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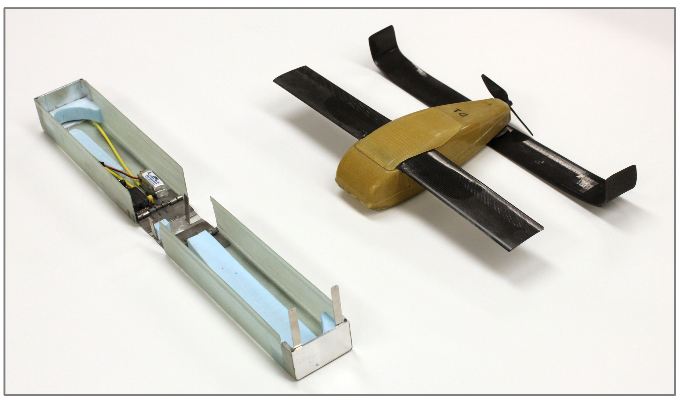
A Small, Mid-Air-Deployable, Folding Electric Drone and Adaptable Aircraft (AAM) Architecture

The Challenge: Sensors on the ground and in space monitor our environment continuously, but sensor networks in the air are uncommon and short-lived. Airplanes need to expend energy to stay aloft, and flying multiple aircraft in tight formations is both risky and expensive. Being able to deploy multi-sensor networks in midair would benefit atmospheric science. Flying one airplane through a target area yields only a single data trace, making it hard to gather real-time, big-picture data about weather systems. Long-range communication might be unreliable in military applications. When looking for traces of radiation or chemicals in the atmosphere, thoroughly sensing the composition of air matter over a large area can be critical. These factors provided the foundation for Tony's primary invention.



An unrelated aeronautics challenge involves the ever-growing cost of aircraft construction. The largest expenses associated with building new aircraft are the manufacturing systems and engineering time. Compared with automobiles, airplanes don't sell in great numbers, so their development costs are spread over far fewer units. Consequently, new aircraft aren't being designed for many market sectors. The Cessna 172, the most popular small airplane in the U.S. today, hasn't changed much since its 1955 debut. As Tony has noted, "if the same cost structure and design approach applied to developing automobiles, we'd still be buying large sedans with tail fins." This challenge provided the grist for Tony's secondary invention.

The Solutions: An unmanned aerial vehicle (UAV, or drone) that would deploy from a mothership, fly at high altitudes, and maintain enough velocity to remain on-site in high winds would address the cited sensor-network challenges. Tony's primary invention, the Locust UAV, was specifically designed to meet those criteria. It launches from an existing aircraft's anti-missile flare dispensers, limiting its size to a little bigger than a dollar bill. The flare dispenser uses a pyrotechnic charge to eject the aircraft, which is cushioned by foam inside a hard rectangular case. The case enters the airstream at jet speeds in the hundreds of miles per hour. A streamer on the back of the case orients it nose-down. When the vehicle slows to deployment speed (around 100 mph), atmospheric drag causes the clamshell case to separate from the vehicle, revealing the Kevlar body and its folded carbon-fiber wings. The UAV then unfolds and pivots its wings, which are just three times the thickness of a human hair, into an "H" shape. A small electric motor propels the drone at up to 70 mph (113 kph) for up to 30 minutes. When the battery is depleted, the aircraft glides to earth and is discarded due to its relatively low cost (at least as military systems go). A follow-on model called Firefly that uses a solid rocket engine to attain speeds up to Mach 0.8 (614 mph/988 kph) is currently under development.

Tony’s secondary invention, Adaptable Aircraft Manufacturing (AAM) architecture, has the potential to reduce manufacturing costs and increase speed of development of new aircraft by generating parts on demand. The time and money invested in development are spread not just over the individual airplanes of one model, but over all similar models. This idea isn't new. Boeing and Airbus airliners use "stretched" airframes to hold more passengers, and the F-35 fighter jet reuses components like wings and tails across a range of variants. Just as convergent evolution led dolphins and sharks to have the same shape, airplane wings converge on the same ideal form for a given specialty. Tony's unique AAM process takes advantage of this commonality to get a wide variety of overlapping wing shapes out of the same mold. Instead of using an entire mold to make one specific wing panel, as is done now, a manufacturer can use part of the mold to create the necessary part and then trim it down to size. Within the parameters supported by the mold, designers can choose how long and skinny the wing will be, its thickness, and its area. This unlocks the production of low-volume prototypes such as research aircraft and specialized military aircraft that would otherwise be too expensive to build. Without AAM, your options for flying a new payload are either to buy an existing airplane that's probably sub-optimal for your needs, or to design and build the plane that's ideal for your payload, but unaffordable. With AAM, you can quickly and affordably create a design that's specific to your needs and good enough to get the job done.

Commercialization: MIT Lincoln Laboratory and the U.S. Air Force funded Tony’s UAV research. His primary invention, Locust, has already been adapted and further developed by MIT Lincoln Laboratory for the U.S. military as an autonomous swarming network called Perdix. Its missions will include Intelligence, Surveillance, and Reconnaissance. Locust/Perdix UAVs can also be used as atmospheric science probes.

Tony’s secondary invention, AAM, isn't likely to disrupt the production of high-volume, high-use airliners that need specific parts optimized for fuel efficiency and other characteristics. Rather, it makes possible low-volume, time-critical designs, such as for research aircraft and prototypes, that otherwise would never be built. Longer term, building airplane parts to order has direct applications for both civil transport and military aircraft development. The system is currently being developed using a more mathematically rigorous model to determine its feasibility for larger aircraft and a greater variety of military missions.