AE3340 Trade Studies

Trade Study of choice

Airframe Materials. To accomplish the weight-savings necessary for this new hybrid-electric method of propulsion, it is necessary to evaluate the materials that go into the airframe. The struggle to find durable, yet light materials with predictable behavior has existed since the beginning of flight itself. Going into the future, it will be necessary to constantly revisit this subsystem.

Evaluation Criteria

Strength: It is important that the yield strength of the material be known against the forces it will be under (aeroelastic and aerodynamic). The material must survive the extremes of flight, such as a hard landing condition and bird strikes. This ranks highly.

Material durability: The material used must be resistant to the other stresses involved in flying: heat and cold cycles, moisture and corrosion, electro-static discharge (lightning). This ranks highly as well, as the aircraft needs to be able to be maintained over its lifetime without constant worry of airframe fatigue or corrosion.

Predictability: We need to know how the material is going to behave cyclically as well as under a constant strain in order to predict when repairs are necessary before they happen. I will rank this highly because it is of the utmost importance for safety.

Weight: The material needs to be as light as possible in order to maximize Thrust to Weight ratio. Since the propulsion system is unknown, this will be ranked in the middle. Weight will most likely be involve in a tradeoff scenario.

Cost: To make the airline feasible, this evaluation criterion is inevitable. However, since we do not know the financial needs of the stakeholders, we will rank it in the middle.

Lifecycle Ecology: Is the process of making/harvesting this material eco-friendly? Has the material been recycled? What will become of the aircraft after its 30-year lifespan? Because it is not involved in safety or feasibility of the project, it ranks lower than everything else, but is nonetheless important.

Availability: What is the lead time on certain materials? Is there a supply chain readily available to meet the deadline of the amount of aircraft we need by EIS date? This is a high rank – if the material is not available, the conversation is a non-starter.

Alternatives

Aluminum/Titanium combo: This classic is a baseline for our aircraft. Aluminum is flexible and light. Titanium is strong, durable, and does not weigh as much as steel. Both metals have been used for over a century and have predictable behaviors. They are tried and true airframe materials.

Polymer-based composite: Polymers have promising insulating properties and are also flexible and light. However, strength and durability may be the issues here preventing the use of polymer composite materials. Also, the behavior of polymers is not always understood, detracting from the ability to safely maintain the airframe. However, depending on the polymers, it is entirely possible to create the aircraft from wholly recycled materials.

Carbon-fiber-based composite: Carbon-fiber is easy to manufacture, repair, and manipulate. However, like polymers, it is not as predictable as metals and perhaps would detract from the safety of the aircraft. It may also be difficult to recycle.

Fully Re-use the airframe of an existing retired aircraft: There are many aircraft that are sitting in the desert, robbed of their useful parts, but the airframe is still present. Is it possible to alter airframes that already exist for our purposes?

Wood: The world's first aircraft utilized fully wooden components. Wood is heavy, but insulating, pliant, and easy to obtain as well as eco-conscious. There is technology being developed to utilize wood for cubesats this year, 2023. Would the same technology make wood relevant again for aviation?