Ansys

CASE STUDY /

Ansys + Electroflight

"Electroflight needed to select a material with a glass transition temperature that was greater than the battery operating temperature, which was a difficult challenge. The Granta material database accelerated the task of searching for and selecting a suitable alternative."

Mark Collins

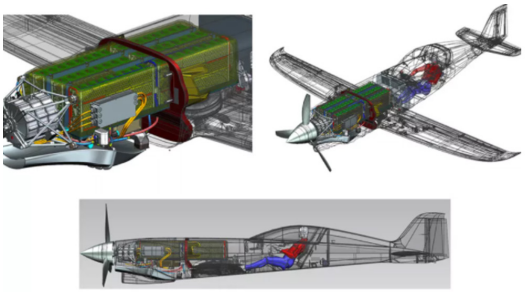
Lead Mechanical Simulation Engineer / Electroflight

CASE STUDY

Material Selection for Speed & Sustainability at Electroflight

Electroflight's objective was to break the world speed record for the fastest all-electric aircraft, becoming a testbed for advances in aerospace electrification. It broke this record in late 2021.

To achieve its performance targets required a lightweight, low-drag airframe and new electrified powertrain, battery, and cooling systems to be developed to cost and time.



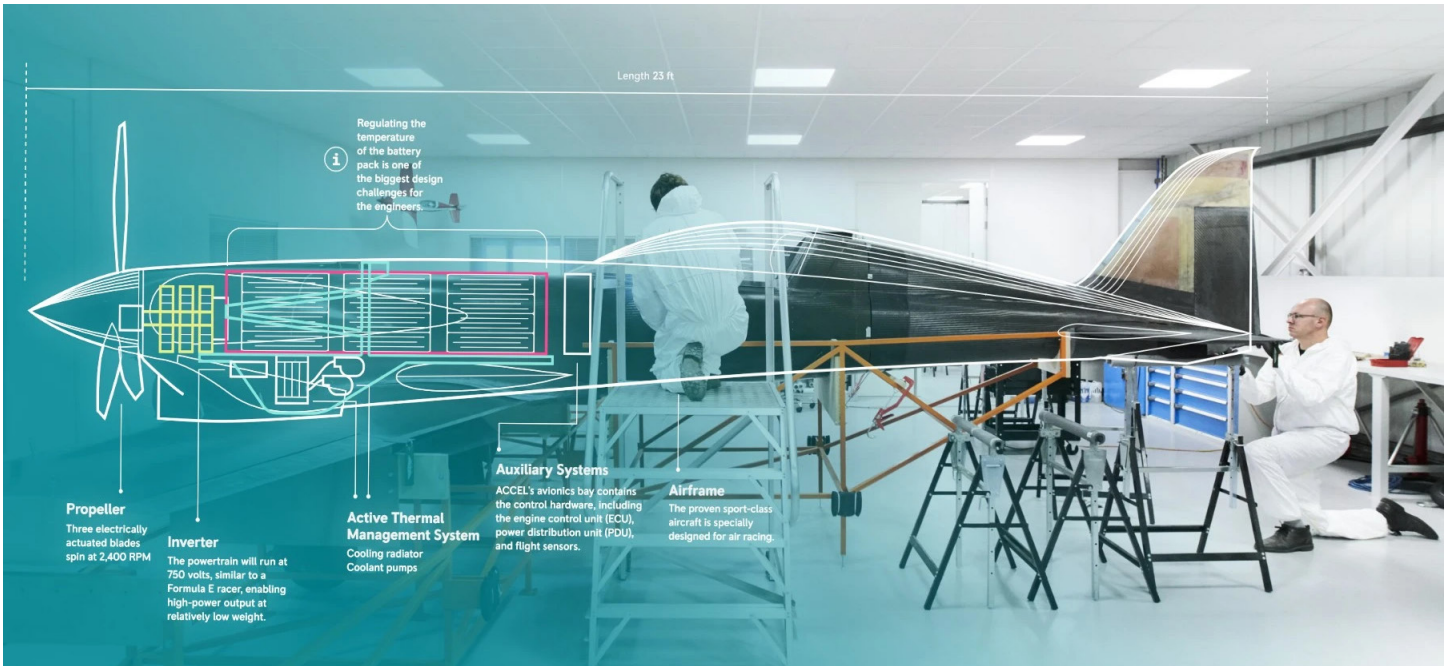
Challenge

The design of the aircraft required structural dynamic and thermal simulation to be coupled with careful material selection to achieve weight and sustainability targets. Simulation analysts required material properties to be instantly accessible and directly embedded in their software.

Finding a material for the battery mounting plate with a glass transition temperature that was greater than the battery operating temperature and perform well during a thermal runaway event was a key challenge. All components of the bill of material (BoM) needed to be scrutinized to assess and minimize the environmental impact and substitute any hazardous substances in line with local regulation.

Technology Used

- Ansys Mechanical
- Ansys Fluent
- Ansys Discovery
- Ansys Granta MDS
- Ansys Granta MI
- Ansys Granta Selector



Credit: Rolls-Royce ACCEL Project

/ Engineering Solution

Engineers at Electroflight used a flexible, cloud-based license to Ansys Mechanical for structural dynamics simulations and Ansys Fluent and Discovery to model cooling. Material data was then integrated and interrogated within these simulation tools via Ansys Granta. There were three solution areas where Granta was used:

1. Integrating Material Data Into Simulation

Granta's Material Data for Simulation (MDS), a bolt-on available within Mechanical and Fluent, was used to offer additional material property information. This was useful for early concept evaluation in Mechanical because material data is instantly available. It was also useful for validating material property data for similar types of commercially available material.

2. Early-stage Sustainability & Hazardous Substance Assessment

As this was a zero-emissions prototype aircraft, the partners involved wanted to understand the environmental impact. A preliminary BoM was created to allow the assessment both in terms of sustainability and hazardous substances in the design. The Granta MI BoM Analyzer functionality was used as part of the analysis to estimate the CO^2 emissions for material and processing of the BoM.

Similarly, it was used to assess the restricted substances. This gave designers a view of where they might have compliance issues and gave them data to be able to trade off with substitute materials.

The environmental impact of a new material selection can also be performed rapidly with this analyzer.

Item	Name	EU RoHS	China ...	ELV	SIN List	REAC...	IAEG A...
Spirit or Innovation		✗	✗	✗	✓	✗	✗
Airframe		✗	✗	✗	✓	✗	✗
Powertrain		✓	✓	✓	✓	✗	✗
Motor		✓	✓	✓	✓	✓	✓
magnet-neodymium-n3...	Neodymium Iron Boron magn...	✓	✓	✓	✓	✓	✓
copper-c10200-hard	Wrought Copper Alloy: hc-Cu...	✓	✓	✓	✓	✓	✓
aluminum-333-0-moldc...	333.0 (Aluminum Association)	✓	✓	✓	✓	✓	✓
Inverters		✓	✓	✓	✓	✗	✗
inductor-ringcorechoke...	Inductor, ring core choke type	✓	✓	✓	✓	✗	✗
Propeller		✓	✓	✓	✓	✓	✓
wood-beech-fagussylv...	Fagus sylvatica (L)	✓	✓	✓	✓	✓	✓
Mechanical frame		✓	✓	✓	✓	✓	✓
aluminum-2014-t6	2014, wrought	✓	✓	✓	✓	✓	✓
HV wiring		✓	✓	✓	✓	✗	✗
copper-c10200-soft	Wrought Copper Alloy: hc-Cu...	✓	✓	✓	✓	✓	✓
plastic-pe-cross-linked-...	Crosslinked polyethylene / XL...	✓	✓	✓	✓	✗	✗

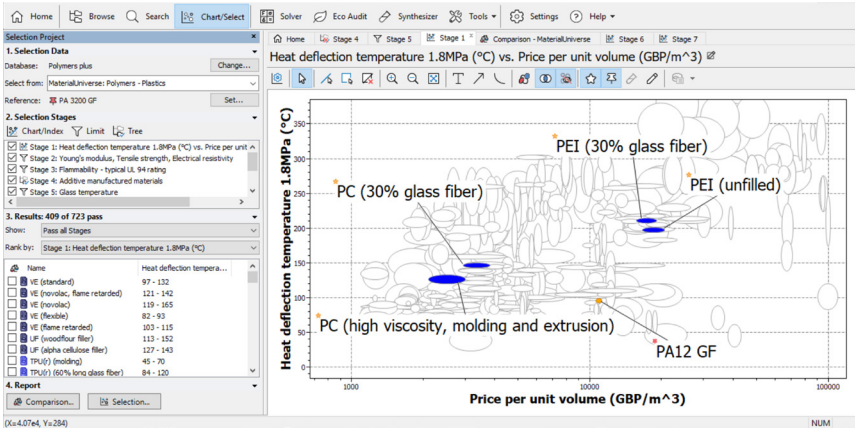
Using Ansys Granta MI to assess restricted substances across the BoM

3. Selecting the Right Material for the Critical Battery Mounting Plate

The original design required battery cells to be mounted on a 3D printed mounting plate made from polymer, but was found to have reduced stiffness properties as temperatures increased. Ansys Granta Selector was used to perform an initial screening of polymers by inputting the engineering requirements (temperature resistance, mechanical, electrical resistivity, flammability) and making trade-offs such as:

1. Heat deflection temperature versus price
2. Resonant frequency versus damping
3. Glass temperature versus toughness

Several candidate polymers were identified: polyamide (PA), polycarbonate (PC) and polyetherimide (PEI). Granta Selector was then used to enable an assessment of the environmental impact and hazardous substance risk of these new material options.



Ashby plot from Ansys Granta Selector showing a trade-off of various polymers comparing thermal characteristics against cost

/ Results

- Faster concept evaluation within Mechanical, with direct access to simulation-ready material property data
- Tools to quickly assess product sustainability at early stages of design to minimize costly changes at later stages
- Enable visibility of the aircraft's BoM compliance to local regulations such as REACH, EU RoHS, IAEG, etc.
- Solving critical material challenges by down-selecting materials based on specific requirements

/ Company Description:

Electroflight is a startup based in the U.K. and formed in 2011. It is a technology and engineering services business specializing in high-integrity bespoke battery systems for aerospace and defense. It partnered with Rolls-Royce and YASA as part of the ACCEL project, funded by U.K. ATI and Innovate U.K. to develop the "spirit of innovation" aircraft.

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