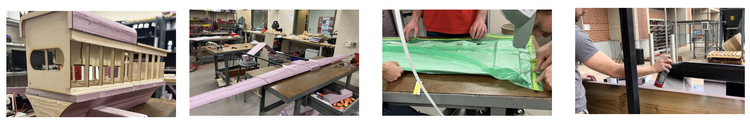




Manufacturing

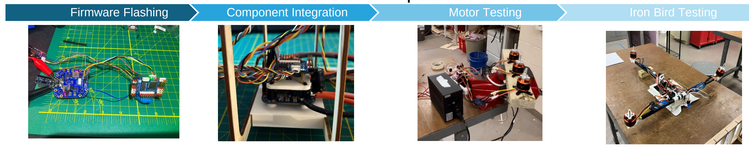
Structures

Fuselage Frame → Foam Core → Carbon Fiber Layup → Finishing and Painting



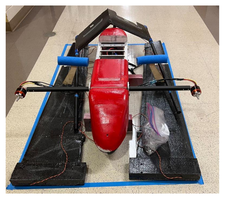
Avionics & Propulsion

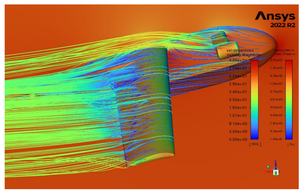
Firmware Flashing → Component Integration → Motor Testing → Iron Bird Testing



- The Hull and wings involved splitting the CAD model, hot wiring foam pieces, composite layups and water jetting metal part.
- Avionics required modifying a power distribution board and a Matek flight controller.
- The Propulsion system was built by soldering connections, mounting motors, and propellers.

Final Prototype and V&V&T





Flight Testing

After initial setbacks from high wind and failed hand launches, HERO 1 proved its VTOL and cruise flight capabilities by successfully transitioning mid-flight.

Flight Test Video

NASA Gateways to Blue Skies

NASA's 2024 Gateways to Blue Skies Competition challenged teams to design a clean-energy natural disaster response system. REACHR was selected as one of eight finalists to present a system proposal at NASA Ames Research Center in May 2024. This system integrates Innovative aviation and surveillance technologies and can be Implemented by 2035.

Proposal Video

NC STATE MAE

REACHR

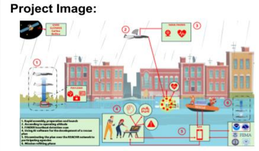
(Reconnaissance and Emergency Aircraft for Critical Hurricane Relief)

GATEWAYS TO BLUESKIES

Project Summary:

- **Disaster & Management Phase:** Hurricane (and water-based emergency) response
- **Use Case:** Minimizing first responder time and risk by locating and communicating with stranded victims, planning response and rescue route, and delivering supplies
- **Systems Overview:** V/STOL flying boat UAV platform equipped with AI route planning,LiDAR, FLIR, NASA's FINDER, 5G cellular relay antennae, solar enhanced batteries, and web application communications

Project Image:



Team Composition/Roles:

- North Carolina State University Aerospace Engineering (AE) Senior Design Team
- **Team Composition:**
  - *Team Lead:* Tobias Hullette (Senior in AE)
  - Brian Shi (Senior in AE)
  - Caleb Kebede (Senior in AE)
  - Sebastian Perna (Senior in AE)
  - Jose Vizcarrondo (Senior in AE)
  - Lucas Andrews (Senior in AE)
- **Qualifications for Success:** As an accomplished aerospace senior design team, REACHR demonstrates bold innovation, collaborative excellence, and technical prowess, excited to present groundbreaking solutions for the 2024 NASA Gateways to Blue Skies competition.

Proposed deployment timeline:

2024-25	Preliminary Design, Critical Design Customer Approval, Customer Funding Field Tailoring
2026-28	Prototyping and Testing,System Integration Field Testing Barrier Analysis
2029-31	Final Design, Manufacturing Customer Training Risk Mitigation, Regulation Approval
2032-34	Distribution Customer Operational Integration Field Training Regulation Approval