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AEROVEL "STROLLS-OUT" FLEXROTOR
LONG-ENDURANCE ROBOTIC AIRCRAFT WITH VTOL

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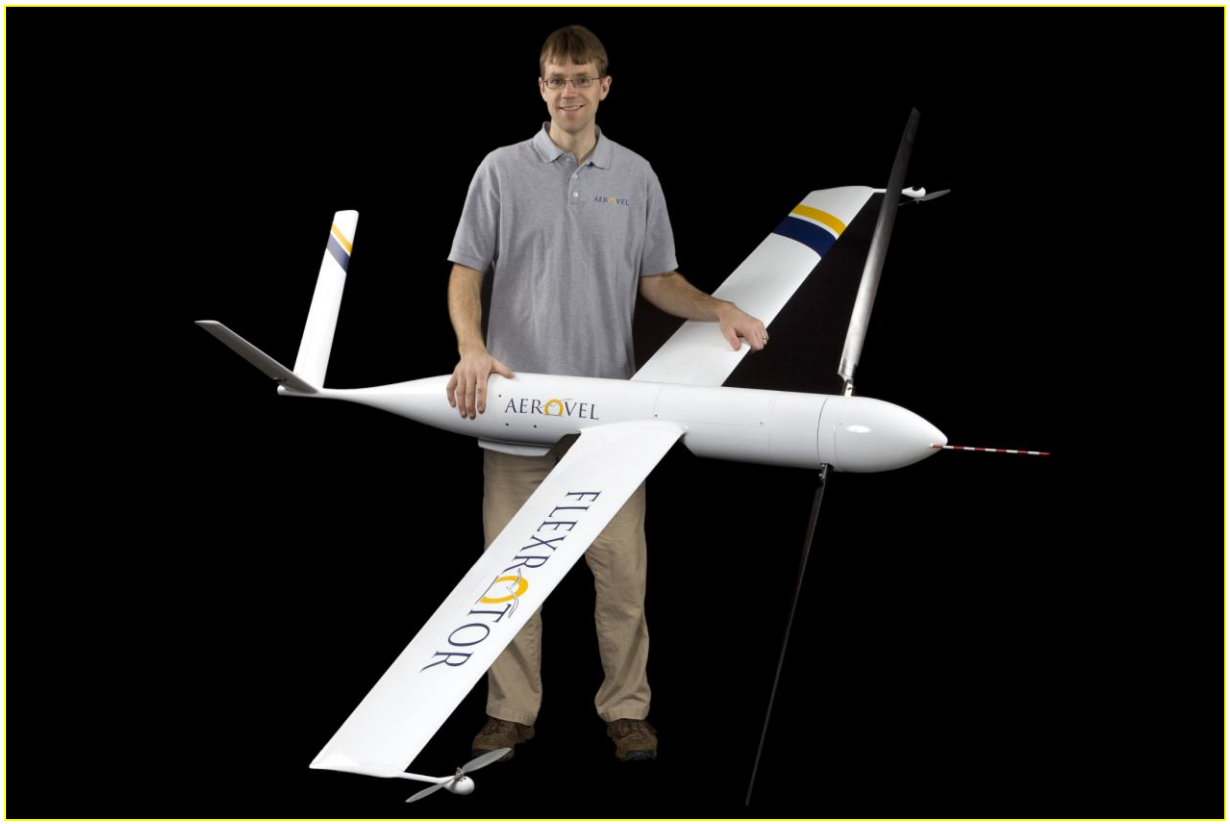
When a new airliner is ready for its public debut, it emerges from a giant hangar in a glitzy roll-out extravaganza. But when you have a very small aircraft and an equally small company, you have to think on a different scale. Tad McGeer, Aerovel's president, recalls that "We started a company called Insitu in 1992 to develop the miniature *Aerosonde* for long-range weather reconnaissance. When we had a prototype more or less assembled, we decided that a roll-out was in order, so we walked out back to our shop" – in a proverbial Silicon Valley garage – "and gave the aircraft a little push out into the driveway." *Aerosonde* eventually became part of AAI's product line, while McGeer's Silicon Valley start-up went on to develop *Scaneagle*, and was bought by Boeing in 2008 for a rumored $400M. Lately McGeer's new start-up, Aerovel, has been busy in another garage – this time in Washington's Columbia Gorge – and has now brought another miniature UAV out into the light of day. "It doesn't have an undercarriage, so we couldn't do a roll-out," he explains, "but it's easy to carry so we had a stroll-out instead."

The aircraft is dubbed *Flexrotor*, and it promises some remarkable steps forward for miniature UAVs in the 20 kg class. The key driver, McGeer observes, is economics: "The main reason that UAVs have not made much headway in civil applications is that their economics are poor. If their costs were lower, then people would be a lot more motivated to remove regulatory obstacles – due not only to the FAA and its counterparts, but also to ITAR. *Flexrotor* is designed to offer a compelling economic proposition."

Like McGeer's previous aircraft, *Flexrotor* is tabletop-sized but offers even longer range and endurance. "With a 1 kg payload, as is typical for imaging or geomagnetic survey, we expect about half again more range and endurance that we had with *Aerosonde*" – which in 1998 made the first unmanned transatlantic flight, covering more than 3000 km in about 27 hours. This by itself would be impressive, but it is all the more remarkable when combined with a capability not normally associated with long range: vertical takeoff and landing.

"Our interest in VTOL is economic," says McGeer. "With *Scaneagle* we made operations practical for boats like tuna seiners, but the equipment" – a pneumatic catapult for launch, and a *Skyhook*, which McGeer and his colleagues patented in 2001, for retrieval – "is too big for small vessels, or to be conveniently shipped. With VTOL your ground equipment can be made much more portable, which is not just convenient but, for some applications, positively enabling."

Yet how can VTOL be obtained together with large payload/range? Aerovel's solution is reminiscent of the tailsitter experimental fighters of the 1950s, although, as McGeer points out, "*Flexrotor* isn't actually meant to sit on its tail." It is, however, essentially an efficient winged airframe with a large rotor in place of a propellor. For hover, it pitches from wing-borne flight to nose-vertical, and uses helicopter-style collective and cyclic pitch controls. Meanwhile small electrically-powered wing-tip thrusters play the role of a helicopter's tail rotor. The main rotor is



Aerovel's *Flexrotor* prototype

powered by a single-cylinder 28 cc two-stroke through a reduction gearbox. It is placed forward of the wing in a tractor layout, but aft of a non-rotating nose reserved for an imaging turret or other payload.

Yet a tailsitter that never sits? "We want to avoid the weight and drag of an undercarriage, and to operate in the sort of conditions which rule out just hovering onto a helideck. For *Scaneagle* we had Skyhook, which is now used routinely in strong winds and sea states. For *Flexrotor* we're developing a technique which should be comparably robust, but takes advantage of hover to make the base equipment much lighter and more portable."

"And then," McGeer adds, with a twinkle in his eye, "there's another thing."

"On *Scaneagle* we developed automatic launch and retrieval, but hover allows us to take a big further step. *Flexrotor* is being designed to make the whole turnaround automatic: retrieval, parking, refueling, and launch, all using one lightweight base station. So we'll be able to eliminate the manpower, and some of the risks, associated with deck handling."

The benefits would be telling for an application like airborne geomagnetic survey, which was first done robotically by Fugro Airborne's *GeoRanger* variant of *Scaneagle*. "It's a natural job for robots: flying parallel lines very precisely at low altitude, usually in remote areas. A ground

station and a bunch of *Flexrotors* could be shipped into a rough base site, and one person could keep them flying from there with high utilisation. That's a formula for getting costs down."

"We're grateful to have small-business support from DARPA and the Office of Naval Research, in collaboration with the University of Washington," says McGeer, but most of Aerovel's funding is private. When will the aircraft be available? "We'll know better after we get more test time on the driveline, but the goal is to fly in mid-2010. The first aircraft is for work on the powerplant, hover-and-transition control, and automated turnaround. We'll do a design iteration based on what we learn from flight test, and with luck we might be ready for a user trial with a long-range aircraft late in 2011."

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