

TOM HOFFMANN

Plugged In!

The Future of Electric-Powered Aircraft

It doesn't seem that long ago when the thought of an all-electric powered car zooming down the highway was reserved only for those with vivid imaginations. The obstacles to practicality just seemed too burdensome to overcome while remaining at a price point that would still attract consumers.



Photo courtesy of e-volo

Today, although the industry is still evolving — and admittedly advances are still needed — there is a growing list of highway-capable and reasonably-priced electric cars to choose from. The jury's still out on a few things, like long term battery reliability and appeasing the “range anxiety” for owners, but there is little doubt that the economic and environmental appeal of electric cars will continue to make inroads in the marketplace as battery technology and hybrid systems mature.

So why not with aircraft as well? Surely plugging in instead of fueling up would be music to a pilot's ears, particularly with the price of aviation fuel. As with most emerging technologies introduced into a highly regulated environment, it's foreseeable, but not without its challenges.

Electro-Analysis

“Electric propulsion for aircraft has the potential to be a real game-changer for general aviation,” said Thomas Gunnarson, a transportation industry analyst with the FAA's Aircraft Certification Service in Kansas City, Missouri. “We may be behind where the auto industry is on this now, but we're gaining ground quickly.”

Gunnarson is part of the Programs and Procedures Branch in the Small Airplane Directorate that specializes in studying innovative applications of technology to improve safety and reliability for general aviation. “We're looking at the total package that electric propulsion technology can bring us,” said Gunnarson. “Before it can be implemented, however, we must first determine if it is safe, economical, and practical in the aviation environment.”

Current FAA regulations do not yet address the specific design and airworthiness requirements of electric propulsion systems in aircraft. But thanks to the efforts of Gunnarson and others at the FAA, that is changing. An important first step was the formation of the F37 Light Sport Aircraft (LSA) Committee — a subgroup of the consensus standards leader ASTM International — to create standards for electric propulsion systems for LSA. The Small Airplane Directorate has also completed an internal regulatory analysis of what rules need to change to

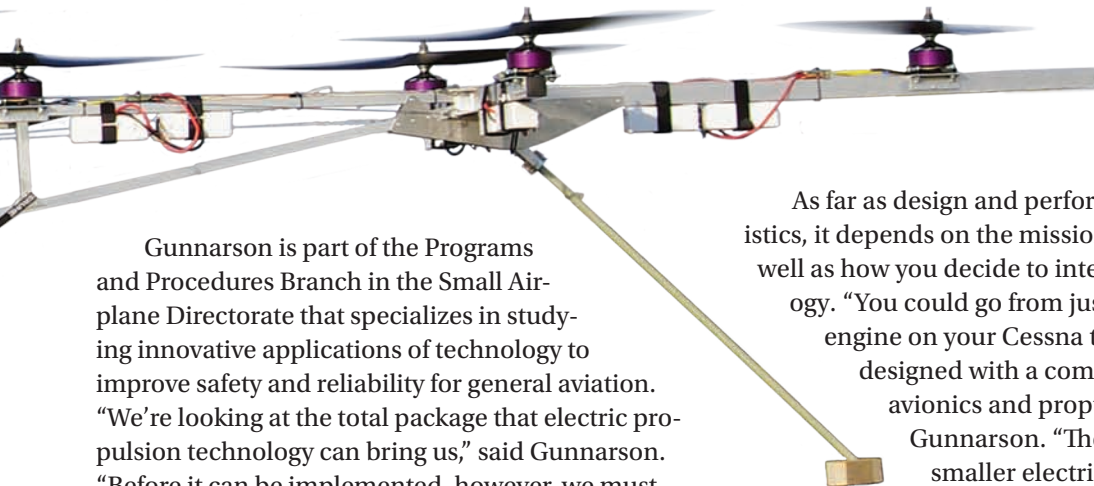
allow things to move forward. In addition to providing the basis for a good regulatory framework, the study also revealed several key factors for the team to consider when integrating this type of technology into aircraft, such as battery technology and performance limitations.

Due to lower costs and fewer regulatory barriers, LSA is the logical place to initially focus on applying this technology. Eventually, as the technology matures and more knowledge is gained, it may be possible to adapt it to type-certificated aircraft, provided the FAA can achieve safety expectations appropriate for the type of aircraft and its intended operations.

Not Your Father's Basic Trainer

So what exactly will an electric aircraft of the future look and feel like? At its core, the three main components of an electric propulsion system include:

- The motor (or motors) that provide power
- The motor controller that controls the application of the power
- Rechargeable batteries



As far as design and performance characteristics, it depends on the mission of the aircraft as well as how you decide to integrate the technology. “You could go from just swapping out the engine on your Cessna to having an aircraft designed with a completely integrated avionics and propulsion system,” said Gunnarson. “The use of lighter and smaller electric motors will provide more flexibility in how you design aircraft and could very well change the way we think about traditional flying.”

Take the e-volo Volocopter (shown left) for example. This vertical take-off and landing manned aircraft uses 18 small electric motors and is maneuvered by varying the thrust of each of these motors. Can you say Jetsons?!

Sheer Simplicity

In addition to the growing influx of ingenious new design concepts, there are also a number of benefits electric propulsion systems offer, many



Solar-powered aircraft, like the Solar Impulse shown here, may help raise awareness of electric flight and other renewable energies.

Photo courtesy of © Solar Impulse / Jean Revillard

focusing on simplicity of design, operation, and maintenance. For example, there's no more worrying about carburetor heat, fuel mixture settings, or fuel selectors for the engine. And with the motor shaft and propeller being the only two moving parts, there's an immediate reduction in failure points.

Increased cabin comfort is another benefit pilots may notice, thanks to a significant reduction in noise and vibration. The smooth torque of electric motors

or having them connect a laptop to your motor with a USB cable."

And let's not forget about another huge benefit and one of the main drivers behind electric propulsion technology: nearly zero emissions! No gas also means no more fuel drain samples seeping into the ground, no more fuel leaks to worry about, and no more 100LL fumes in the cockpit.

Warning: Batteries Low

Of course, with any new technology, there are also drawbacks and unknowns. This is particularly true with battery technology. Questions in this arena continue to loom, like how often batteries need replacement and whether their power-to-weight ratios will improve enough to be viable for more than just short hops. Recent issues with the Boeing 787 *Dreamliner* also brought to light the issue of battery volatility.

The good news is that battery technology is a rapidly advancing industry thanks in part to the ravenous appetite for larger, brighter, and longer lasting tablets and smart phones. The electric car industry is another key player in battery advancement, and both industries could stand to learn from each other. "Electric vehicle manufacturers would likely be very interested in the lighter and more efficient batteries designed for use in aircraft," said Wes Ryan, Programs and Procedures Branch manager for FAA's Small Airplane Directorate. Aircraft manufacturers

The use of lighter and smaller electric motors will provide more flexibility in how you design aircraft and could very well change the way we think about traditional flying

may allow them to operate at different speeds than traditional reciprocating engines, potentially reducing propeller

noise, engine noise, and the overall decibel level of the aircraft passing overhead.

Maintenance with these types of aircraft would also be greatly simplified and inspection intervals and time between overhaul (TBO) could increase drastically. One reason for that is the use of "air bearings," which all but eliminate internal friction within the engine. And from a safety standpoint, the level of built-in system monitoring will be markedly more sophisticated.

"You're likely to have a system that monitors and records performance of your batteries and motor and be able to download it to a computer at any time," said Gunnarson. "Your next inspection may involve handing over a thumb drive to a mechanic,

would also benefit from safety lessons already well understood in the automotive market. “Working together with them may help reduce costs, improve safety features, and speed up development.”

Another important bellwether for future electric propulsion development is the booming unmanned aircraft system (UAS) market. They often use electric propulsion systems or combinations of gas-powered and electric motors, and have been successful with long-range missions for many years. The prominence of the unmanned aircraft market has also served as the springboard for onboard electric generation systems like those used by the U.S. Navy’s fleet of UAS flying with electricity-producing hydrogen power systems.

Another electric energy source for aviation that is on the rise and which has received some recent buzz in the news is solar power. You have probably heard about the planned U.S. transcontinental flight this summer by the *Solar Impulse*, a Swiss long-range solar powered aircraft. It remains to be seen, but the attention from this nearly 3,000-mile trip — without so much as a drop of fuel — could prove to be an important catalyst for raising awareness of electric flight and other renewable energies.

“Although solar technology isn’t commercially viable at this time, the concepts behind it are sound,” said Gunnarson. “If it ever gets really efficient, it could have a real positive effect on electric propulsion. For now, I’d say it’s only feasible as an adjunct to existing technology.”

Waiting for the “Green” Light

In the United States and abroad, experimental prototypes are pushing the envelope of electric propulsion to new limits in hopes of understanding more about its potential and capturing greater market appeal. Among some of today’s key players with commercial availability are Pipistrel’s *Taurus Electro G2* electric-powered motor glider, Yuneec International’s e430 twin seat LSA, and Lange Aviation’s *Antares 20E* self-launching sailplane. There’s also a growing variety of electric powered weight-shift control trikes, powered parachutes, and hang gliders surfacing in the market.

You may be able to check out some of these designs up close at air show events like AirVenture and Sun ‘n Fun, or at the annual AERO Friedrichshafen exhibit in Germany. The latter is also host to the e-flight expo that brings together regulators, researchers, and designers from around the world each year to help lay the path for greater acceptance

Pipistrel’s Taurus Electro G2 electric-powered motor glider.



Photo courtesy of Pipistrel

of electric-powered aircraft. Their last meeting on April 25 included the FAA, the European Aviation Safety Agency (EASA), and ASTM International as active participants. They discussed recent technology and product developments, emerging challenges and safety issues, and plans for how to logically sequence the steps necessary for a meaningful certification basis.

The Future of Electric

So are electric aircraft in our future? “It may take some time before it replaces traditional propulsion technology,” said Gunnarson, “but I do see electric power in our future.” There are a few items Gunnarson believes must come together before that can happen, however. Among them are an improved and matured battery technology and a clear consensus on the regulatory changes and standards required to safely integrate this change.

“We realize the exciting benefits electric propulsion brings to the aviation community as well as the environment. That is why we are committed to gaining the experience we need to create a clear and safe path towards making this technology a reality.”

I can almost feel the electricity in the air! ✈️

Tom Hoffmann is the managing editor of the FAA Safety Briefing. He is a commercial pilot and holds an A&P certificate.

Learn More

The Comparative Aircraft Flight Efficiency (CAFÉ) Foundation’s aviation news blog

<http://blog.cafefoundation.org/>