A flying car... seriously

The "Transition," a concept roadable airplane from MIT's Terrafugia, is designed to fit comfortably in your garage.

Why can't my airplane be more like my car—or vice versa?

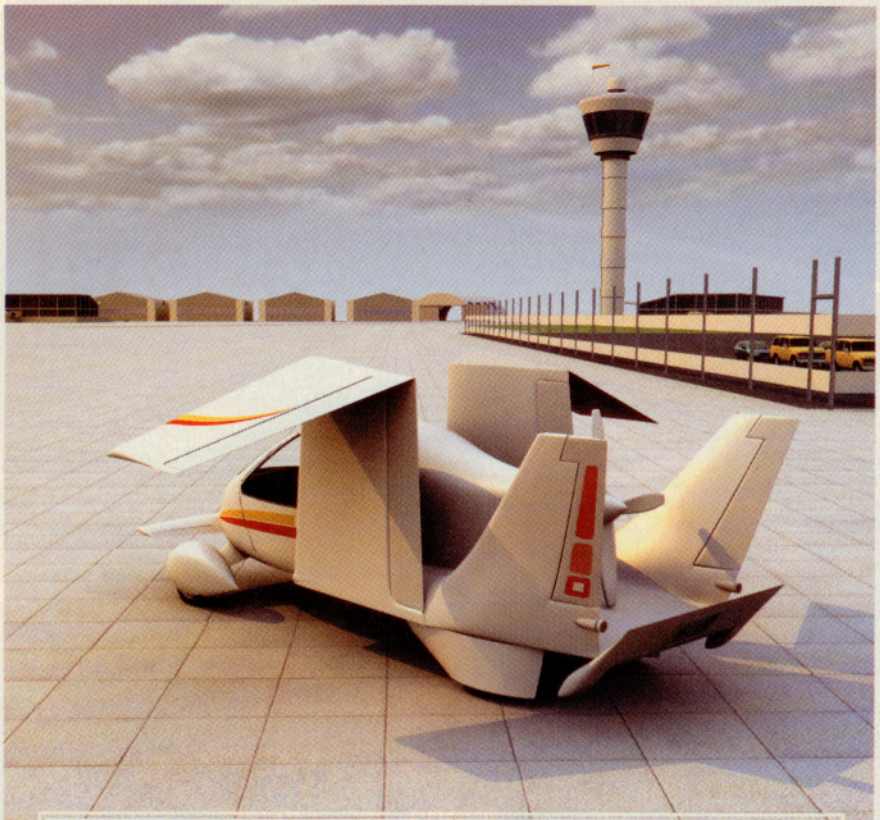
BY TOM LeCOMPTE

Since the dawn of aviation, the idea of a "roadable" aircraft, or flying car, has captivated the imagination—intriguing futurists, inspiring dreamers, and spawning a multitude of whimsical and fictional creations—from *Chitty Chitty Bang Bang* to *Blade Runner* to *The Jetsons.*

Beyond science fiction, the challenge of producing a real "dual use" vehicle has been more elusive, frustrating inventors and entrepreneurs over the years. Of nearly 100 published concepts, only a few have ever been built, fewer still ever flown, and not one put into production.

Among those who tried and failed was Glenn Curtiss, the Wright brothers' chief rival, whose "Autoplane" was first unveiled at the Pan-American Aeronautic Exposition in New York in February 1917, and patented in 1919, but never took more than a few short hops. The first flying car that really flew was Waldo Waterman's "Arrowbile," flown in 1937, but never brought to market. Robert Fulton's "Airphibian," built in 1945, was the first dual-use vehicle to be certified by the government for production but, despite its technical success, it was abandoned when Fulton failed to find a reliable financial backer. Following Fulton, the most successful roadable aircraft to date was the "Aerocar," built by Molt Taylor in 1949, certified by the FAA in 1956, considered by Ford Motor Co. in 1970, but never mass-

ILLUSTRATION BY JOHN MACNEILL



At the push of a button, the Transition's 27-foot wingspan folds and the craft is set for highway use. It fits into a standard garage.

The Transition is a small two-place aircraft with a twin tail, pusher propeller, and folding wings, and is powered by a 100-horsepower engine.

produced (see "Baby, You Can Fly My Car," page 76). Still, the dream endures.

Enter MIT

The latest entry is Terrafugia's "Transition," the brainchild of a group of fresh-faced Massachusetts Institute of Technology grad students. Carl Dietrich, Terrafugia chief executive officer and a doctoral candidate in aeronautics, who with partner Samuel Schweighart, also an MIT Ph.D., came up with the idea, which is several years from becoming a reality, admits that the track record for such vehicles is not good. For one thing, the compromises needed to make a vehicle that is both airworthy and roadworthy have resulted in vehicles that are both bad airplanes and lousy cars. Additionally, even if a vehicle that is technically feasible can be designed, the challenge remains to prove that it is financially viable. "Molt Taylor came the closest," Dietrich says, but he gave up after collecting 278 deposits. "So we're really in unknown territory."

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Rounding out the Terrafugia team are Anna Mracek, Alex Min, and Arun Prakash, all MIT grad students as well as pilots, and Milo Mracek, most recently with McDonnell Douglas before joining Terrafugia.

Before beginning the design process, Dietrich and company studied numbers, lots of numbers. Among the data looked at were statistics showing that Americans take 370 million trips per year between 100 and 500 miles (with a median average being 368 miles). Because most of these trips are such that commercial airline service is not practical and they are to locations that trains and mass transit generally don't serve, 94 percent of them are made in cars. Indeed, a recent *USA Today* survey revealed that airlines have cut back on short-haul flights under 400 miles by 25 percent. Although very light jets (VLJs) and associated air-taxi services aim to serve business fliers traveling between 250 and

600 miles, Terrafugia sees the Transition as filling the need of those looking to travel between 100 and about 450 miles—a distance that most current light aircraft could be marketed as serving.

Yet, general aviation is not seen by the public as an attractive alternative. Even private pilots don't fly as often as they could. A 2002 survey by MIT Professor of Aeronautics R. John Hansman (an advisor to the group) and Raytheon Senior Engineer Troy Downen identified four main obstacles to more widespread use of general aviation. To many pilots, the reasons are familiar enough: weather, expense, mobility at the destination, and the time required to go from doorstep to destination. As a result, too many small airplanes sit tied down, turning into expensive ramp ornaments.

The design

Proving to themselves that there was a potential market for a roadable aircraft, the Terrafugia team set about designing its vehicle. Rather than reach for some pie-in-the-sky vision of putting "an airplane in every garage," the group strove to make the Transition simple and practical, settling on a more-or-less conventional aircraft design and relying on available technology and construction techniques.

"We looked at the lessons of the past and learned that the most successful were roadable aircraft, not flying cars," Dietrich says. The most important decision came by way of the FAA, which two years ago finalized the new light sport aircraft and sport pilot classifications. Fitting the Transition within LSA limits (1,320 pounds and a maximum airspeed in level flight of 120 knots) will streamline the development and certification process, Dietrich says. This, along with sport pilot certification (no medical required, and half the training time required compared to a private pilot certificate), will make the Transition more accessible to pilots and thus widen its potential customer base.

However, making an aircraft that is tough enough for highway use and weighs 1,320 pounds or less "is going to be hard," admits Dietrich. The Federal Highway Administration will require that the Transition, like all cars, have air bags and 2.5-mph crash-resistant bumpers and meet all other Depart-

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Almost famous

Beyond the design challenges, the biggest hurdle facing the Transition is gaining credibility. "There have been so many of these things that we know we have to overcome a perception problem," Dietrich says. At every step, the group has worked methodically to distance itself from the legacy of wacky aeronautical novelties. If the Transition is to succeed, Dietrich explains, it needs to be an aircraft in which "practicality rules over coolness."

To this end, the Terrafugia team has reached out to regulators, aviation experts, and pilots to get a variety of insights and opinions on the Transition. Meetings with the Highway Administration and the FAA were encouraging, says Dietrich. The FAA, in particular, was intrigued by the Transition for reasons of safety: By giving pilots the alternative of landing and driving around bad weather, the Transition could reduce incidents of VFR into IFR. At EAA AirVenture 2006 in Oshkosh, more than 5,000 visitors stopped by the Terrafugia booth, including famed aircraft designer Burt Rutan and FAA Administrator Marion Blakey. The fact that Cessna unveiled its potential entry into the light sport aircraft field at Oshkosh gave Dietrich and his colleagues affirmation that their decision to go the LSA route was correct.

A number of Terrafugia-hosted events for pilots have generated much interest and a few tough questions. "One pilot who flies in New England asked if the wheelpants would be removable for winter flying," Dietrich says. "It was something we hadn't thought of." Others have asked how engine time will be calculated between in-flight time and on-road time when figuring time between overhauls. That, Dietrich says, is yet to be determined, along with a number of other issues, such as exactly how one will insure his or her Transition.

Such outreach has gone a long way to giving Terrafugia a level of legitimacy, but there is bound to be some skepticism. "The price isn't bad," says Gerald Bernstein, aviation analyst at San Francisco-based Velocity Group, "but it's got to appeal to a very, very niche market." Most pilots, explains Bernstein, would be reluctant to plunk down that kind of money on a new and unproven technology, particularly with a small, unknown company behind it.

The key, according to Bruce Chadbourne, a professor at Embry-Riddle Aeronautical University in Florida who specializes in general aviation marketing, is how utilitarian the vehicle will be. Being a light sport aircraft, it will have certain legal restrictions—VFR only, under 10,000 feet msl, special endorsements for flying in controlled airspace—that limit its usefulness. On the ground, it also will have to prove itself as to how stable it is on the highway, say, when a tractor-trailer passes, and how durable it is on potholed city streets.

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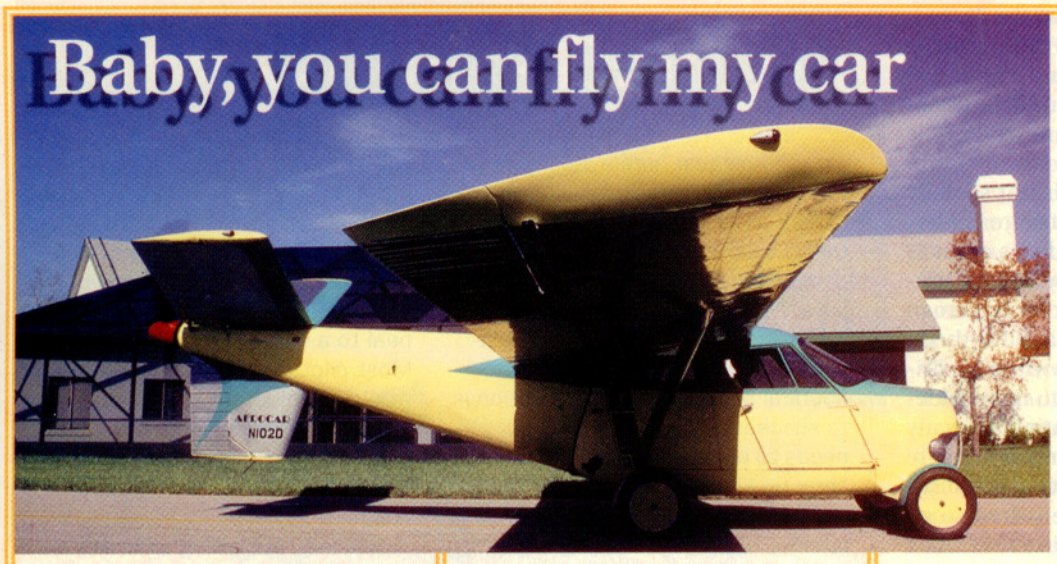
"There are a lot of people who will put down that kind of money just to have the latest toy," Chadbourne says. "But that is only a very small part of the market. To succeed, it will have to be more than simply a 'neat' thing."

Undaunted, Terrafugia has begun taking refundable $7,400 deposits (5 percent of the anticipated purchase price) to secure positions. The deposits, held in escrow, will not go toward the estimated $10 million to get the first Transition prototype off the ground, but will go a long way in giving the Transition the legitimacy it needs to convince investors the company is worth the risk.

If everything goes well, the first prototype could be airborne by 2009.

—*TL*

Baby, you can fly my car



The "Aerocar" was developed by Molt Taylor. N102D was the last model built, in 1960.

It's a quest as old as aviation itself: to build an airplane that the average person can both fly and drive. Many have tried. No one has succeeded. Still, the idea endures.

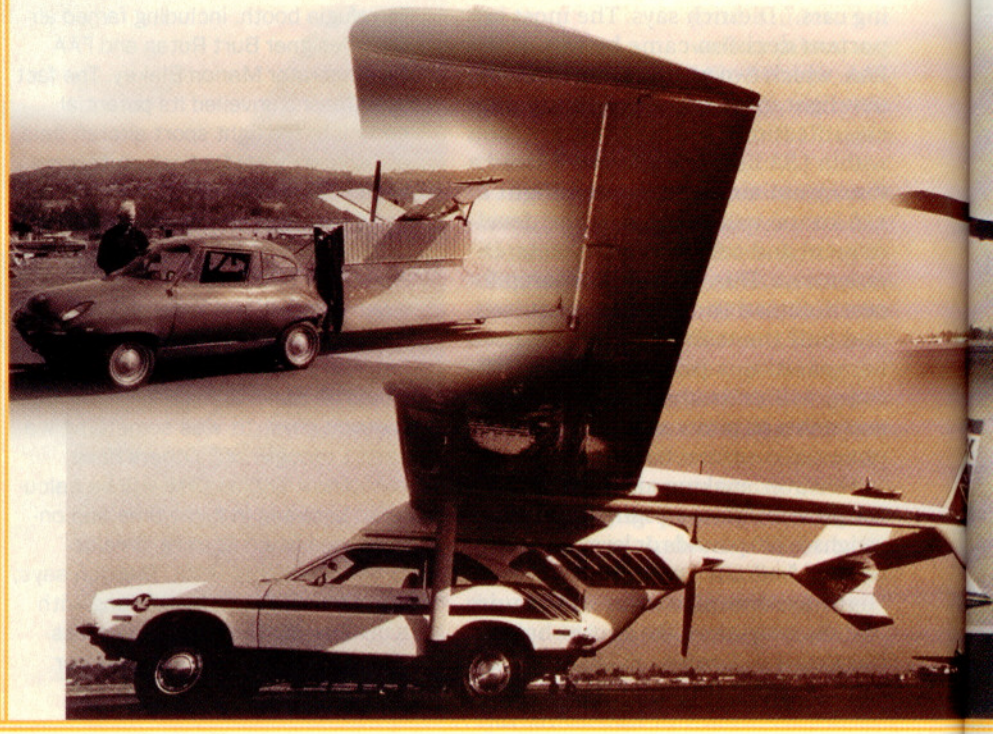
In 1918, the first patent for a flying car was issued to a Felix Longobardi. Longobardi's design was for a vehicle that would convert from a car to an aircraft to a boat. It was never built. The following year, pioneer aviator Glenn Curtiss received a patent for his "Autoplane." The triplane, built and exhibited at the Pan-American Aeronautic Exposition in New York City's Grand Central Palace, had a 40-foot wingspan. The vehicle was aluminum-bodied and had twin-boom tails, along with small canard wings on the front of the car. The motor under a car hood used a shaft and belts to drive a four-blade prop at the rear of the cab. It never flew more than a few short hops.

In 1926, automotive pioneer Henry Ford unveiled the "sky flivver," a tiny 350-pound, single-seat monoplane. Although not technically a "dual use" vehicle, the prototype aspired to fulfill Ford's dream of building "everyman's" airplane. Three different versions of the craft were flown, but after Ford's friend and pilot Harry Brooks was killed in a crash of one in 1928, Ford withdrew the project. Still, he professed faith in the concept, saying, "Mark my word. A combination airplane and motor car is coming. You may smile. But it will come."

In 1933, the U.S. government got involved in promoting the concept when aviation enthusiast and Bureau of Air Commerce chief Eugene Vidal (father of novelist Gore Vidal) offered government grants to manufacturers of a "poor man's airplane." He promised a two- or three-seat, all-metal machine costing $700, about the price of a Pontiac automobile and $300 to $500 less than any airplane then on the market. Vidal's plan drew angry criticism. Manufacturers of small planes described it as an "all mental" airplane, an unrealistic fantasy that would only destroy the sales of existing aircraft.

California inventor Waldo Waterman took Vidal up on his offer. In 1936, he showed off the "Arrowbile," a tailless airplane with detachable wings powered by a Studebaker car engine. First flown in February 1937, the Arrowbile's only flight control device was a control wheel yoke that was suspended in front of the pilot from the cabin ceiling. Fore-and-aft movement of the yoke provided pitch control, and turning the wheel provided coordinated directional control. Brakes and a foot-operated starter button were on the floor. But at an estimated price of $3,000, the Arrowbile was way more than the $700 target. Five Arrowbiles were built, but Waterman was never able to put it into production.

In 1950, Robert Fulton's "Airphibian" became the first dual-use vehicle certified by the government. Fulton's two-seat prototype consisted of two basic components: a small four-wheel vehicle and a separate wing and tail assembly. Once on the ground, the passenger compartment could simply be



detached from the wings and tail and then driven away. Early promotional brochures and newsreels showed a woman in a white dress and heels detaching and rolling away the tail and wing, or reattaching the propeller with a few twists of a built-in wrench.

Powered by a 150-horsepower, six-cylinder engine, the Airphibian drove at 50 mph and flew at 120 mph. It took off in 800 feet. The same controls could be used for flying and driving, with the wheel used for steering on the ground and in the air, and the foot pedals converting from airplane rudder pedals to automobile clutch and brake pedals. Connecting and disconnecting control cables when converting from flying to driving were cleverly accomplished through a series of interconnecting pushrods that would mate when the two components were linked. All the instruments and electrical elements automatically engaged and synchronized when the flight and road units were locked together. The engine would not start unless the units were properly secured. Fulton logged more than 100,000 miles in the Airphibian, but had to quit the project when his financial backer dropped out.

Following the Airphibian, the most successful roadable aircraft was the "Aerocar." Built in 1949 by Molt Taylor, who credited his inspiration to having met Fulton and having seen his Airphibian, the Aerocar had a detachable wings and tail section. Five were built and flown (TV celebrity Bob Cummings bought one) but, like Fulton, Taylor could not get the financial backing to put his vehicle into production.

There have been many just as ambitious but less successful experimental hybrids.

In the 1950s and 1960s, Leland Bryan produced a series of highway-certified folding-wing "roadables" that used their pusher propellers for both air and road power. The project ended when Bryan died in the crash of one in 1974. And in 1973, Henry Smolinski fastened the wings, tail, and aft engine of a twin-engine Cessna Skymaster to one ill-fated Ford Pinto. The wing struts collapsed on its first test flight, killing Smolinski and the pilot.

Currently, in addition to the Transition, there are more than 30 concepts for dual-use vehicles—from the "AeroCycle," a combination motorcycle and aircraft (www.wolffaerocycle.com), to the LaBiche Aerospace FSC-1, a dual-use high-performance aircraft and sports car that promises speeds of 290 mph in the air and 180 mph on the ground (www.labicheaerospace.com), to the "Skycar," a vertical takeoff and landing vehicle that uses "powered lift," the same technology used by the military's vertical takeoff and landing Harrier "Jump Jet" (www.moller.com/skycar). In 2004, Boeing revealed its own as-yet-unnamed concept, a dual-rotor-powered vehicle. For a complete listing, go online (www.roadabletimes.com).

A large part of the enduring appeal of roadable aircraft, according to Bruce Chadbourne, professor of general aviation marketing at Embry-Riddle Aeronautical University, is the technical challenge of combining "two fundamentally incompatible" modes of transportation. That is, the challenge of designing a practical vehicle that is light enough to fly and stable both in the air and on the ground; that can fit into the dimensions needed to travel along roads; that can combine two control systems; and that is useful. The technical challenges can be overcome. A bigger challenge is finding a market for such a vehicle. Even if you could put "an airplane in every garage," the fact remains that, well, Americans love their cars. —*TL*

Molt Taylor with his first "Aerocar," built in 1949 (far left). The "Mizar" was developed by Henry Smolinski at Advanced Vehicle Engineers of Van Nuys, California. Its design was a Ford Pinto mated to the airframe of a Cessna Skymaster.

INTERACTIVE ▶

***AOPA PILOT* ONLINE**

Watch the Transition—in this animation from Terrafugia—take off, fly, land, and fit snugly into its neighborhood garage and see more historic photographs of other flying cars on *AOPA Pilot* Online
www.aopa.org/pilot/flyingcar.

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ment of Transportation standards (such as headlights, taillights, emissions, and rearview mirrors). "We're going to have to destroy five of these things before it ever gets certified," Dietrich says.

After 50 different design iterations on the vehicle's shape, including two wind-tunnel models, the result is a small two-place aircraft with a twin tail, pusher propeller, and folding wings. Built of a combination of composite materials and aluminum, the Transition, configured for flight, will have a 27-foot wingspan, 830-pound empty weight, and 48-inch-wide cabin.

Powered by a 100-horsepower engine burning 4 gallons per hour (either avgas or autogas), it will fly about 500 miles carrying a projected payload of 430 pounds at 120 mph up to 10,000 feet with a fuel capacity of 20 gallons.

Converting at the push of a button, the vehicle, wings folded, will be set for highway use and, at the end of the day, fit into a standard garage. The target price for true door-to-door transportation: $148,000.

"We tried to hammer out and pick the compromises that will affect pilots in the least annoying way," Dietrich says. For example, to make the vehicle more stable on the road, the Transition's center of gravity needs to be more rearward than would be ideal for flight. This means a longer takeoff roll (about 1,500 feet) and, once at rotation speed (70 mph), more of a launch than a lifting into the sky. Or, as Dietrich explains, "it will be a much more exciting takeoff." AOPA

Tom LeCompte is an editor and journalist living in Western Massachusetts. He is a private pilot with more than 850 flight hours.