

# Electrification of Aircraft Propulsion



To provide aircraft suitable for short-distance travel while reducing emissions, Zunum Aero is turning to electrification to create hybrid-electric systems. The challenge of developing these more electric aircraft requires the deployment of engineering simulation to achieve performance goals and to reduce the time and costs of testing.

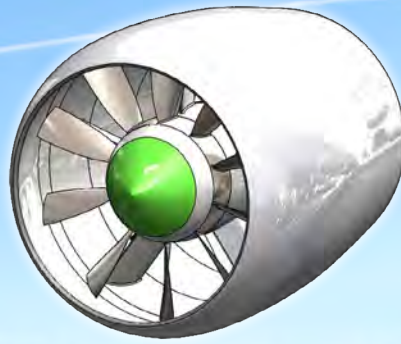
By **Patrick Noble**, Propulsion Staff Engineer, Zunum Aero, Seattle, USA

**W**ith 13,500 airports in the United States, short-haul, regional air travel should be easy — a quick drive to a convenient air field and you are ready for takeoff.

Zunum Aero is determined to close the vast regional transport gap with the aid of technology for electric propulsion. The company, which is supported by Boeing HorizonX, Jet Blue Technology Ventures and the State of Washington Clean Energy Fund, envisions a door-to-door air system very different from today's jet-driven hub-and-spoke model of flying. Its coordinated network will eventually reach 5,000 secondary airports across



**“In my career, I have relied on ANSYS Mechanical products for over 20 years to develop the highly optimized solutions required for the aerospace industry.”**



◀ Zunum Aero's Quiet Electric Propulsors offer range-optimized quiet fans with integrated electric motors.

the U.S. — and another 5,000 worldwide — with scale-independent hybrid-electric aircraft that reduce emissions and noise. Countries around the world include electrification in their lower energy, emissions and noise programs, such as CLEEN in the U.S. and Clean Sky in Europe.

#### **HYBRID-ELECTRIC PROPULSION**

Optimizing a quiet, lightweight hybrid-electric propulsion system with efficient aerodynamic designs is paramount to achieving the aircraft's performance objectives. To deliver a propulsor (a ducted fan prototype) for ground-based testing, Zunum Aero simulates component performance with several products from the ANSYS software suite obtained through the ANSYS Startup Program.

By accurately capturing the structural, aerodynamic and thermal loading behavior of each component,

Zunum Aero can make informed decisions about everything from large architectural issues — propulsor size, for example — to detailed system interfaces and joint behavior. Simulation provides a reliable way to prove concept feasibility, improve efficiency and optimize design before the hardware and test phases of product development.

#### **STRUCTURAL TESTING AND THERMAL MANAGEMENT**

The Zunum Aero Quiet Electric Propulsor combines low-pressure fans with integrated fault-tolerant electric motors and controllers. To understand how each propulsor component performs under all operational parameters, operating conditions and failure modes,



Electrifying the Aviation Industry  
[ansys.com/electrifying-aviation](https://ansys.com/electrifying-aviation)

Zunum Aero simulates behavior with a combination of ANSYS Mechanical, ANSYS Fluent and ANSYS CFX software.

Specifically, design engineers at Zunum Aero's test facility near Seattle, Washington, analyze the structural integrity of propulsion components with ANSYS Mechanical. Not only does the software allow the engineering team to simulate steady-state, modal and structural dynamics parameters, it also helps engineers to understand the complete response of each component individually and how they work together. In addition, engineers model internal and external flows for aerodynamic pressure loss estimates and design optimization using ANSYS CFD.

Because heat directly affects product reliability, the temperature of electrical components must remain within a set window. Zunum Aero uses ANSYS Fluent for thermal management. Engineers perform CFD fluid flow and heat transfer analysis to predict temperature and heat rejection, and to design the cooling system.

Although the company is still in its initial phases of designing, optimizing and integrating various thermal systems for the best overall aircraft-level performance, Zunum Aero senior principal engineer Dave Bedel says they could not have come this far without ANSYS simulation software.

"The scripting and parametric analysis capability of ANSYS Mechanical is essential for our work on the Zunum Aero Quiet Electric Propulsor," Bedel said. "In my career, I have relied on ANSYS Mechanical products


for over 20 years to develop the highly optimized solutions required for the aerospace industry."

#### APPLYING MULTIPHYSICS SIMULATION

Delivering a propulsion system is not a single-discipline assignment. In this case, it takes collaboration of engineers from Zunum Aero's power and propulsion groups to explore all the possible designs that could meet the propulsion requirements for the lowest-total-cost door-to-door aircraft.

Through its compatibility and integrations capabilities, ANSYS software enables multiphysics evaluations for faster design optimization. By simulating multiple designs, the design team can analyze more components at a proof-of-concept level in the virtual world, without having to spend time or resources on testing. In fact, it is estimated that, without simulation, validating the aircraft would have required nearly double the time. But even more than that, ANSYS helped Zunum Aero save millions of dollars in hardware tests.

#### EFFICIENT LOCAL AIR TRAVEL

Flights from thousands of airports that get travelers to their destinations at a fraction of the cost — with less noise to disturb neighbors and lower emissions for a healthier planet — is a lofty vision. But with the help of ANSYS simulation software, Zunum's goal of delivering a certified hybrid-electric aircraft is in sight. 

***“It is estimated that without simulation, validating the aircraft would have required nearly double the time.”***



Designing the More Electric Aircraft  
[ansys.com/designing-electric](https://ansys.com/designing-electric)