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What Next, Flying Cars? The Roadable Aircraft Story

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What Next, Flying Cars?

The Roadable Aircraft Story

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Part 1

The Holy Grail

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Exceeding the Grasp

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"Ah, but a man's reach should exceed his grasp, or what's a heaven for?
***Robert Browning*, Poet**

5

Above: caption: "The Cars of Tomorrow - 1958 Pontiac"
Left: a "Flying Auto," as featured on the cover of *Mechanics and Handicraft* magazine, January 1937

6

The Future That Never Was

7

Above: for decades, people have dreamed of flying cars. This conceptual design appeared in a ca. 1950s issue of *Popular Mechanics* magazine

Left: cover of the Dec. 1947 issue of the French magazine *Sciences et Techniques Pour Tous* featuring GM's "RocAtomic" Hovercar: *"Powered by atomic energy, this vehicle has no wheels and floats a few centimeters above the road."* Designers of flying cars borrowed freely from this image; from the giant nacelles and tail fins to the bubble canopy.

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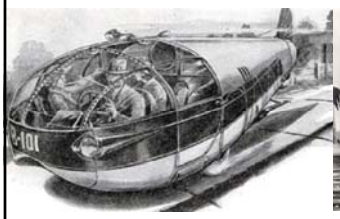

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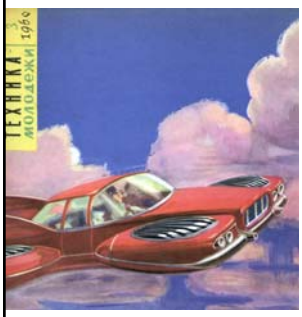

***Tekhnika Molodezhi* ("Technology for the Youth") is a Russian monthly science magazine that's been published since 1933. Like its U.S. and French counterparts (i.e *Popular Mechanics* and *Le Petite Journal*) the magazine is famous for its spectacular covers, often depicting scenes from an imagined future. At left, the Soviet flying car - 1960 style.**

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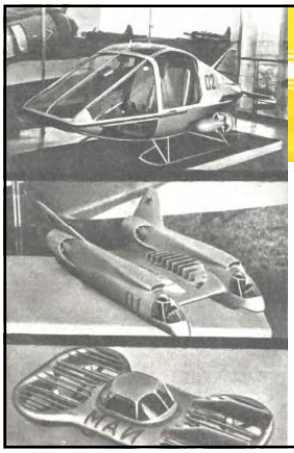

Above: caption: "Flying car, according to Soviet designers, 1967"

Left: caption: "MAI Russian flying car concept line-up from 1955"

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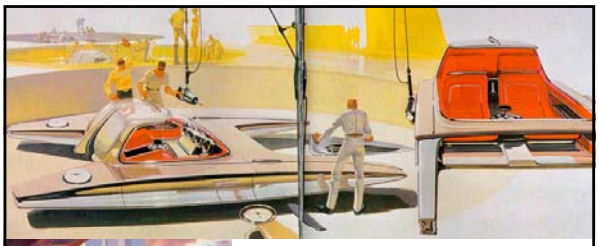

Above, a futuristic gas station for flying cars and at left, the flying car culture of the future – from the book *Sentinel*, by futurist *Syd Mead*

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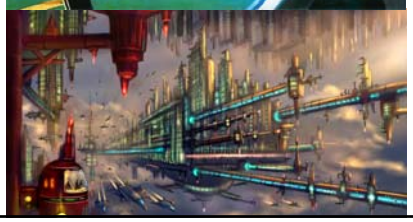

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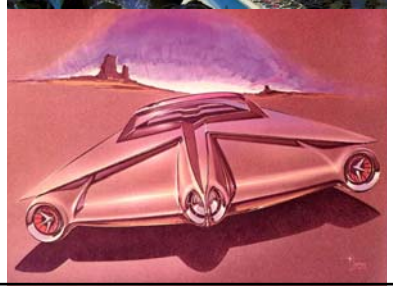

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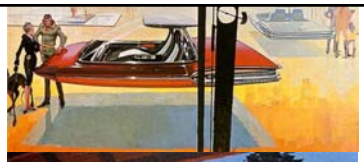

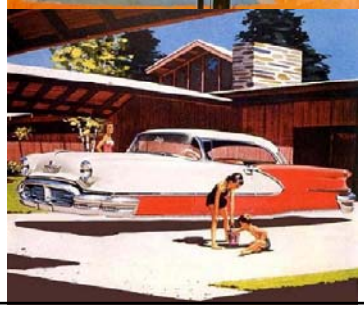

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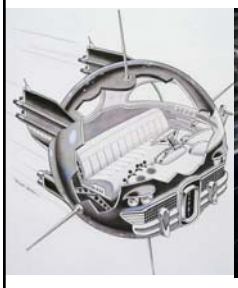

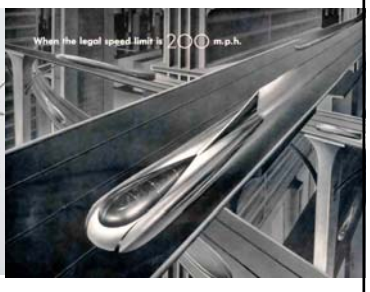

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Above: caption: "The Sky Commuter (ca. 1990)." Developed by *Boeing* in the 1980s, for just $71,500 you could own the *Sky Commuter* concept car. Powered by a gas-turbine engine linked to helicopter-like driveshafts, the *Sky Commuter* was to be an alternative to the plane-strapped-to-car designs of the previous decades. Boeing spent $6 million developing the concept, but it never went into production.

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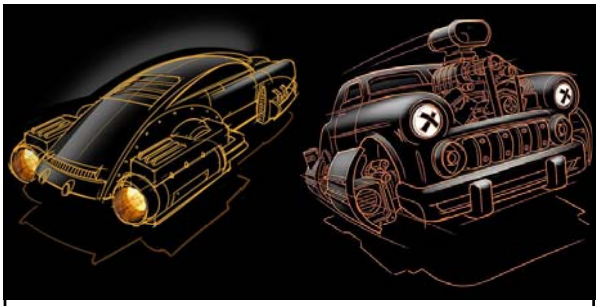

"Here we are, less than a month until the turn of the millennium, and what I want to know is, what happened to the flying cars? We're about to become Americans of the 21st century. People have been predicting what we'd be like for more than 100 years, and our accoutrements don't entirely live up to expectations…Our failure to produce flying cars seems like a particular betrayal since it was so central to our image."
***Gail Collins,* Journalist (December 1999)**

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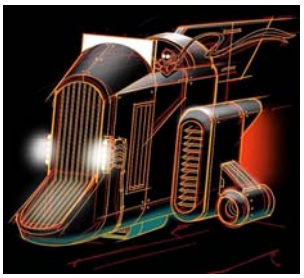
Above L&R: present-day (2015) "Hovercar" concepts (by *Donvitoart*)



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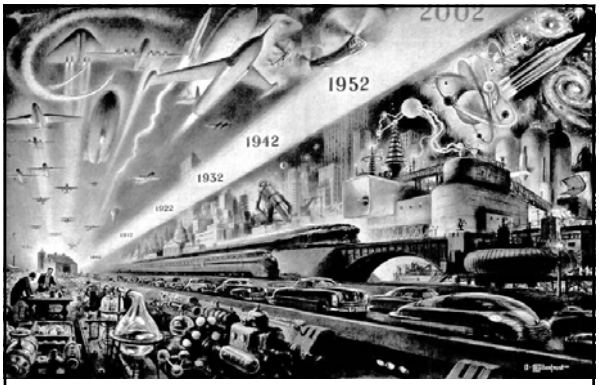

Above: "The March of Progress" (as it appeared in a 1952 issue of *Popular Mechanics* magazine)

23

Trial and Error

24

Above L&R: caption: "The M400 Skycar." The *Skycar* VTOL (*Vertical Take-Off and Landing*) is termed a "flying car," this despite the fact that it's not intended for road travel. It is the life's work of inventor *Paul Moller* - a Canadian engineer and university professor, Moller is the creator of the "Supertrapp" exhaust popular with motorcyclists. His Skycar has short wings and uses four turbine engines (for both lift and propulsion) and is expected to have a cruising speed of 275 mph and a top speed of 375 mph. A full-size model test flight first took place in 1967 (a demonstration flight scheduled for October 2011 was cancelled).

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In 2003, the SEC (*Securities and Exchange Commission*) filed a civil fraud action against *Moller International* for selling unregistered shares of stock directly to the public via the internet, raising approximately $5.1 million from more than 500 investors nationwide. A $50K fine was imposed on the fledgling company for "making unsubstantiated claims" about the *Skycar*.

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Flying Ferrari

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"It's an idea that's never really taken off, despite featuring in countless books and films. But the flying car could become a reality in two years, claim its makers. Called the Autovolantor, it is being marketed as the perfect way for the rich and famous to avoid traffic jams, simply by taking to the skies. Its creators say it will cost £500,000 and allow drivers to reach speeds of 100 mph on the ground and 150 mph in the air. Designer Bruce Calkins says the car, based on the £200,000 Ferrari 599 GTB, will be powered by eight fans mounted in its fuselage. He said: 'On the ground these fans push the vehicle around with a firm but not-too-powerful thrust of deflected air. Once in the air the vehicle maneuvers like a helicopter, tilting nose down to move forward, rolling right or left for changes in direction. While maximum altitude could be much higher, the energy to obtain altitudes above 5,000 feet would be significant so we expect it to stay below that height.' Mr. Calkins said the car will run on a hybrid fuel and electric system to power the thrusters, creating as much as 800 horsepower. He believes it will be able to travel for 75 miles by air or 150 miles by ground before it needs refueling. As yet, the design is in its infancy and only a tiny scale model exists…"
***Daily Mail*, November 3rd 2008**

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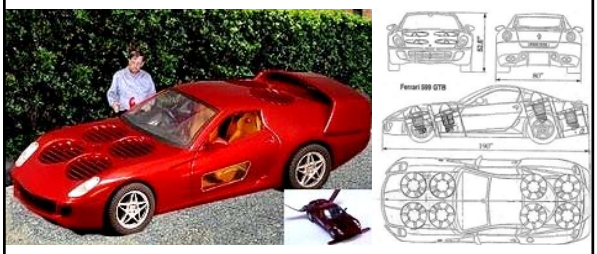

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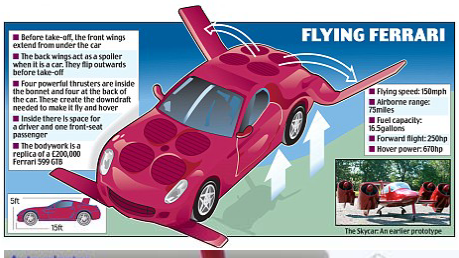

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"…Mr. Calkins added: 'At first we were very skeptical that we could adapt a ground-vehicle with our technologies and make it work. But the model allowed us to verify quickly that it could in fact be done.' The ambitious project was launched at aircraft designers Moller Int'l. in the U.S. after the company received a request to design the vehicle from a wealthy businessman who found the commute from the center of Moscow to his country home would often be delayed by congestion. For decades Dr. Paul Moller, the company's founder and president, has dreamt of achieving a workable combination of ground and air transport. But despite the backing of a wealthy investor, he has yet to produce any practical real-world drive-and-fly vehicles…"

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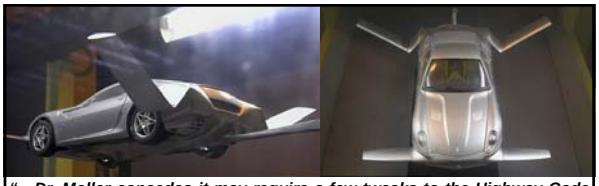
***Daily Mail,* November 3rd 2008**



"…Dr. Moller concedes it may require a few tweaks to the Highway Code before the Autovolantor is allowed to hit the high street, saying: 'It seems that it might be practical in some parts of the world, but in our view a roadable aircraft, rather than a flying car, is still more practical for the greatest number of people. The Autovolantor is technically possible, but flying it in many cities is not going to be politically acceptable until it has been deployed successfully in other roles and environments. Practical or not, it excites the imagination to think about being able to rise vertically out of a traffic jam and just go.'"

***Daily Mail,* November 3rd 2008**

Left: caption: "The 'Autovolantor' used a specially designed hybrid fuel and electric system and could reach altitudes of up to 5,000-feet"

Right: caption: "Creator Moller hopes the car could be available in just two years, but the asking price of £500,000 could put a few off"

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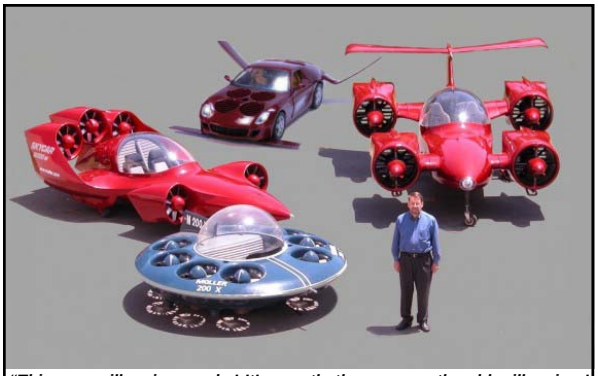

"This new millennium sucks! It's exactly the same as the old millennium! You know why? No flying cars!"

***Lewis Black,* Comedian (ca. 2001)**

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Above: inventor *Paul Moller* poses with his prototype flying car fleet

At the Movies

35

Flying cars have made their presence known in popular culture since the 19th Century. In the 20th Century, they were particularly prominent in science fiction films. For example, the 1977 sci-fi classic *Star Wars* features a "Landspeeder," which hovers just above the ground. "Air-speeders" can be seen in all three Star Wars sequels, from 1999's *The Phantom Menace* onward. They're featured prominently in *Attack of the Clones*, where an early chase sequence involves flying cars. In 2005's *Revenge of the Sith*, the character *Bail Organa* rides a retro-futuristic vehicle that, apart from its impressive flying abilities, resembles a 1950s-style automobile. A "Spinner" is the generic term for the fictional flying cars used in *Blade Runner* (1982). Set in a futuristic Los Angeles of 2019, a spinner can be driven as a car and/or take-off vertically, hover and cruise using jet propulsion.

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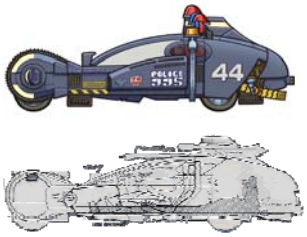
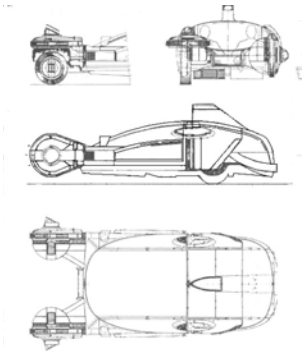


In the film, Spinners are used extensively by the police to patrol and survey the population. The vehicle was conceived and designed by *Syd Mead,* who described the *Spinner* as an "aerodyne" - a vehicle which directs air downward to create lift (press kits for *Blade Runner* stated that the spinner was propelled by three engines: conventional internal combustion, jet and anti-gravity). Mead's conceptual drawings were transformed into twenty-five working vehicles by automobile customizer *Gene Winfield*. A Spinner is on permanent exhibit at the *Science Fiction Museum and Hall of Fame* in Seattle, WA. 37

Above: caption: "2019 L.A.P.D Spinner (Blade Runner)"



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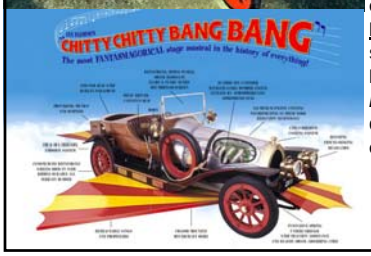
Above: in *The Fifth Element* (1997), set in 2263 NYC, flying cars are used as the main means of transportation. The production design for the film was developed by French comics creators *Jean Giraud* and *Jean-Claude Mezieres*, Mezieres wrote the book *The Circles of Power*, which features a character named *S'Traks*, who drives a flying taxicab through the congested air traffic of the vast metropolis on the planet *Rubanis*. This character was changed to a taxicab driver who drives/flies his cab through a futuristic NYC. 40

Above: in the best-selling animated film *The Animatrix* (2003, part of the *The Matrix* saga), specifically in the episode entitled: *The Second Renaissance*, appears a TV commercial announcing a flying car called the *Versatran* 41

Top: caption: "The 'Back to the Future' films featured a flying DeLorean car." In *Back to the Future Part II* and the ending of *Back to the Future*, Doc Brown invites Marty and his girlfriend Jennifer into his modified flying *DeLorean* time machine and time travels to the far-off year 2015, where flying hovercars are a common sight.

Bottom: caption: "The Flying Maruti." Indian inventor *A.K. Vishwanath* swears his *Flying Maruti* can fly, or will. The car, with a Suzuki hull, rotor blades affixed to the roof and extended wheel arches (for "vacuum suction") is the wishful thinking of Vishwanath's company: *B'Lorean*, a combination of his hometown of Bangalore and the Delorean car featured in the *Back to the Future* films. 42



Top: caption: "'Chitty Chitty Bang Bang' is the story of a flying car written by Ian Fleming of James Bond fame"
Bottom: poster for the stage production of Ian Fleming's *Chitty Chitty Bang Bang* (featuring a description of its famous flying car)

43

Above: caption: "Harry Potter and Ron Weasley travel in a magic-powered flying car in 'Harry Potter and the Chamber of Secrets'"

44

"In the 1974 James Bond film 'The Man With the Golden Gun,' the evil title character, Francisco Scaramanga, eludes Agent 007 by attaching a jet engine, wings and tail assembly to his AMC Matador Coupe and flying away. It's Hollywood, of course. But the idea of a flying car has long gripped the imagination of a gridlocked public. 'It's always been, and will continue to be, a dream for any mechanic,' said Tyghe Trimble, the online editor of Popular Mechanics. 'People are trying to reach this Holy Grail'…"
***The New York Times*, April 11th 2009**

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47

Above: caption: "In a later James Bond film *Octopussy,* agent 007 got a flying car of his very own (with folding wings)"
Left: caption: "The Bede BD-5J 'Acrostar' Jet on the set of the James Bond classic Octopussy"

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Top: caption: "1904 – Jules Verne's Master of the World features the Terror – a boat car and air-craft that 'darts through space with speed…superior to that of the largest birds'"
Bottom: caption: "'The Jetsons,' a TV series from the 1960s, depicted the world in 2062 with flying cars and ro-bots"

50

Left: caption: "Jesse James' 'Red Baron.'" In 2006, for a stunt on his reality TV show *Monster Garage,* motorcycle-builder *Jesse James* attached wings, a tail and a Ford V-8 engine to a *Panoz Esperante*. Then, he took his creation to an airstrip near Kitty Hawk, NC, where the Wright Bros. first flew. On his first flight, James was able to get the 305-hp powered Esperante air-borne at 80 mph and flew the car for three seconds (airborne for about 350-feet).

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"It's like trying to mate a pig and an elephant. You don't get a very good elephant, or a very good pig."
***Lionel Salisbury*, Editor of the *Roadable Times* (2008)**

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Part 2

Learning to Fly

54

In the Beginning

55

The 1841 *Henson Aerial Steam Carriage* (left). *William Samuel Henson* and *John Stringfellow* patented this flying car in 1841. The duo were never able to build a functioning version of their monoplane, which had a theoretical wingspan of 150-feet.

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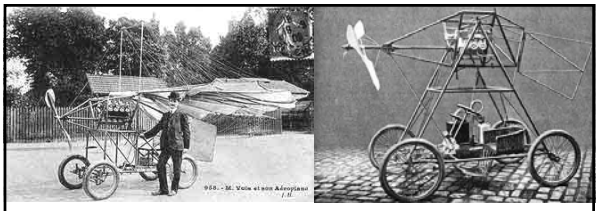

Left: caption: "1906 - Trajan Vuia tests flying auto near Paris, France." There is some ambiguities as to whether *Trajan Vuia* of Romania was the first person to build a "flying car." The "Vuia 1" (right) was completed in December 1905 and the inventor set out to test his machine. On the *Montesson Plain* (near Paris) he conducted his first trials, using only the sub-frame (without mounting the wings). After he became comfortable operating the sub-frame, Vuia added the wings. He decided to make his first flight on March 18th 1906. At three o'clock in the afternoon, he started the engine and let it warm up for about five minutes. He accelerated for about 50-meters after which *Vuia 1* left the ground and flew to a height of about three-feet (for +/-40-feet across the ground). In the early days of both cars (a/k/a "Horseless Carriages") and planes, there were no restrictions on the design/construction of either type (as there is today). But even for 1906, a propeller-driven motor car that could also fly (sort of) was quite a novelty.

57

Left: an account of Tajan Vuia's first flight appeared on the front page of the *New York Herald*. Vuia's aircraft is considered by some to be the first attempt to build a "roadable aircraft" (a/k/a "flying car"). On March 3rd 1906, Vuia made a brief hop (39-feet or 12-meters) in the world's first tractor monoplane. However, the aircraft was not a success, but it did start an important aircraft design trend. On August 12th 1906, Vuia tried once again to fly his tractor monoplane. The last attempted flight ended with a crash (on August 19th 1906).

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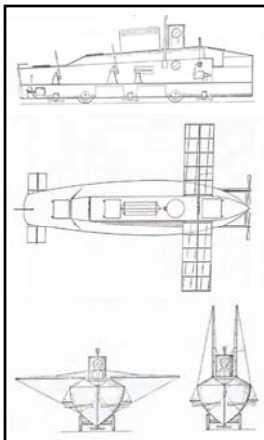

Left (top-to-bottom): it was an aircraft, road vehicle and gunboat combined. It had the very latest in radio antennas. It had air-screws and retractable wings on the front for flight. It had propellers on the underside (for added lift). It had one rudder (to be used for both flying and sailing) and a propeller at the stern for propulsion (when waterborne). Four wheels provided motion on the ground and three cannons protected it from enemies (top). The unusual design by *Felix Longobardi* even got patent protection (on December 3rd 1918). While it might have been buoyant on the water, it would have been lumbering on land and it certainly never would have taken flight. Even so, the 1918 design, a product no doubt of the exigencies of war, was bold in its vision and ambition.

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A Few Short Hops

60

"Now if we can just take off the wings and drive this thing down the road, we'd really have something!"
Glenn Hammond Curtiss, **Aviation Pioneer**
Left: caption: "Glenn H. Curtiss was a noted motorcycle builder and racer, who built and produced engines for aircraft as early as 1906"

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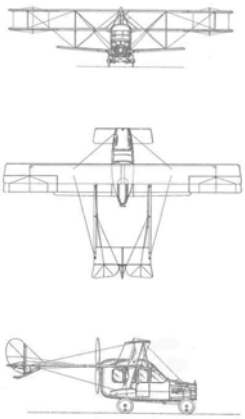

"…In 1917, the pioneering aviator Glenn Curtiss built what is widely considered the first serious attempt at a flying car. Unfortunately his huge, three-winged Autoplane didn't do much more than hop…"
***The New York Times*, April 11th 2009**
Above: caption: "Here is a practical automobile that is also an aeroplane. It has an aluminum body, heater and plastic windows."
Left (top-to-bottom): front, plan and side view/s of the Curtiss Autoplane

62

Above: caption: "Curtiss built this autoplane for the 'flying commuter' before the war. Today he predicts we'll fly to work in 'flying motorcycles', having folding wings and rollers for wheels."
Left T&B: caption: "Curtiss Autoplane (Model 11) 1917; 100hp Curtiss OXX-3 pusher; span: (upper) 40'-6" (lower) 23'-4" length: 27'-0" load: 710 lbs. Aluminum-bodied hybrid car-plane with twin-boom tails, small canard wings on front of car. The motor under a car hood used an extended shaft and belts to drive a four-blade prop at the rear of the cab. Road speed (wings removed) was 45 mph. Never attained sustained flight, only a few short hops."

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"…The history of roadable aircraft, as their proponents call them, is littered with frustrated - ambitions. Glenn Curtiss' failed 1917 Autoplane, which was supposed to usher in an era of ubiquitous flying-car ownership, was the first of many disappointments. Over the decades, dozens of companies have drawn blueprints, built prototypes and solicited investor money, and ended up with almost nothing to show for their efforts…"
***Popular Mechanics*, January 2011**

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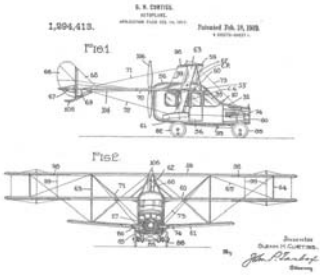

Legendary aviator *Glenn Curtiss* (rival of the *Wright Brothers* and a founder of the U.S. aircraft industry) could also be considered to be the "Father of Flying Cars." In 1917, he unveiled the *Model 11 Curtiss Autoplane* at NYC's 1917 *Pan-American Aeronautic Exposition*. Widely considered the first of its kind, the aluminum Autoplane had a Model T-like body, four wheels, a 40-foot wingspan and a giant 4-bladed pusher propeller. Although the Autoplane only managed "a few short hops," people lauded Curtiss' "aerial limousine" as the forerunner for personal vehicles to come.

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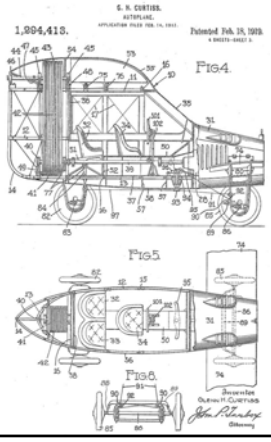

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A Knack for Invention

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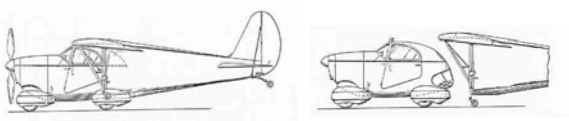


"…Subsequent inventors of flying cars - or, in the parlance of the trade, 'roadable aircraft' - haven't fared much better. In 1949, the prolific inventor Robert E. Fulton Jr. built the Airphibian, which he once drove and flew from Connecticut to attend 'Kiss Me, Kate' on Broadway…"

***The New York Times*, April 11th 2009**

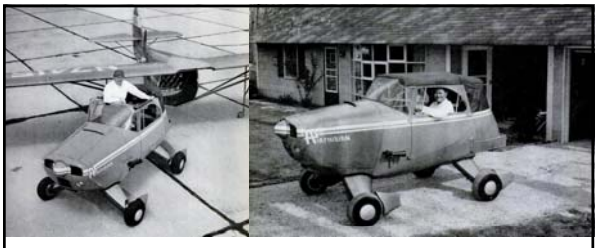
RE: while developing his *Airphibian* (above L&R), American inventor *Robert E. Fulton* took a different route than his peers. Instead of altering an automobile for flight, he adapted an airplane for the road. Fulton's idea for a flying car came from his frustration at having to find ground transportation after landing at an airport. He concluded it would be much more convenient to land wherever you wanted to and proceed to your destination after a simple one-man, five-minute effort at detaching the wings.

69

70

From 1945 to 1952, without any training or experience designing aircraft (he used information extracted from an *Aeronautics for Pilots* pamphlet), architect and inventor *Robert Edison Fulton, Jr.* conceived, designed, built, tested and logged more than 100K miles in his dream machine; the *Airphibian.* Fulton claimed it only took one person to remove and/or attach the modular wing and tail assembly. The concept won conditional approval from the forerunner of the *Federal Aviation Administration* (FAA) - the *Civil Aviation Administration* (CAA), and the *Airphibian* flew successfully. However, it never attracted investors and a production version was never built. The prototype was first flown on November 7th 1946 (even *Charles Lindbergh* piloted the prototype). By 1954, the *Continental Company* (which Fulton had formed in 1945 to produce the Airphibian) went bust. The Airphibian retains the distinction of being the first "flying car" to be certified (in 1950) by the federal government.

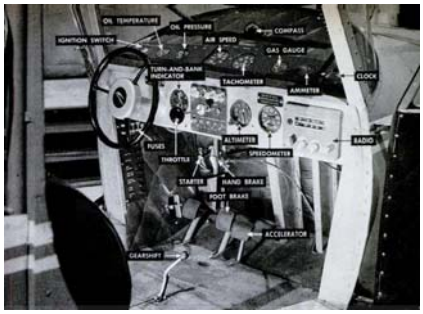
71



Left: caption: "Detached fuselage is left standing on its outriggers and tail wheel, and car is ready to roll on highway. Fabric top is buttoned to top of the windshield for driving in wet weather."

Right: caption: "Just leave the wings at the airport and drive the Airphibian home"

72



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Without Soiling Her Gloves

77

"…In the past, roadable plane designs have been most limited by the challenge of merging two technologies into one craft. Nowhere else do car transmissions and airplane propellers operate on the same engine. The Aerocar, designed by Moulton Taylor, was one of the more successful marriages of these different technologies. The Civilian Aeronautics Association, the predecessor of the FAA, approved this two-seater vehicle with a top speed of 110 miles per hour in the air in 1956 for use by private pilots. After a flight, the pilot could manually fold back the wings against the body, or trailer them behind the car…"

***Popular Mechanics,* July 2010**

78

"With its wings folded back against the fuselage, his flying auto is ready to cruise down the highway at 50 miles an hour. According to its Longview, Calif., designer, the airship can be converted to the auto 'even by a woman, without soiling her gloves.'"

***Yuma Daily Sun* (Yuma, AZ), April 25th 1950**

79

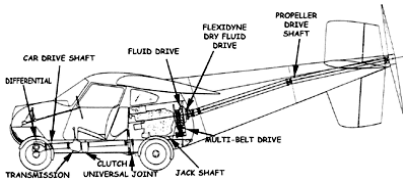
"…In 1956, Moulton Taylor, an aeronautical engineer, came up with the Aerocar, one of which was used by the television and film actor Bob Cummings. But neither the Airphibian nor Aerocar ever went into mass production…"

***The New York Times*, April 11th 2009**

RE: in 1949, *Moulton B. Taylor* created the first *AEROCAR*. His company was *AEROCAR, Inc.* of Longview, Washington.

Left: caption: "AEROCAR is the all-purpose vehicle the traveling public has dreamed of. The powerful little coupe with its fluid drive and unencumbered by wings is ideal for driving in traffic – fast on the get-away and easy to park – a full-fledged automobile…"

80



"…Even though it was functional as both a basic car and plane, the Aerocar, like most other flying-car designs, had its mechanical shortcomings. As an aircraft it was overweight and underpowered, and as a car it could not compete with the powerful American-made cars of the day. 'Yes, it flew, but it didn't have the range, it didn't have the altitude, it didn't have some of the amenities that a normal airplane would have - so it kind of was a drawback,' says Alan Westby, director of the AirVenture museum in Wisconsin…"

***Popular Mechanics*, July 2010**

Above: caption: "Aerocar Details"

81

"…Taylor, whose previous work included developing the first cruise missile, thought his Aerocar would bring aviation to the masses. 'He was absolutely fascinated with creating roadable planes, the everyman kind of vehicle,' Westby says. The ideal candidate for a flying car is very wealthy, has a pilot's license and has access to a runway - hardly a description of the everyman. Despite generating lots of attention, Taylor could not collect enough down payments, and the project's investors dropped out. Only four prototype models were ever built…"

***Popular Mechanics*, July 2010**

Left: cover of *Air Trails Magazine*, May 1951

82

83

"…In the 1970s, a persistent Taylor attempted to market a third version of the Aerocar, (he built a second version, but it was not designed for road travel) which Frank A. Tinker, a writer for Popular Mechanics, found surprisingly stable in the sky. But even with improved mechanics and retractable wheels, this model also never made it to market…"

***Popular Mechanics*, July 2010**

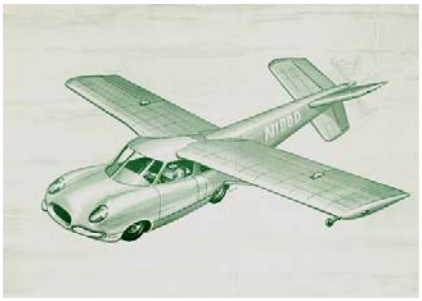
RE: PM first featured a concept of the roadable airplane in 1942, calling the idea "Ten years ahead of it time" and speculated that post-WWII transportation would rely on the concept

Above: caption: "Aerocar Model III"

84

"It's a particularly difficult road to not only meet all the aircraft regulations, but to also meet the current automotive regulations"
Jake Schultz, **Author**
RE: the Aerocar III's failure was not mainly due to engineering issues but, rather, increasing government safety standards that kept it firmly on the ground. By 1972, automotive safety regulations were becoming more stringent; cars had to comply with bumper, side impact and crumple zone requirements while airplanes had their own safety requirement issues to deal with. To satisfy both would have resulted in an aircraft that was simply too heavy. The *Aerocar III* would never be more than an experimental aircraft and *Moulton Taylor* would put to rest his dream of a roadable aircraft.

85



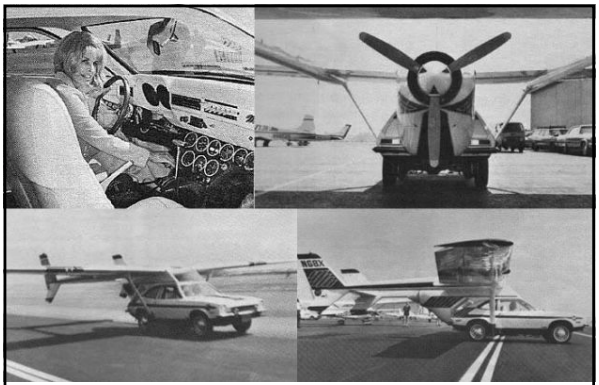
86

The Flying Pinto

87

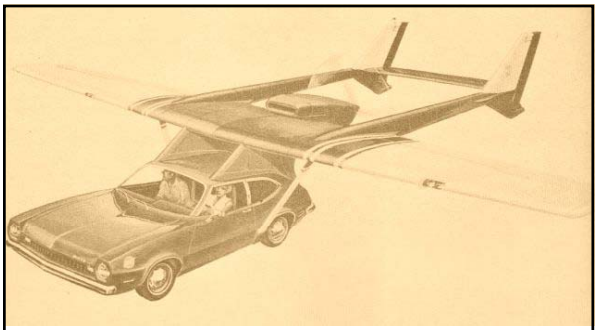
"…In 1973, Henry Smolinski fashioned the AVE Mizar from a Cessna Skymaster and a Ford Pinto (yes, a Pinto). The hybrid came apart in midair, killing Smolinski and his pilot, Harold Blake…"
The New York Times, **April 11th 2009**
Above: caption: "An experimental car-plane hybrid – half Ford Pinto and half Cessna Skymaster – lifted off the runway at the airport at Oxnard, Calif., in a secret test flight. It reached an altitude of 120 feet in initial tests, then made an unscheduled landing in a field 1½ miles away because of a propeller problem. Charles Janisse, the test pilot, drove the undamaged craft back to the airport on a road cleared of conventional automobile traffic."

88



Above: caption: "The AVE Mizar, a roadable airplane. The prototype Mizar has a 210 Continental, but future models will run up to a 300-hp Lycoming. The Pinto's dash has altimeter, airspeed indicator and other flight instruments.

89



Above: caption: "Artist's rendering shows what an Advanced Vehicle Engineers' Aircar will look like when airborne. Modified production Ford Pinto is utilized with an airframe and engine of a Cessna, which is detachable in minutes so car may be used on highways." The *Mizar* was intended for production and was expected to sell for less than $19K. Unlike earlier roadable aircraft designs, it had no provision for towing the wing/tail/engine module on the road.

90

91

"Alas, sometime late in 1973, Msrs. Smolinski and Blake climbed aboard the 'Mizar' and rolled down the runway. During the takeoff, the peculiar marriage of wheels and wings divorced, and the Advanced Vehicle Engineers found themselves sailing through the California sky in a very un-advanced vehicle, a wingless Pinto. With the death of the two principal developers, the Mizar project dissolved."
Bill Higgins
Left: caption: "Blazing crash killed the two men who developed the land-air vehicle. The prototype plunged to earth about a mile from Ventura County Airport late Tuesday afternoon. Killed were Henry A. Smolinski, 40, Santa Susana, and Harold Blake, 40, Los Angeles. They were the founders and top two officers of Advanced Vehicle Engineers, launched at Van Nuys in 1968."

92

Above: caption: "Vespa 400 Flying Car (1973-1977)." *Robert Lebouder* produced an auto-plane prototype called the *Vespa 400*. Very similar to the *AVE Mizar*, the Vespa 400 connected to the plane just as the *Ford Pinto* integrated into the AVE Mizar. The Vespa 400 completed several demonstration flights until an emergency landing damaged its wings.

93

Basic Physics

94

"…Why have so many talented dreamers failed to make the flying car a reality? The answer: physics. Cars and airplanes operate in very different environments, so building a car that doubles as an airplane results in an inferior version of both. The challenges are so intractable that flying cars have become a cultural punch line, a metaphor for technological promises that never come true…"
***Popular Mechanics*, January 2011**

95

"…cars have an aerodynamic that makes them hug the ground, whereas an aircraft is designed to do just the opposite. And cars need even weight distribution on all four wheels, while an aircraft has 90 percent of its weight on the back wheels."
***John Brown*, Chief Editor of *Roadable Times* (2009)**

96

"To get the flying car that we envision requires that human beings not pilot the vehicles themselves. A flying car that works on a large scale has to be autonomous to some degree because humans can't pilot in general. We're lousy drivers on the ground. When you add another dimension to that and take away the road, that makes things even more difficult. Long after we have the technology, we still won't have flying cars because we'll still have to figure out who's responsible when the thing wrecks."

Daniel Wilson,* Author of *Where's My Jetpack? A Guide to the Amazing Science Fiction Future That Never Arrived

97

"It's just basic physics. Any vehicle that takes off and lands vertically is unstable…I truly believe we could have a practical flying car within five years"

***Rob Bulaga,* President of *Trek Aerospace* of Folsom, CA**

RE: Trek is adapting a "Personal Aerial Vehicle" (PAV) concept originally developed for DARPA (*Defense Advanced Research Project Agency*) to create a civilian vehicle. The two-seater *Tyrannos* (above L&R) has ducted propellers powered by gasoline engines (with a battery backup). Although its been possible to make such vehicles for decades, they are notoriously difficult to fly. To make it practical, computers are needed to make the constant adjustments required to achieve stable flight. Without them, even just hovering is like "trying to stand on a beachball" (according to Bulaga).

98

99

Come Together

100

"With a car there's a one-to-one relationship between how much you turn the wheel and how much the vehicle turns. In an aircraft if you make an input on the stick or yoke, the flight path changes in all three directions…automation interprets the inputs from the stick at a behavioral level. That's the long-term vision."

***Ken Goodrich,* Research Engineer at NASA's *Langley Research Center* in Hampton, VA**

RE: NASA has been working on creating control systems for aircraft that are designed to make flying easier and safer. Essentially, this means getting the plane to fly itself (with some higher-level guidance from the pilot). The aim of the project is to enable a greater number of people to become pilots. In Europe, a similar project was launched in 2011 called "myCopter" (the aim of which is to develop semi-autonomous aircraft for general use). With the FAA loosening its regulatory grip and with the cost and reliability of sensors and control systems improving, it appears all the necessary components for a flying car are - at long last, coming together.

101

Part 3

The Challenge

102

Well Known in the Art

103

"…Roadable aircraft are well known in the art. The flying car or roadable aircraft may be defined as a vehicle, which may legally travel on roads and can take off, fly, and land as an aircraft. In practice, the vehicle usually has to be converted from a standard fixed-wing aircraft to one with sufficient roadworthiness. However, in the long history of roadable aircraft, there has yet to be one design, which has met with any significant commercial success or adaptation…"

Re: excerpt from a ca. 2009 U.S. Patent application for a "Roadable Aircraft"

104

Apples and Oranges

105

"…These types of vehicles present a number of challenges for designers. Ideally, the car-plane combinations would not be expensive and would not require the skills of a trained pilot to fly. 'When you try to combine them you get the worst of both worlds: a very heavy, slow, expensive vehicle that's hard to use,' said Mark Moore, head of the Personal Air Vehicle (PAV) division of the vehicle systems program at Nasa's Langley Research Center..."

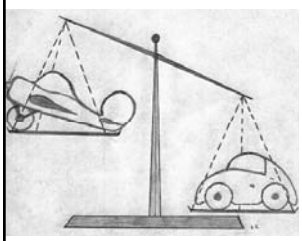
***BBC News*, September 22nd 2004**

106

"…'There have been 104 flying cars,' said John Brown, chief editor of the website Roadable Times, 'and none have been practical.' Mr. Brown, who has identified 26 distinct technical hurdles, ticked off a few of them. 'Cars and airplanes have completely different types of engines'…"

***The New York Times*, April 11th 2009**

107



Left: caption: "The first challenge in designing a roadable aircraft is to establish a satisfactory weight for the machine. An airplane must be as light as possible whereas an automobile may be as heavy as necessary. In fact, the heavier it is, the better it holds the road."

108

The next challenge is to establish the ***C**enter-of-**G**ravity* (CG) for the vehicle. It's sometimes necessary to find a way to shift the CG, when changing from flight-mode to car-mode, and vice-versa. Basic engineering for the automobile calls for a CG (and the driver) to be located half-way between the front and rear wheels (for the most comfortable ride). Locating the CG in an airplane is done for different reasons. It's usually slightly ahead of the ***C**enter-of-**L**ift* (CL). The reason being that in a power-off situation, the craft will gently nose down and keep flying (if it were behind the CL, the aircraft would nose up and eventually stall). It's usual to place the pilot at the CG also because the weight of the pilot is a variable. When located at the CG, he/she may be light or heavy and still be accommodated with a minimum of trim adjustment. The CG must also be slightly ahead of the main gear (on a tricycle landing gear arrangement) to keep the tail of the aircraft from tipping over when parked. As well, the CG may not be too far ahead of the main gear. If it is, the aircraft will not rotate for take-off. Thus, there are some basic incompatibilities that must be dealt with in the design of roadable aircraft.

109

Dimensions of the vehicle must also be considered carefully. The automobile has limitations on size depending, firstly, on an allowable road width of 8-feet. After that, size depends on whether it's target market (i.e. luxury, economy etc.). The wing span typically takes up most of the width of an aircraft, however, it's possible to build an aircraft with no wings at all. Such an aircraft could be built using vectored thrust, ducted fans and/or rotors (a/k/a "**V**ertical **T**ake-**O**ff and **L**anding" or VTOL). If a wing is desired, it's possible to build one with a span of only eight-feet to accommodate the width limitation imposed on road vehicles. However, performance may be affected in a variety of ways. The span can be increased by using folding or telescoping wings that may be extended or by using attachable wings. There are advantages and disadvantages to all of these configurations.

110

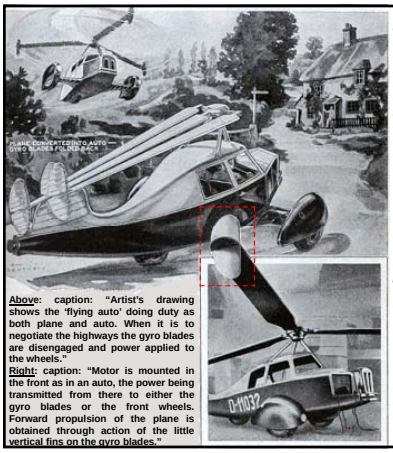
Drivable Gyro

111

Above: caption: "The 1923 Pitcairn PCA-2." In many respects, the ***Autogyro*** is the true predecessor of flying cars. Harold Pitcairn's PCA-2 was the first rotary-wing aircraft to achieve type certification in the U.S. and was mass marketed. In one memorable promotional stunt in 1931, pilot ***Jim Ray*** famously landed and took-off from both the White House lawn and from a parking lot in front of the Capitol Building in Washington D.C.

112

113



Above: caption: "Artist's drawing shows the 'flying auto' doing duty as both plane and auto. When it is to negotiate the highways the gyro blades are disengaged and power applied to the wheels."

Right: caption: "Motor is mounted in the front as in an auto, the power being transmitted from there to either the gyro blades or the front wheels. Forward propulsion of the plane is obtained through action of the little vertical fins on the gyro blades."

"The 'flying auto,' a combination airplane and automobile which negotiates roads and air lanes with equal facility, has at last appeared in the aeronautical world. Designed by two German engineers, the craft is a development of the autogyro. A great advantage, however, is that no propeller for the drive in the direction of flight is necessary. The little vertical fins on the gyro blades give the necessary force to drive the car forward in the air. When the craft is to be made ready for a trip along the highways the gyro blades are folded back as illustrated in the artist's drawing. On the road the motor, which is located in the front as an accompanying photo shows, drives the wheels like a regular auto, the steering, however, being done by the rear wheel. Streamlining principles are applied as in a plane, which makes for maximum speed. The 'flying auto' was exhibited at the Berlin airplane show. Some difficulty has been encountered in mounting the engine, so that it is not likely that the plane will soon come into use."
Modern Mechanix, January 1933

114

"Unusual Craft Has No Wings and Vanes Fold So it Can Be Stored in a One-Car Garage. One overhead handle in the cabin of the latest type of autogiro, now being successfully tested and flown at Willow Grove, Pa., enables the pilot to steer up, down, or sideways and to bank the craft simply by tilting the windmill-like rotor. The experimental model carries a horizontal rudder, but tests indicate that this may be superfluous. There are no ailerons or elevators, and the stub wing usually present in this type of craft is missing. Because of the simplicity of control, the new craft is expected to be especially suited to the novice pilot and is soon to be marketed. Other striking innovations are embodied in the new machine. A clutch disconnects the motor from the propeller and transfers the power to a tail wheel, steered from the cabin, so that the plane can run out of its hangar under its own power. The vanes fold out of the way when the plane is stored so it occupies no more space than an auto. It has a top speed of 105 miles an hour."
Popular Science, October 1933 115
Above: caption: "The newest autogiro, as illustration shows, is steered by tilting vanes and runs on ground with power transferred to wheels. Inset illustrations show height of autogiro to be that of a man and its width that of a car."

"The wing-less autogiro and the invention of a combined land and air drive makes the dream of the flying auto come true. Flying automobiles are within reach of the public today as a result of a dual drive for land or air invented by Edward A. Stalker, of Ann Arbor, Mich. His gear drive in-cludes a simple clutch which engages a wheel to drive the car on land or a propeller to push the ve-hicle through the air…"
Modern Mechanix, July 1935 116

"…Based on this invention, the giro-automobile was designed. In appearance it resembles the modern streamlined, rear engine automobile. No wings are necessary as autogiro blades would provide the necessary lift. The U.S. Bureau of Air Commerce has ordered the Pitcairn Autogiro Company to design an autogiro airplane-automobile for amateur fliers, which with its rotor blades folded back and its engine geared to the wheels that can be driven on a highway like a motor car."
Modern Mechanix, July 1935

Inset (Lower Right): caption: "Drive wheel A in diagram would propel flying automobile on land. To takeoff giro blades are started spinning and drive wheel runs the car for short distance needed for autogiro takeoff. In flight, wheel would drop, engaging shaft C which drives propeller for forward flight."

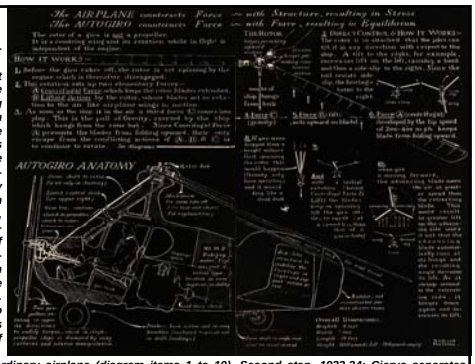
117
Above: caption: "Photos show latest Pitcairn autogiro"

"…after sixteen years the autogiro has only now become an auto-giro…"
Fortune magazine, March 1936
RE: the "roadable" autogiro had been a *Pitcairn Aviation* project for the *Bureau of Air Commerce* under the leadership of *Eugene Vidal*. Pitcairn's chief test pilot *Jim Ray* had previously delivered the *Pitcairn AC-35* to the federal government by landing it in a Washington D.C. park, folding its blades back, and driving it through the streets (above). The roadable autogiro did receive media attention, appearing in several publications (left), but failed to excite the public-at-large who saw it as a novelty rather than a practical conveyance. 118

Convenient for the Absent-Minded

119

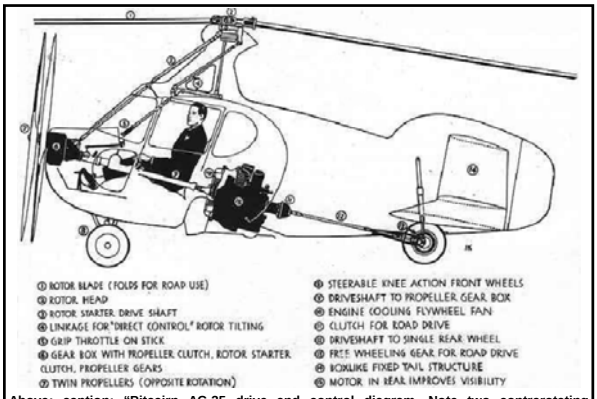
"YOU CANNOT DO THIS YET…and it may be many a day before you can. But the reborn autogiro, described in the accompanying text, is designed to make possible the commuter's itinerary pictured around these two pages. The new two-passenger ship, to be demonstrated this spring, will weigh 750 pounds empty and be narrow enough of beam, when rotor blades are folded back over the tail, to be stowed in an ordinary garage and not to be a road hog on the highways. It will have a top speed in the air of 110 miles per hour, twenty five on wheels. The 'roadable' mechanism consists of a small transmission and a shaft to the rear wheel from the engine, which is mounted inside the cabin, abaft the seats. A clutch disengages the propeller for road touring. The front wheels are steerable, operated by the rudder pedals. The pilot will use the same motions for steering on the ground as in the air, which should be convenient for the absent-minded." 120
RE: excerpt (highlighted) from a 1936 advertisement for the *Pitcairn AC-35* "Roadable" hybrid Autogiro (continued…)



"ANATOMY OF AUTOROTATION…
In the diagram at right are set forth the principles underlying why and how an autogiro flies…The reborn autogiro is the product of three steps in development, each sharply mile-marked by an invention. First step, 1920-23: Cierva separates the speed of the mechanical lifting surfaces from the speed of the machine as a whole. That is, the ability to maintain flight was made independent of high forward speed, life's breath to an ordinary airplane (diagram items 1 to 10). Second step, 1932-34: Cierva separates control – steering, banking, climbing, gliding – from forward speed. Control is wedded to lift, and lift is constant at all speeds (item 7). Third step, 1934-35: Cierva achieves direct take-off by storing up surplus energy in the rotor by overspeeding it on the ground. To the ability to take off with no forward run."

121

RE: excerpt (continued) from a 1936 advertisement for the *Pitcairn AC-35* "Roadable" hybrid Autogiro



Above: caption: "Pitcairn AC-35 drive and control diagram. Note two contrarotating propellers. The dual propeller feature was abandoned in favor of a large single propeller because a report says, 'Propellers set up a howel that could shatter glass.'"

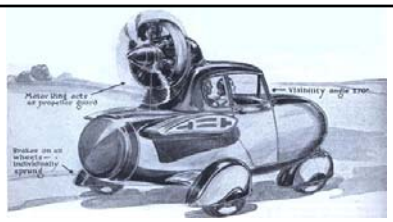
122

123

124

The Ascender

125



"A startling new vehicle which may be used in the air as a fast, sturdy airplane, and on the ground as a speedy, comfortable two-passenger coupe car, will shortly be available to aviation enthusiasts. The craft is really a streamlined mid-wing monoplane of 30-foot wing span, propelled by a 125-horsepower air cooled motor of regulation aircraft type. For ground use the ship may be quickly converted into a streamline car, simply by removing the wings and the rear end of the fuselage, leaving the closed cabin body resting on its three wheels, ready to drive through the streets. This transformation occupies about 20 minutes, by means of quickly detachable joints…"

***Modern Mechanix and Inventions*, April 1933**

Above: caption: "The airplane is made ready for street use in 20 minutes by removing the wings and tail unit, easily detachable. Note the location of motor where it serves equally well for ground or air use. Angle of visibility is exceptionally broad."

126

"…The development of the 'Ascender,' as the new ship is called, has taken many months of painstaking work in the selfsame Engineering Department which produced the fastest airplane in the world, Doolittle's 'Flying Silo' which set a new world's record of 290 m.p.h. at the Cleveland air races last fall…"
***Modern Mechanix and Inventions,* April 1933**
Above: caption: "The convertible airplane-auto has been designed by the makers of this famous Gee-Bee type sport-plane which won the Cleveland air races last summer at 296 mph"

127

128

"…The first Ascender has already been built and flown enough to prove itself a most unusual craft both in the air and on the ground. Control of this craft, in the air and on the ground, is by an automobile type steering wheel, a foot accelerator, and hand and foot operated brakes which act on all three wheels. While on the ground the ship rests on a three wheel landing gear, each wheel of which is equipped with internal brake and hydraulic shock absorber, as well as a large airwheel tire. The front wheel is steerable with the rudder of the ship, so that when the pilot moves the steering wheel to right or left, either on the ground or in the air, he guides the direction of his craft as he would a motor car…"
***Modern Mechanix and Inventions,* April 1933**

129

"…On the takeoff there is no necessity of getting the tail up and balancing on two wheels while steering the ship down the runway by means of a rudder bar, as one is obliged to do in piloting the ordinary airplane. In this new craft, one merely sits behind the wheel, opens the throttle, and drives the ship down the field or runway as one would a car, with no possibility of 'nosing over' even if brakes are applied suddenly, or from obstructions such as bumps, ditches, or soft spots. When sufficient speed has been attained the driver has merely to pull the wheel slightly toward him, whereupon the front wheel leaves the ground and the ship 'takes the air'…"
***Modern Mechanix and Inventions,* April 1933**

130

"…Landing the Ascender is a simpler task than in the ordinary airplane. It is no longer necessary for the pilot to judge his speed and distance so that the ship will stop flying directly over the spot in the field where he wishes to land. With this craft, he need merely throttle the engine, point the nose down until the ship assumes a normal glide toward the field and set the ship onto the ground at a speed much greater than is safely possible in the ordinary airplane. As soon as the two rear wheels touch the ground, the front one is forced down, and brakes may be immediately applied to bring the ship to a smooth stop."
***Modern Mechanix and Inventions,* April 1933**

131

The design described in this 1933 article has several undesirable features. The positioning of the engine at the top-rear of the cabin would result in a high center-of-gravity (which, in combination with the tricycle wheel layout, would make for difficult handling on the road). The placement of the engine immediately behind and above the heads of the occupants would also make for an uncomfortably noisy cabin. Aside from this, the small diameter propeller which, presumably, would be directly coupled to the crankshaft and was positioned with much of the propeller blocked-off by the cabin, would not be very efficient. As well, unless a reversible pitch propeller was used (unlikely given the time period) there would be no way of backing up. Another concern is the bolting-on of the wings properly.
Left: caption: "Two views of the 'Ascender,' showing appearance in flight and method of converting into an automobile. On the ground, a wire screen is usually employed around the propeller as a safe-guard, though the arc of the blade is well within the confines of the car."

132

Another challenge is the control system of the vehicle, which are significantly different in automobiles and aircraft. Aircraft are controlled in three axes: ***roll***, ***pitch*** and ***yaw.*** The most common control system to manage these requirements is a wheel on a yoke. The wheel is rotated to the right or left to control roll about the axis through the length of the aircraft. The pilot pulls or pushes on the yoke to control pitch, thus a push forward moves the nose down, a pull back pitches the nose up. Yaw, which is movement to the left or right, is controlled by the rudder pedals. However, in normal flight an aircraft is turned by using inputs in all three axes. Usually, it's gently rolled to the left or right, causing induced yaw. The rudder pedals are then used to coordinate the turn. In addition, the pilot may pull back on the yoke to keep the nose up. In a sharp turn, the pilot may add a fourth element of control by adding power (to compensate for the loss of lift when an aircraft is rolled sharply).

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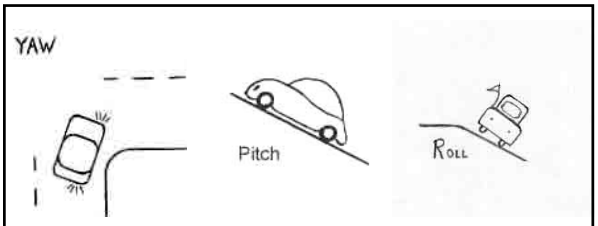


The only directional change available in an automobile is ***yaw*** (left), which is achieved by turning the steering wheel. ***Pitch*** (middle) may be induced by driving up or down a hill. ***Roll*** (right) may be induced by driving the car along the side of a ditch. Since a dual purpose land-air vehicle must have all of the capabilities required by both a car and an airplane, it's desirable to achieve this without having the cabin cluttered with too many controls (i.e. gas pedal, brake pedal, rudder pedals, parking brake pedal).

134

It's conceivable to steer a car with a joy stick, thus simplifying the design of a roadable aircraft. However, most people would be uncomfortable without the familiar steering wheel. For them, this design would be totally unacceptable. A similar problem could arise in the combining of the control systems of a car and a plane. It's also conceivable to use the steering wheel as a method of yaw control while in flight. This would eliminate the rudder pedals and would eliminate "control clutter" on the floor boards. Roll and Pitch control could be handled in another way (i.e. joy stick) and, technically, this could be easily achieved. Engine power could be controlled by the gas pedal. However, licensed pilots flying today's general aviation aircraft ordinarily use the wheel of an aircraft for roll control - they do not use a wheel for yaw control. Drastic changes in the established, familiar control systems presently in place could be disorienting and dangerous. After all, it's the trained pilot who, initially at least, will be the prime market for any new roadable aircraft design.

135

Another concern in designing dual-purpose transportation is how the vehicle is likely to be used. The average use of a privately owned, general aviation aircraft is somewhere in the neighborhood of fifty hours per year. It's not uncommon for the same pilot to use his automobile fifty hours per month and in some cases he/she will use it fifty hours per week. As such, a truly practical roadable aircraft must be as comfortable to fly as it is to drive.

136

Airplane vs. Automobile

137

"Now that the airplane has taken its place along with the automobile as an accepted means of transportation, it is not amiss to see just what we can expect from it in so far as service is concerned. This month, U.S. Army Air Corps Major H.H. Arnold compares the privately owned sport plane with the automobile as a means of long distance transportation for pleasure and business. No comparison has been made on short trips, where, of course, the auto is supreme…"
Modern Mechanics and Inventions, **April 1931**
Above L&R: to win a bet concerning which was the fastest way to deliver a message; airplanes or messenger pigeons, in 1922 *Major H.H. Arnold* raced carrier pigeons 650 miles from Portland, OR, to San Francisco, CA, in a *De-Havilland DH-4* (right) – the standard *U.S. Army Air Service* airplane, at the time

138

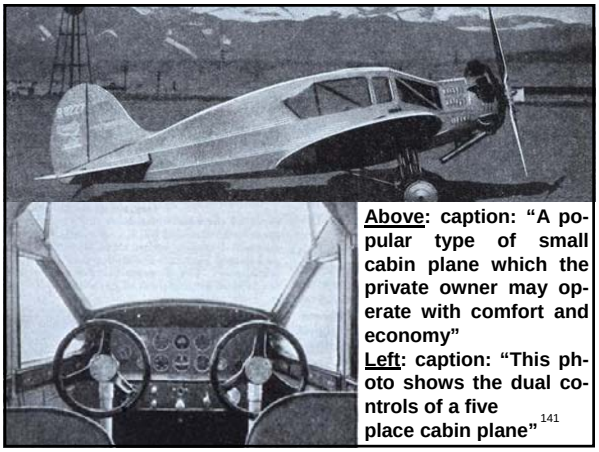
"It's got to be done and done quickly, so let's get it done"
H.H. Arnold

RE: known for his genial disposition and his no-nonsense pragmatic organization and management skills *Henry Harley* ("Hap") *Arnold* was born in Gladwyn, Pennsylvania on June 25th 1886. Following graduation from the *United States Military Academy* at *West Point*, he was appointed Second Lieutenant of Infantry (on June 14th 1907). In April 1911, he was detailed to the *Signal Corps*, piloting the Wright bi-plane (in fact, he was one of the first pilots taught by the Wright Brothers). In June 1912, Arnold established a new altitude record when he piloted a *Brugree-Wright* airplane to a height of 6,540-feet. He established several aeronautical records and progressed rapidly through the ranks and, on February 11th 1935, received the rank of Brigadier General. With war clouds gathering, on September 29th 1938 he was named Chief of Staff of the *U.S. Army Air Corps* (USAAC). The *U.S. Army Air Forces* (USAAF) was established in 1941 and Arnold was promoted to Major General, becoming Chief of Staff for Air and Chief of the USAAF. General Arnold retired on June 30th 1946 with the rating/s of *Command Pilot* and *Combat Observer*. His many accomplishments, of both personal and national significance, gained him the distinction of becoming the first five-star General of the *United States Air Force* (on May 7th 1949) by an act of Congress. He died on January 15th 1950

139

"…Modern airplanes have cruising speeds varying from 105 miles an hour to 175 miles an hour. The sport planes cruise along at 105 to 120 miles an hour, the high powered, semi-racing types press 200 miles an hour, and the mail planes cruise along at speeds varying from 120 to 140 miles an hour. Accordingly it is safe for us to use a cruising speed of 115 miles an hour for airplanes…"
***Modern Mechanics and Inventions,* April 1931**

140



<u>Above</u>: caption: "A popular type of small cabin plane which the private owner may operate with comfort and economy"
<u>Left</u>: caption: "This photo shows the dual controls of a five place cabin plane"

141

By Comparison

142

"…Now as to automobiles, it is seldom that a driver is found who averages better than 35 miles an hour for distance covered at the end of a day's run. Accordingly we will take 35 miles an hour for our cruising speed knowing full well that there have been automobiles make as high as 75 or 80 miles an hour on the road, also realizing that there are certain exceptional places where traffic is light, roads are good and wide and there are few towns. Under such conditions autos can and are doing much better than our 35 miles an hour average. Then, too, Hawks averaged 250 miles an hour in his dash across the continent but we will still use our 115 mile an hour average for our comparison…"
***Modern Mechanics and Inventions,* April 1931**

143

"…If an auto and a plane both start from the same point and cruise along for 6 continuous hours, the auto will have reached a point 210 miles away while the plane will have gone 690 miles. There are now so many lighted airways that it is possible for the airplane to take the air and keep traveling both day and night…"
***Modern Mechanics and Inventions,* April 1931**

144

"…Let us assume that both airplane and auto start out from Dayton, Ohio and travel west and that the auto does not stop for gas or oil or if it does the time is negligible. With our plane, however, we must stop every four hours for gas and oil. Accordingly we figure a loss of three-fourths of an hour at the end of every four hours' travel of the plane. Therefore, at the end of the twenty-four hours the auto will be at Grand Island, Neb., while the plane will have passed over San Francisco and will be 300 miles out over the Pacific…"

***Modern Mechanics and Inventions*, April 1931**

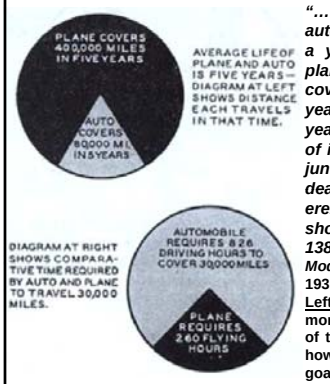
Left: caption: "This sketch compares the radius of activity of the automobile and airplane. The circles compare the area accessible to both auto and plane on typical week-end trips within a four-hour ride."

145

"…Bad weather is not the bugaboo to the airman that it used to be. Planes fly now through rain, snow and low clouds. Accordingly it is safe to assume that there are 200 flying days a year. Actually the air mail operates 350 days in practically all parts of the United States. However, as both planes and autos must go in for repairs and maintenance when they are on regular runs, let us assume that we have 200 working days a year and that we travel for 6 hours every day. At the end of the year the auto will have covered 42,000 miles and the plane 138,000 miles…

***Modern Mechanics and Inventions*, April 1931**

146



"…Now actually there are very few autos that cover such a distance in a year while there are many airplanes on regular air lines which cover as high as 150,000 miles a year. Furthermore, at the end of the year's run with 42,000 miles in back of it the auto is ready for either the junk man or the second hand dealer. With the airplane it is different. When it comes out of the shop, it will be ready for another 138,000 miles…"

***Modern Mechanics and Inventions*, April 1931**

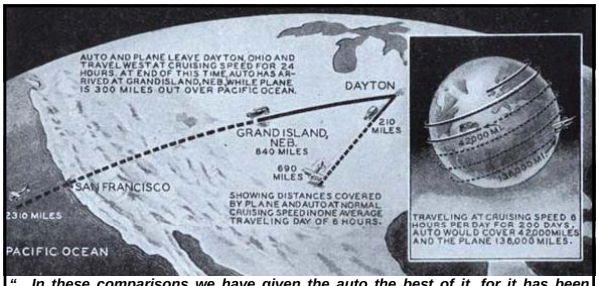
Left: caption: "In this age of hustle, more miles and less hours are the goal of travelers. These diagrams show you how the airplane helps you reach that goal."

147

"…Now compare the radius of activity of the auto against that of the plane. If Dayton is the starting point and both start out traveling for 6 hours the auto will reach a point some 60 miles south of Louisville, Ky., while the plane will have reached Mobile, Ala. For week end trips, assuming that all travel is done in four or five hours on Saturday and a similar amount for the return trip on Sunday, the autoist can reach South Bend, perhaps Chicago, Louisville, Charlestown, W. Va., Cleveland and Detroit. Compare that with the airman who can choose between such cities as Milwaukee, St. Louis, Memphis, Birmingham, Raleigh, Richmond, Washington, Philadelphia and New York…"

***Modern Mechanics and Inventions*, April 1931**

148



"…In these comparisons we have given the auto the best of it, for it has been assumed that both auto and plane travel in a straight line to their destination. Perhaps some day there will be such perfect roads but today it is seldom that a driver can arrive at his destination without covering about one-third more distance than the air line. While the plane may be held up by head winds one day, tail winds are sure to average up the flying time sooner or later…"

***Modern Mechanics and Inventions*, April 1931**

Above: caption: "This diagram gives you a graphic idea of the ground covering abilities of the airplane as compared to the automobile. The inset shows the yearly mileage to be expected from plane and auto."

149

Limitations

150

"…People long since have recognized the limitations of the auto. There are many parts of the United States where even today, all autos stay off the roads for 24 to 36 hours after a heavy rain. Few people take their cars out for pleasure during a blizzard, on icy streets, in heavy fog or when the snow is piled up several feet deep. In the same way people will ultimately learn the limitations of the airplane. They will not expect it to do the impossible…"
***Modern Mechanics and Inventions,* April 1931**

151

Time Will Come

152

"…The time will come when our airplane travel will be treated in the same matter-of-fact manner as that of the auto and train. As the days pass, the public seems to appreciate more and more the advantages that the plane has over earth bound transportation. In case of necessity the plane can travel through all kinds of weather conditions. Watch the air mail. However, just because it can is no reason for tempting fate. Even railroad trains are sometimes delayed for hours and in some cases stopped altogether by heavy snow storms."
***Modern Mechanics and Inventions,* April 1931**

153

Supply and Demand

154

Another challenge is marketability. A normal production run for an automobile is at least 200K units (it can be as high as 800K units). Development costs and tooling make high production runs essential to make the model economically viable. The market for aircraft is considerably different. For example, in 1998, some 2,200 general aviation aircraft were produced (this figure doesn't include "homebuilts," which would add several thousand worldwide). The introduction of a truly viable roadable aircraft would modify the demand for general aviation aircraft, but the degree is impossible to predict. However, it's certain that the demand for automobiles would still greatly outpace the demand for aircraft. For an auto manufacturer to be interested in producing a land-air vehicle, the erstwhile inventor must come up with some way to accommodate such an imbalance in supply/demand. However, in any proposed design, it's expected that it will be necessary for the operator to make changes of some sort to convert from flying to driving-mode and vice-versa easily and quickly, in particular if the design calls for attachable/detachable components. It's essential that they are included and available for use at any time. A pilot must be able to fly part-way to their destination then be able to continue on by road if the weather has degraded. This is not possible if something he/she needs has been left behind at an airport.

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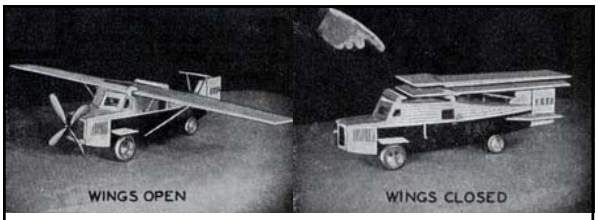
Part 4

Two Types

156

Dual Purpose

157



"There is no telling what aviation may come to. In the future we may see such contraptions as shown above flying about."
***Modern Mechanix and Inventions*, December 1930**
Above: caption: "In the future things like this may be seen romping up and down the highways and airways." Dual-purpose land-air vehicles come in two basic types: *Modular* and *Integrated.* The "Modular" type has two major components; the automobile and the air frame. Whether referred to as a "flying automobile" or a "roadable aircraft," the net result is that when the machine is used for ground transportation, the two modules come apart. The airframe is either towed behind the car or it is left at home or at the airport for use when needed.

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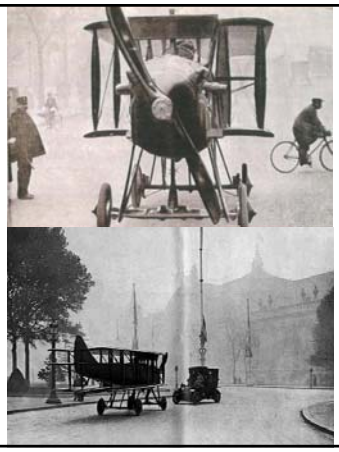
Above: caption: "1921 - The Tampier Roadable biplane lands at the Paris Air Salon and takes a 2-hour, 15-mph drive in the city. It had two engines; 12-cylinder for flight and a 4-cylinder for road travel." The wings could be removed while the fuselage rode on four wheels. *Rene Tampier* tried to market it to the concept to the French military, claiming that it could be carried on ships or driven along the road with cavalry and the removable wings meant it could be stored in a garage. With space for two, the *Tampier Roadable* featured lightweight components and the steering linkage for the wheels could be folded up for less drag during flight.

159



160

161

Left: caption: "Aircoupe Autoplane (1950)." *James W. Holland* had a similar idea to *Rene Tampier*. He removed the wings from an *Eco Ercoupe* monoplane and used it for city travel (as seen in this March 1950 photograph taken in Valdosta, Georgia). Like Tampier, Holland met with little success – on the ground and/or in the air.

162

Inspired by the early detachable-wing *Airphibian* of 1945, *Moulton Taylor* built a four-wing, four-wheel flying car in 1949. The *Aerocar* (left) was a two-seater with a body-shaped like that of a *Crosley Hotshot* (right). A single 150-hp *Lycoming* engine powered a pusher propeller that the operator removed before driving on the road (it also powered the front wheels through a conventional gearbox). The wings could be folded back in five minutes. With wings extended, the Aerocar had a wingspan of 34-feet and was 21-feet long (it had a steering wheel and a hand throttle). In 1956, the CAA certified the Aerocar as an aircraft, with a road speed of 60 mph and an airspeed of between 100 and 117 mph (depending on the engine version used). Altitude was limited to 12K-feet. When offered for sale in the mid-1950s, it sold for about $25K (restored examples have sold for +$2 million).

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164

"…The Fulton Airphibian, the first flying car to be approved by the CAA in 1950, also never sold a model, and for many of the same reasons. The vehicle, while being the first to successfully convert from a car to a plane, could only go 55 miles per hour on the road and could barely top 100 in the sky. In addition to the mechanical shortcomings, it was hard to market. It suffered from a cumbersome conversion process, and its detachable wings and propeller had to be left at the airport. Simply put, it was still more convenient to have both a car and a plane…"
Popular Mechanics, July 2010
Above: caption: "In 1946, Robert Fulton, distant relative of the steam engine inventor, developed the Airphibian"

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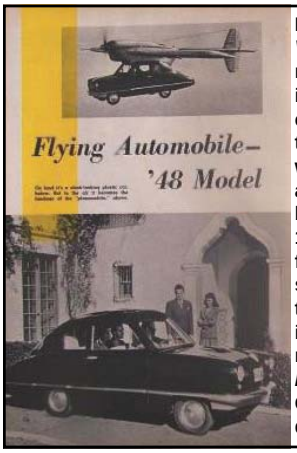
166

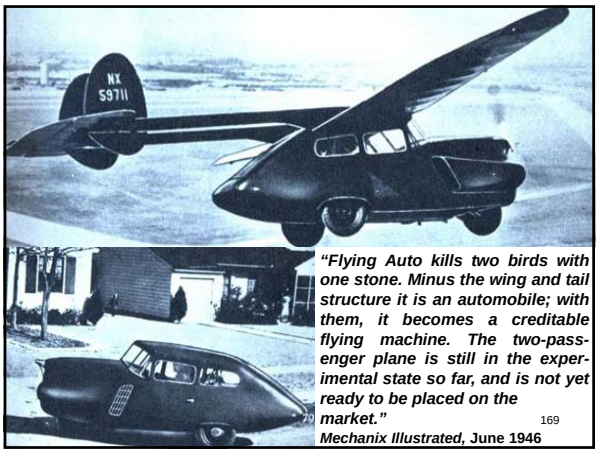
ConVairCar

167



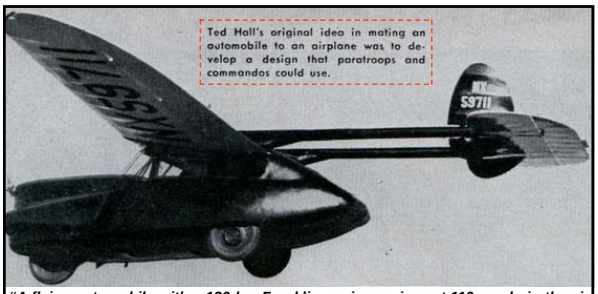
In April 1946, *Consolidated-Vultee Aircraft Corp.* (later renamed *Convair*) commissioned a flying car suitable for everyday use. The result was the *Convair Model 116*, a 3-wheeled, 2-seater with detachable monoplane wings, tail, booms and propeller. In July 1946, the Model 116 made its first flight and completed sixty-six others. Hall subsequently tweaked the Model 116 to give it a more powerful engine and refined body, resulting in the *Model 118* or *ConVairCar* (left). Convair planned to produce 160K Model 118s.

168



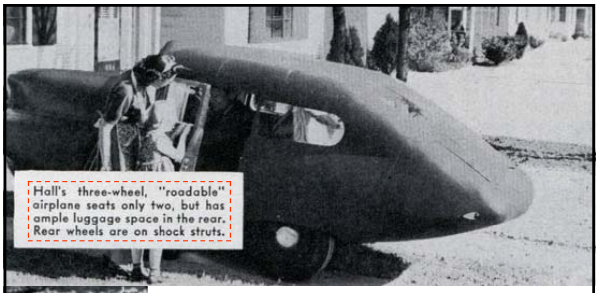
"Flying Auto kills two birds with one stone. Minus the wing and tail structure it is an automobile; with them, it becomes a creditable flying machine. The two-passenger plane is still in the experimental state so far, and is not yet ready to be placed on the market." 169

Mechanix Illustrated, June 1946



"A flying automobile with a 130-hp. Franklin engine cruises at 110 m.p.h, in the air and travels 60 m.p.h, on the road. Those speeds were set by the first model of a design by Ted Hall, aviation engineer. Portable Products Corp., Garland, Tex., is considering the possibilities of producing it. The 'roadable' plane has detachable propeller, wing, booms, and tail. The forward end of the engine crankshaft turns the prop, while a shaft extends aft from the engine into a conventional automobile transmission and differential. Power goes both to propeller and rear wheels for the take-off." 170

Popular Science, April 1946



Left: caption: "With its 30-foot wing and its tail removed, the flying auto looks pretty much like other cars on a highway. Its chassis is conventional." 171

Above & Left: caption: "Convair Model 118, or the Hall Flying Car." In 1946, *Ted Hall* and *Tommy Thompson* (of the *Consolidated-Vultee Aircraft Corporation*) designed and built the two-seat, three-wheeled *Convair Model 116.* Hall later designed the *Model 118* (two prototypes were built). 172

Serious accidents have impeded progress in the development of a successful roadable aircraft. *Theodore P. Hall* designed the *ConVairCar* - a very promising aircraft, for the *Consolidated-Vultee Aircraft Corporation*. In 1947, a one-hour long demonstration flight ended prematurely due to low fuel. An emergency landing destroyed the car and damaged the wings. Despite the fact that there was nothing wrong with the craft and nobody died, the crash generated negative publicity which was sufficient to terminate the very worthwhile effort.

Above: caption: "Convair 116 ConVairCar." The Model 118 was a re-engined development of the *Model 116*, designed by *Theodore P. Hall*. A 25.5 hp *Crosley* engine was in the rear, powering the plastic-bodied 4-seat car and a 190-hp *Lycoming O-435C* engine built on the 34.5-foot wing for flying. Pilot *Reuben Snodgrass* flew it for the first time on November 1st 1947, but the prototype crashed within three weeks due to fuel starvation. Using the same wing and another car body, it flew again on January 29th 1948, piloted by *W.G. Griswold*. Both machines used the same registration. 173

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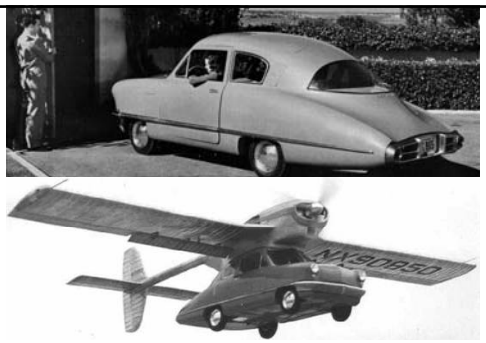
The idea behind the *ConVairCar* was to take a car with seating for four passengers and attach a wing and engine module to the roof. It had a 35-foot wingspan and an integral 190-hp *Lycoming* aircraft engine mid-span. When adapted for the road, the lightweight, fiberglass-bodied car was powered by a small 25-hp *Crosley* engine. The wing and engine module could be removed and towed behind the car.

175

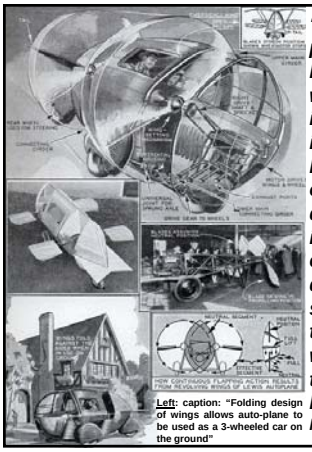


Above: caption: "Ted Hall's idea was to make separate car and flight models. Car would be sold; flight unit made available for rent at airports. Crosley engine powered fiberglass car, while 190-bhp Lycoming was used in rigid flight module. Consolidated-Vultee put $800,000 into its development."

176

Dual purpose land-air machines that are self-contained (with all the components for flight and for driving included in the one unit) have come to be known as "Integrated" vehicles (however, it may be necessary to extend or retract certain components when changing from one mode to the other). The big advantage that an integrated design has over a modular design is the fact that all the components reside in the one vehicle; there is no airframe that has to be towed around or stored somewhere - it's built into the machine. The conversion can be made from one mode to the other, preferably at the touch of a button. But the integrated design pays a price for this convenience. All the gear and mechanical devices needed to protect, extend and/or retract the integrated airframe come at a cost in added weight and complexity to the design. Not only do they add to the expense, these devices also add operating expense for the owner. Over and above that, this convenience has limitations in usage. The operator of an integrated vehicle cannot just pull off to the side of the road, spread his wings and fly away. Not only is it unlawful, it's also dangerous. To take to the air, the owner of an integrated vehicle must travel to an airport, just like the modular vehicle. Thus, the potential advantage over a modular design is substantially diminished.

177



Left: caption: "Folding design of wings allows auto-plane to be used as a 3-wheeled car on the ground"

"Built entirely without propellers as such, but deriving lift from revolving wings which spin in windmill fashion, a unique auto-airplane invented by Paul Lewis, of Denver, Col., gives promise of portending a new trend of development. Principles of its construction are explained in these photographs and drawings. One of the photos shows the lifting wings being tested in the workshop, where they developed a vertical lift of twelve pounds per horsepower."
***Modern Mechanix*, June 1933**

178

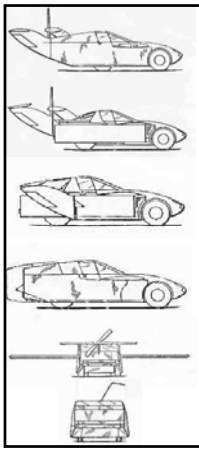
Push-Button Convertibility

179

The *AviAuto Roadable Aircraft* was a prototype flying car developed at the *Florida Institute of Technology* utilizing a spherical mechanism which resulted in significant cost and weight savings. In early designs, two planar hinges (each actuated by a stepper motor and gear head) were used to deploy and retract each wing. The AviAuto was originally conceived, designed and developed by *Harvey Miller* of Baker City, OR. His main objective was to build a roadable aircraft that could be changed from ground to flying mode at the touch of a button. To accomplish this feat, components of the airframe were designed to be stored in compartments within the body of the vehicle. Miller was awarded patent rights to his design in 1981. In 1989, he started collaborating on the development of the design with *J. Robert Smurthwaite*, also of Baker City. Their most significant change at that time was to incorporate a second engine into the vehicle. The original concept called for one engine for both flying and ground service. It was felt that to qualify for FAA certification, the use of an auto engine and front-wheel drive when on the ground (along with a certified aircraft engine for flight) would be more suitable.

Above L&R: scale model of the AviAuto with wings and tail retracted (left) and extended (right)

180



Left: caption: "This is a side view of the AviAuto in flying mode configuration. The wings and tail booms are extended. The rear axle of the vehicle has been moved forward to place the center of gravity in a more favorable position for take-off rotation."

Left: caption: "The pilot pushes a button to initiate conversion to ground mode. The first action is the shifting of the rear axle to the aft position. The wings rotate and fold back along the sides of the body.

Left: caption: "The tail booms retract along with the engine pylon. The outboard tips of the upper horizontal tail fold down. The flaps and ailerons fold down and the wing tips fold inward at the back of the body of the vehicle."

Left: caption: "Running boards emerge from the lower car body to support and protect the folded wings. The job description of the pilot now changes. He becomes a chauffer and drives away."

Left: caption: "End view of the AviAuto in flying configuration"

Left: caption: "End view of the AviAuto in Road configuration"

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When All Is Said and Done

182

"It turns out that if you optimize the performance of a car and of an airplane, they are very far away in terms of mechanical features. So you can make a flying car. But they are not very good planes, and they are not very good cars."
***Gregory Benford,* Physicist and Science-Fiction Writer (2010)**
RE: when all is said and done, there will probably be a market for both types of roadable aircraft designs. The owner who will use his vehicle as a car most of the time has little need of an aircraft incorporated into his personal ground transportation. This person will probably purchase a modular vehicle whereas the individual who plans to use his dual-purpose land-air machine mostly as an airplane will probably favor an integrated design. As for cost, there are those who would buy a roadable aircraft simply for the pleasure of owning such an unusual vehicle. For such people, the price will not be a major consideration. However, it is to be expected that the size of the market will not be particularly large thus the unit cost high. In any event, to be competitive any roadable aircraft design must be saleable at a price less than that of the combined cost of a comparable aircraft and automobile.

183

Of Two Minds

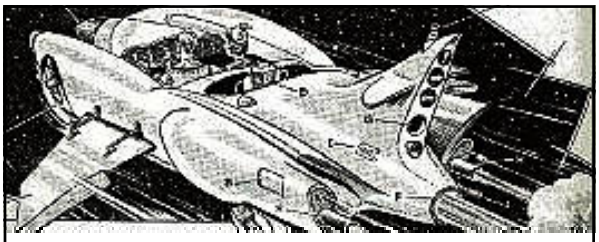
184

"I'm debating, like, should there be flying cars or shouldn't there be flying cars? I'm of two minds on that. If there are flying cars then, well, obviously you have added this additional dimension where a car could potentially fall on your head and would be susceptible to weather. And of course you would have to have a flying car that - where it will be like on autopilot, because otherwise forget it. It's got to be autopilot, but even on autopilot, and even if you've got redundant motors and blades, you are still going from near zero chance of something falling on your head to something greater than that. And there's also the noise challenge...Something that I do think that would help a lot in cities is more tunnels, essentially with flying cars you are talking about going 3D. And there's a fundamental flaw with cities where you've got dense office buildings and apartment buildings and duplexes and they are operating on three dimensions. But then you go down to the street, and suddenly it's two dimensional...I think if you were to extrapolate that to cars and have more car tunnels, then you would alleviate the congestion completely...and you wouldn't need a flying car in that case, and it would always work, even if the weather is bad. It would never ice up and it would not fall on your head…"
***Elon Musk* (2015)**

185

Time and the Future

186



"It's like we're living in the '50s here!"

RE: aired on January 8th 1998, *Seinfeld*'s 167th episode: *The Dealership,* featured George and Jerry complaining about the non-existence of flying cars (as of the late 1990s)

Above: a 1957 cartoon by *Washington Star* editorial cartoonist *Jim Barryman*. The parodied list of features of the "Stratomobile for 1977" – the "car with the backward blast," included a 57K-hp "ultramoronic turbo-awful" jet engine; a nose radar, a "powered oxygen pump for pressurizing hardtop bubble," a nose cone and an "aperture for space gun." For a demonstration, "Call MOon 00-U2."

187

"We had this sort of optimism in the '50s and '60s, a feeling that things were inevitable because of technology. And flying cars were on the short list. I don't think we're going to have freeways in the sky any time soon."

***Matt Novak,* the host of *Paleofuture.com*, an internet blog that looks at past predictions of the future (August 2008)**

Left: caption: "Engine in rear? Tricycle wheels? Polarized plastic top? Atomic power? Just as at home in the water or in the air as on the highway? Whatever the car of the future is like, you can be sure of this – it will have bearings, and the bearings will be protected with National Oil Seals…" (ca. 1950s advertisement)

188

Fly Like the Birds

189

Left: caption: "*100 years from now*…

WE MAY 'FLY LIKE THE BIRDS'

Time and the future will reveal many wonders…But in that Jules Verne-like world of tomorrow you'll find one familiar note: water and gas will still be carried by the dependable cast iron pipe laid today…" (ca. 1950s advertisement)

190

Your Personal Flying Carpet

191

Left: caption: "Your Personal 'Flying Carpet.' Step into it, press a button, and off you go to market, to a friend's home, or to your job. Take-off and land anywhere; no parking problems. Plug in to any electric outlet for recharging. They're working on it!" (ca. 1950s advertisement)

192

A Big, Bright Tomorrow

193

194

Part 5

One Way or Another

195

The Ground Effect Principle

196

"Call them air cars. Call them ground effect vehicles. Or call them air cushion sleds. But, above all, call them experimental. All the models currently under development pose some difficult problems for the designers and engineers working on them. Such problems as:

- ***How can we make them fly high enough to clear rocks, fences, high waves and other obstacles?***
- ***What is the best way to steer them?***
- ***Will they perform adequately at high speed, if at all?***

Answers are being found, although to date, there appear to be no 'best' answers…"

Science and Mechanics, **June 1960**

197

In 1960, the world was still all about innovative transportation, a carryover from the bygone golden age of the automobile. In the midst of figuring out how humans would get around in the decades to come, some interesting ideas were made manifest. The prototype *Rhoades Hover Scooter* (above L&R) never actually made it into production, but it was one of the most interesting concepts to come out of that time period. It was little more than a seat and handlebars on top of a very loud fan. The spinning fan produced a six-inch cushion of air which kept the scooter just barely off of the surface, allowing it to hover over land (left) and/or water (right) with ease.

198

"The Wright boys would blink in astonishment at some of the weird rigs taking to the air these days. Air-Cars, Sky-Boats, Flying Jeeps, Hovercraft - they're revolutionizing the Age of Flight. Most of these craft are based on two new devices: the ducted fan and the air cushion. The ducted fan is simply a horizontal prop that supports the vehicle on a column of air. Forward movement is provided by slanted vanes. With the air cushion, air under pressure is forced downward, raising the vehicle a few inches above the ground or water."
Mechanix Illustrated, November 1959
Left: caption: "Sky-Car has flown at 30-feet. Ultimate aim is to have craft achieve 150 mph speed in air, 30-40 mph as wheeled land vehicle. Jet fuel is used to power the Sky-Car, which combines the advantages of a jeep and a helicopter."
Right: caption: "New model four passenger, 300 hp Air-Car is scheduled to go into production this fall at Curtiss-Wright's South Bend plant"

199

"…This despite the fact that a lot of money and time have been spent by private individuals, large companies and the United States government, in the hope of some day having a vehicle that will ride comfortably and economically, a few feet off land or water, and over all obstacles in its path. Even the two air cars now being offered for sale by Curtiss-Wright Corp., Woodridge, N.J., might be termed experimental, since their performance is somewhat limited (altitude of the smaller model is only 4 in., that of the larger one 6 to 12 in.) and the company says they are offered for 'off highway use,' which bars them to hopeful commuters…"
Science and Mechanics, June 1960

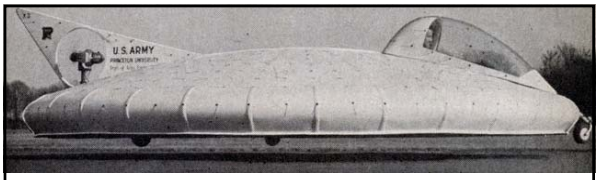
200

Top Left: caption: "Air-Car lifts itself from 6 to 12 inches off the ground. The Curtiss-Wright prototype model can travel in any direction."
Top Right: caption: "Experimental skimmer developed by the Curtiss-Wright Corp. can use conventional type piston engine of from 50 to 200 hp"
Left: caption: "Skimmer is U.S. Navy test job that rides on an inch-thick cushion of compressed air delivered via flexible hose along side"

201

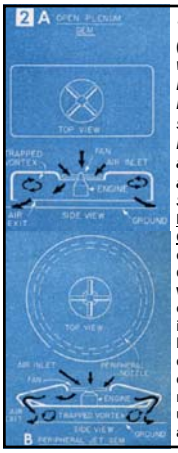
What is an Air Car?

202



"…What is an Air Car? Like their earthbound brothers, air cars come in various shapes and sizes, but they all work on the same basic principle: Air is pulled into the vehicle and blasted out by a propeller through its bottom against the ground, creating a supporting cushion of air on which the car floats. This is simplicity itself. In fact, one experimenter says it is virtually impossible to build an air car that won't get off the ground…"
Science and Mechanics, June 1960
Above: caption: "Altitude: 1 ft. Speed: 25 mph. This is Princeton University's 20-ft., circular air car. Lift is provided by a 43-hp engine powering a 4-ft., 2-blade propeller mounted horizontally in the center of the vehicle. The vertically-mounted prop in the tail rotor (which swivels) helps change direction and provides stability. Forward motion comes almost entirely from control vanes which throttle the craft's peripheral air jet."

203



"…The simplest form is the plenum chamber type (Fig. 2A), which resembles an upside-down pie tin with a propeller mounted on top. Most researchers have started with this type, then moved on to the more sophisticated peripheral jet (Fig. 2B). Findings so far show that the peripheral jet type can achieve higher altitude (given equal base areas, horsepower, and weight) than can the plenum, since its directed air jet both builds and confines the cushion…"
Science and Mechanics, June 1960
Left T&B: caption: "Figs. 2A&B. Most elementary type of Ground Effect Machine (GEM) is the open plenum, in effect an open-bottom box pressurized slightly by an engine-driven fan (2A). The rotating fan produces thrust; and when mounted in the plenum, its thrust is in the direction of lift. Up to a certain point, the peripheral jet type of GEM is similar to the plenum (2B). Here, however, the air is blasted out through a narrow opening around the GEM's circumference, instead of through the entire base. In many cases, the air jets are directed in towards the center of the machine. Thus, a supporting cushion of air is maintained under the GEM. The air jets are deflected by this air cushion and travel outwards at ground level."

204

Short of the Ideal

205

"…Merely getting the vehicle into the air is not sufficient, however. We must be able to control its direction for going forwards, around corners, up inclines and over obstacles. And this is where the present crop of air cars falls far short of the ideal…"
***Science and Mechanics,* June 1960**

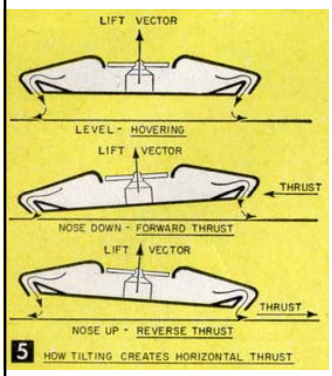
206

Body-English

207

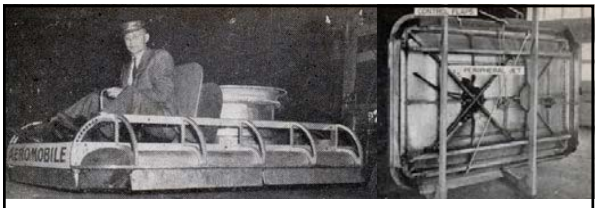
"…Because relatively little is known about the problems raised by an air car in forward flight, researchers are trying several different steering techniques. Some Use Body-English. The most elementary method is plain old body-english - or kinesthetic control. Princeton University built its air scooter expressly to test the feasibility of such control (Fig. 4)…"
***Science and Mechanics,* June 1960**
Above: caption: "Figure 4. Body-english-controlled air scooter built by Princeton University has its propeller mounted vertically for safety (a procedure also recommended for amateur experimenters). The scooter is built of steel tubing, covered with fabric. Its weight is about 120 lbs."

208



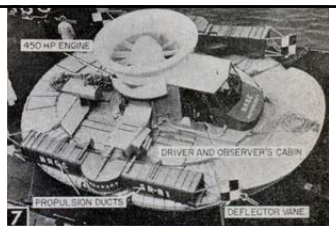
"…Its handlebars are merely for the driver's support; he leans in the direction he wants to head - thus tilting the air car and the angle of its lift vector (Fig. 5), using it for horizontal thrust (just as a helicopter tilts the lift vector of its rotor for forward flight)…"
***Science and Mechanics,* June 1960**
Left: caption: "Figure 5 – How Tilting Creates Horizontal Thrust. An air car can be given direction simply by tilting it. In the drawing at top, the air car is level, its lift vector vertical to the ground and providing nothing but lift. At center, the car has been tilted forward. This tilts the lift vector forwards, making it provide some horizontal thrust in that direction as well as lift. At bottom, the car has been tilted backwards for reverse thrust (backwards movement or braking)."

209



"…Similar to this is the second method, which obtains tilt from controllable flaps or vents in the peripheral jet. Probably the best-known example of this method is the Aeromobile, built by an Illinois doctor, William R. Bertelsen (Fig. 6)…"
***Science and Mechanics,* June 1960**
Above L&R: caption: "Figure 6. Bottom view of the Bertelsen *Aeromobile* shows control flaps deflected. Inward deflection of a flap decreases thrust in that area, causing the car to tilt and move in the direction of the tilt. To go forwards, Dr. Bertelsen deflects the front flap inwards. Side flaps are used for turning and for trimming the load."

210



"…A third method bleeds off part of the air from the propeller and - by sending it out through horizontal openings - uses its reaction thrust to propel and control the air car. An example of this approach is the Hovercraft, built by Saunders-Roe, Ltd., of England. About 70% of the air generated by its power supply (a 4-blade propeller powered by a 450-hp engine) is used for the air cushion. The remaining 30% is used for propulsion, blasted out through ducts at the corners (Fig. 7)…"
Science and Mechanics, **June 1960**
Above: caption: "Figure 7. The *Hovercraft* bleeds-off part of its air supply through horizontal ducts for propulsion. One experimental model has made a 25-mile crossing of the English Channel. Driver has two control sticks and rudder bars. Main stick operates valves in lift-control ducts under the craft to control pitch and roll. Secondary stick opens or closes valves in propulsion ducts. Rudder bars control yaw by varying the angle of the deflector vanes."

211

"…On a smaller scale, the air scooter built by Bell Helicopter Corp., Fort Worth, Tex., uses a combination of the body-english and horizontal duct methods (Fig. 8). To go forward, its driver depresses a foot pedal, opening louvers in the rear of the vehicle. To move in another direction, he turns the handlebars (thus directing thrust out of diagonally-located ports) and applies body-english in the same direction…"
Science and Mechanics, **June 1960**
Left: caption: "Figure 8. Bell Helicopter's plenum chamber air car is powered by a modified 14-hp motorcycle engine turning a 30-in., 2-blade fan. Hair-bristle skirt at the bottom helps to retain the air cushion. Driver's right hand is on throttle, his right foot on accelerator (which opens louvers in the rear of the car). Turning handlebars in direction of desired turn directs thrust out of corner ports."

212

"…The Bell scooter, by the way, is an outgrowth of research carried on at home by two Bell engineers, Ken and Rod Wernicke. After they built small cars capable of carrying their children, and a larger one on which both the men could ride, Bell authorized a project to perfect and build the vehicles…"
Science and Mechanics, **June 1960**

213

"…Other propulsion and steering methods call for a secondary supply of power, such as a conventional air propeller, a ducted fan, or a jet or rocket engine. Of all these methods, the most effective to date seems to be the venting technique used by Dr. Bertelsen. It has several advantages:
• All of the air supply is used to build the cushion. None is bled off through ducts for propulsion.
• The driver does not have to resort to body-english, but can sit comfortably and use a control stick.
• Local thrust control makes possible easy trimming of an off-center load…"
Science and Mechanics, **June 1960**

214

How High?

215

"…How High the Air Car? At present, the most critical shortcoming of the air cars is their limited altitude. To be really useful over all terrain, they should be able to clear fences, logs, boulders and bushes and climb whatever hills they come to. But the Hovercraft moves at most a foot above the ground, Bell's scooter only 2-1/2 in., Princeton's about 3 to 4 in. and Dr. Bertelsen's about 6 in. Such performance limits their operation to relatively smooth surfaces (when an air car traveling 2 in. up meets a log sticking up half a foot - crash!)..."
Science and Mechanics, **June 1960**

216

"…How can they be made to go higher? Some researchers add skirts to the base. Thus, although the car itself goes higher, the effective base - that is, the bottom edge of the skirt - remains close to the ground…"
Science and Mechanics, June 1960

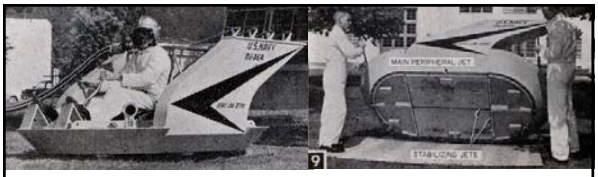
217

"…One home workshopper uses a long polyethylene skirt (Fig. 3) which enables the car to cruise 26 in. up. As with many of the air car experimenters, though, he is not giving away details on exact performance of his car (for example, what happens to the skirt and the air cushion trapped inside it when the car sails over a fence?), since in many cases patent rights and the possibility of great profits are involved…"
Science and Mechanics, June 1960
Above: caption: "Figure 3. Home experimenter N.B. McCreary of Little Rock, Ark., built this air car. It runs on a 1-hp lawnmower motor and – thanks to the polyethylene skirt which traps the air cushion – reaches a height of 26 in. McCreary says his propulsion system is something entirely new but, because of patent rights, he isn't ready to say just how it works."

218

"…Most researchers believe the best way to gain altitude is to use one of two methods:
1) Increase the base area of the machine.
2) Boost the power. Let's consider for a moment something called lift-augmentation. This is the amplification of thrust found near the ground. In other words, the closer to the ground the air car is, the greater lifting capacity it has. Also, lift capacity increases as the base area of the car is increased. Thus, simply by building the vehicle larger, you get more altitude for the same power input. Conversely, by keeping the base area the same (or even reducing it in size) but boosting the power, you can also gain altitude. But going up too high means that the air car might hover at an altitude where maintaining static stability - the tendency of the vehicle to right itself to a level attitude after being tilted by some external force - becomes a problem…"
Science and Mechanics, June 1960

219



"…The peripheral jet air car appears to be inherently stable up to an altitude of about 5% of a base diameter, according to Princeton University researchers, although the use of additional jets in the base can add to its stability (Fig. 9) at higher altitudes…"
Science and Mechanics, June 1960
Above L&R: caption: "Figure 9. Segmenting the base with additional nozzle slots adds to the GEM's static stability. Each compartment acts like a weaker peripheral jet superimposed on the stronger, main jet. Another technique is used in the *Hovercraft:* two concentric peripheral jets, which give the same effect. The GEM shown here is the *Skimmer*, a Navy research craft."

220

"…Thus, if you rely on size alone to gain altitude, any air car big enough to clear fences and hedges probably would be too big for use on narrow streets. On the other hand, the alternative (making them no bigger, but boosting the power) adds greatly to the cost. The only apparent solution is to build different models for different purposes: Small, low-altitude cars for city use and bigger ones for overland travel…"
Science and Mechanics, June 1960

221

The Need for Speed

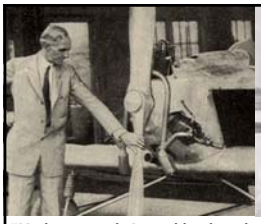
222

"…What About Speed? Another sticky problem is speed. So far the maximum speed of the experimental air cars has been in the neighborhood of 30 or 40 mph, although the Curtiss-Wright Bee (a 12-ft. long, 1,115-lb. model, powered by a 100-hp engine) is said to reach 53 mph. Bear in mind that these speeds are achieved at quite low altitudes, a matter of several inches. What nobody is really certain of is exactly what happens to the supporting air cushion at higher altitudes and higher speeds. In some tests, the air cushion appeared to break down at both high speeds and high altitudes. In others, it actually showed a gain in lift. It is believed possible that different designs might be needed for most efficient operation at different speeds…"
***Science and Mechanics,* June 1960**

223

There's a Ford in Your Future

224




"Mark my word. A combination airplane and motor car is coming. You may smile. But it will come."
Henry Ford
Left: caption: "Henry Ford, inspecting the newest Ford product-one of the smallest single-seaters ever built. When completed, it will embody several novel features to fit the needs of the man of average means wishing to fly his own plane." In September 1926, Henry Ford unveiled the "Sky Flivver" - a 350-pound, single-seat monoplane. Edsel Ford had even declared that, eventually: *"We hope to put a machine in the air that will be proportionately as cheap as our pleasure cars."* The *Sky Flivver* never went into production, despite the fact that at least three distinct versions of the aircraft were flown. When one model crashed in 1928, killing pilot *Harry Brooks* (right), Ford soured on the project. In later years, Ford established an aviation division that produced the highly successful *Ford Trimotor* and, during WWII, the *B-24 Liberator* bomber. Even as late as 1940, Henry Ford was still predicting a future of airborne automobiles.

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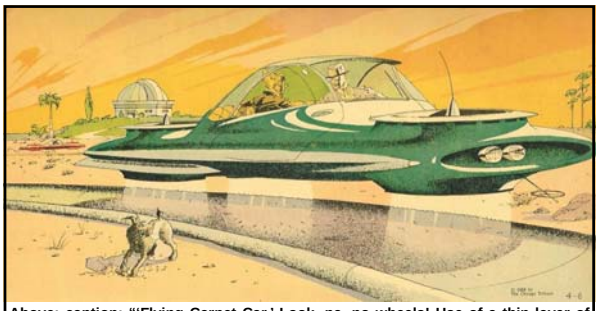
Glideair

227

"Your car of the future may have no wheels. It may not even touch the road as it races along the turnpike at speeds well above 100 mph while you and your family sit back and enjoy the ride - without fear of accident or injury. This revolutionary new mode of travel was recently unveiled by the Ford Motor Company in the form of the Glideair - a wheel-less vehicle that rides on a thin film of air a fraction of an inch above the road…"
***Mechanix Illustrated,* October 1958**

228



Above: caption: "'Flying Carpet Car.' Look, pa, no wheels! Use of a thin layer of compressed air may allow autos to hover and move just above ground level. A pipe dream? Not at all. The concept (already proved) comes from scientist Andre Kucher, vice-president of engineering at one of our major motor companies. His people are studying how to maintain stability. Special highway engineering is one way. Another is skillful design, evidenced already in experimental idea from the staff of motor stylist George W. Walker. Today's earthbound cars won't turn into low flying carpets right away. But it may happen sooner than we think!" 229

"…Says Andrew A. Kucher, Ford's vice president in charge of Engineering and Research: 'We look upon Glideair as a new form of high-speed land transportation, probably in the field of rail surface travel, for fast trips of distances of up to about 1,000 miles.' A gas turbine or turbojet engine would supply the power to both levitate and propel the Glideair. Instead of wheels the vehicle would employ 'levapads,' a Kucher-coined word. Tiny jets of air would stream through holes in the levapads, supporting the vehicle. It is significant to note that levapads have already been designed to fit around a standard rail. They raise the vehicle from the rail and keep it away from the rail sides…"
***Mechanix Illustrated,* October 1958**

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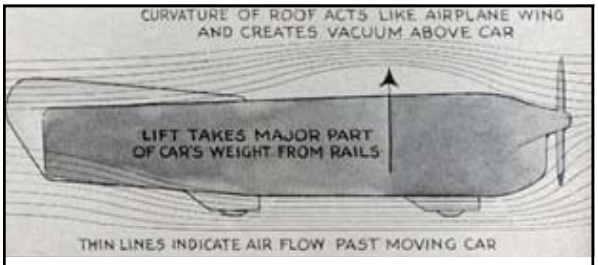
Above: caption: "Fantastic speeds of 200 to 500 mph are foreseen in the future for unwheeled vehicles using monorail system. Levapads would raise vehicle from rail, hold it away from rail sides." 231

The Flying Railroad

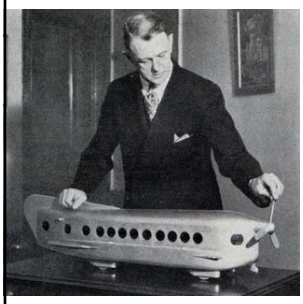
232

"Imagine a flying railroad in which captive airplanes serve as cars. Skimming through the air, the streamlined cars are expected to attain speeds up to more than 200 miles an hour. A cage of rails restrains them from actually leaving the track. That is a brief outline of a project for a high-speed transportation system put forward by a New York engineer, Walter H. Judson, pioneer aviator and formerly chief engineer for a railway car manufacturer. In Judson's opinion, all engineering details have been worked out. With the cooperation of makers of rail-way and electrical machinery, structural steelwork, and airplane equipment, he has prepared a complete plan…"
***Popular Science,* May 1933**

233



"…Judson's plan calls for a light-weight structure of steel with a roadbed of trough-shaped cross section. Two bottom rails will be faced with rubber; these will support the flying car, with its pressed-steel wheels, while it lightens itself with increasing speed. A pair of side rails will serve as buffers and prevent sidesway. L-shaped rails at the top will complete the cage and prevent the car from lifting itself completely from the track…"
***Popular Science,* May 1933**
Above: caption: "Curvature of car's roof exerts a lift at high speeds, like an airplane's wing, tending to make the car rise from the tracks" 234

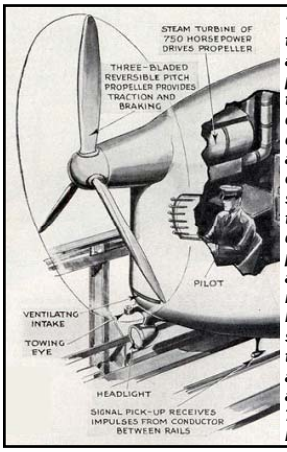


"…The fifty-foot coach, encased in a streamlined shell of light metal alloy, will resemble an airplane fuselage shorn of wings. Wind-tunnel tests show, Judson says, that the curvature of the roof provides sufficient lift at full speed to raise nearly all of the car's weight from the rails. Guide wheels with rubber tires are expected to restrain the car if it should leave the rails entirely, while similar wheels limit sideward movement…The coach Judson plans would accommodate from thirty-six to fifty-four passengers. Its crew would consist of pilot, mechanic, and porter. There is no conductor…"

***Popular Science,* May 1933**

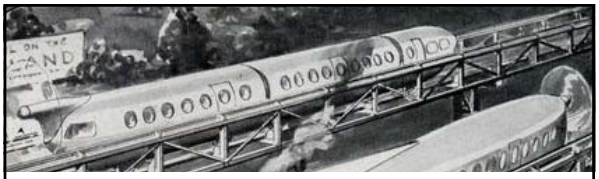
Left: caption: "Walter H. Judson, inventor of the flying railroad, with a model of his high-speed coach. The reversible propeller acts as a brake."

235



"…A compact geared turbine will drive the propeller. Steam is supplied from an oil-burning boiler in a rear compartment, and exhaust steam from the turbine will pass through a condenser, enabling most of the water to be recovered and used over again…Since an ordinary brake would quickly burn out if applied to a vehicle traveling at such speed, the propeller will be made to serve as an air brake. This will be done by reversing the pitch of the propeller blades so that they push the air ahead of the car and retard its motion. When the vehicle has thus been slowed to ninety miles an hour, steam-operated brakes will be applied to I-beams at the sides of the trough and bring the car to a halt. A full stop at a speed of 200 mph can be made in 7,800 feet, Judson calculates…" 236

***Popular Science,* May 1933**



"…For transcontinental service and other long hauls, Judson proposes the use of a flying train of from three to ten coupled sections, instead of the individual coach. A power car at the front would pull a string of passenger or freight-carrying sections, ending in a tapered observation car or caboose, at from 100 to 180 miles an hour Judson says. The cars will be coupled in such a way as to avoid wind drag from vacuum pockets forming between them…"

***Popular Science,* May 1933**

Above: caption: "An individual coach for short runs and, in rear, a streamlined train for long hauls"

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"…An automatic signal system, he says will make it impossible for one car to approach closer than three miles' distance to another. When a danger signal is picked up electrically from an inductor cable running along the center of the trough, the propeller blades will reverse of their own accord and the steam brakes operate after the proper interval. If any foreign object falls into the runway, an emergency signal is automatically flashed to oncoming cars and the usual action of the propeller brake is accelerated. The pilot has no signals to watch, but can talk with other cars and with the train dispatcher through a 'wired wireless' system using the same conductor that carries the signals. These safety features and the absence of any grade crossings greatly reduce the chance of accident, Judson believes. Windows will be sealed and fresh air provided by an air-conditioning system with an inlet at the front of the car…"

***Popular Science,* May 1933**

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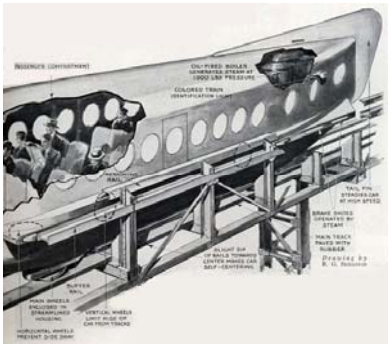


239

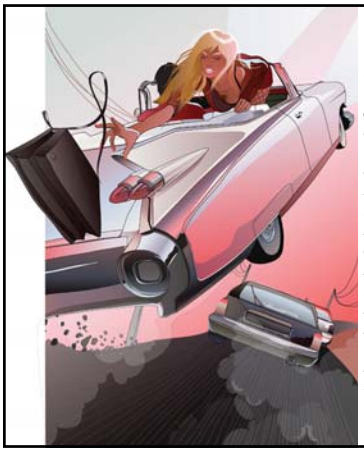
"…Judson announces that a fifteen-and-a-half-mile demonstration line is planned for New Jersey, to serve a community as yet unnamed. Both coaches and trains will be run according to the plan, and will make the trip to a terminal connecting with a New York ferry in six minutes. Commuters and sightseers, Judson says, will be offered an opportunity to use the line, although its principal purpose is to show the feasibility of the system for larger-scale application. He declares its use would bring Chicago within five and a half hours of New York City, and San Francisco eighteen hours from New York. First of the longer runs contemplated by Judson for his system are lines connecting Jersey City and Atlantic City, N. J., with Philadelphia, Pa."

***Popular Science,* May 1933**

240

Wheel-Less

241



"The kind of automobile that futuristic artists have portrayed since the late 1920s and science fiction writers dream about may be closer than we think…serious-minded practical motor car designers working for manufacturers of all the leading makes and some independents are busy 'brainstorming' what the true 'car of the future' will be like, perhaps in just a few years. It may have no actual physical contact with the roadway…"
Lethbridge Herald **(Lethbridge, Alberta, Canada), October 15th 1958**

242

"…There are also others with their fingers in the wheel-less vehicle pie. Noted designer Carl Reynolds recently showed off his concept of a car without wheels which he foresees by 1978. Mr. Reynolds says, 'The highway cruiser, or large passenger car will float, or literally fly a short distance above the road supported on air compressed by turbine-driven ducted fans. In the wheel-less car,' Reynolds goes on to say, 'the driver's controls will be automated to simplify safe and effortless driving…Inter-city expressways will have electronic equipment for driver information as well as for traffic control and guidance…The car without wheels will negotiate fairly rough terrain, even travel over smooth water!'…"
Mechanix Illustrated, **October 1958**

243

Here is the world's newest method of transportation...the Curtiss-Wright

AIR-CAR

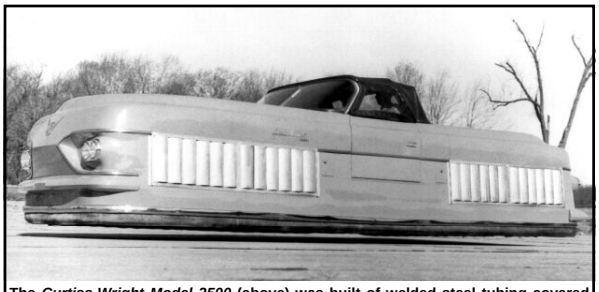
Without the usual wheels, axles, transmission, clutches, etc., the Curtiss-Wright Air-Car travels smoothly over any unobstructed terrain, across water, mud or swamps on a cushion of low pressure, low velocity air. The controls are simple and the vehicle is inherently stable – anyone who can drive a car can operate an air-car. The "Bee" is a compact, two passenger Air-Car which travels at speeds up to 56 mph with a 100 horsepower engine. This is the next model planned for production. The Model 2500 is a 2-engine, 300 horsepower vehicle which comfortably carries four passengers.

Write for information to Dept. AC, Curtiss-Wright Corporation, 304 Valley Blvd., Wood-Ridge, N. J.

Left: caption: "Without the usual wheels, axles, transmission, clutches, etc., the Curtiss-Wright Air-Car travels smoothly over any unobstructed terrain, across water, mud or swamps on a cushion of low pressure low velocity air. The controls are simple and the vehicle is inherently stable – anyone who can drive a car can operate an air-car. The 'Bee' is a compact, two passenger Air-Car which travels at speeds up to 56 mph with a 100 horsepower engine. This is the next model planned for production. The Model 2500 is a 2-engine, 300 horsepower vehicle which comfortably carries four passengers."

After ***Curtiss-Wright*** lost a jet engine contract to ***General Electric*** in the early 1950s, the company had to look for new markets. In 1956, they found one by entering into a management agreement with the troubled ***Studebaker-Packard Corporation***, The S-P deal ended in 1959, just when Curtiss-Wright got the public's attention after some ambitious marketing (like this postcard, left) for their flying car, the "Bee." The ***Bee*** promised a lot long before even a prototype was ready. Even so, in 1959 the world's first "Hovercar" was displayed for all the world to see. The ***Model 2500*** was much larger and was supposed to seat four, but the prototype remained a two-seater. the U.S. Army bought two vehicles for engineering and operational evaluation in 1960, but since it couldn't even deal with a bit of irregular terrain, they abandoned the concept in less than a year.

244



The *Curtiss-Wright Model 2500* (above) was built of welded steel tubing covered by molded sheet metal. It was powered by two 180hp *Lycoming* engines mounted one forward and one aft of the passenger compartment. Each engine was used to drive (via reduction gears) a single four-bladed lift fan placed within a plenum chamber. The two chambers created a cushion of air 10 to 15-inches thick. Forward propulsion was supplied by air bled off the chambers and expelled at low velocity through two sets of louvers on each side of the vehicle. Specifications - Length: 21-feet; Width: 8-feet; Height: 6-feet 1-inch; Weight: 2,770 pounds; Cruising speed: 20 mph; Max speed: 38 mph.

245

Flying Jeeps & Geeps

246

"If the U.S. Army of the future can't beat an enemy, it may scare it to death with a platoon of flying machines like these. This is an artist's conception of air-ground vehicle designs submitted to the Army by various aircraft firms. The goal is to provide the Army with a utility vehicle that will give troops more mobility. These machines are supposed to rise vertically, hover at three feet or zip over mountains at 150 mph. They also are designed to fire rockets, duck behind hills, fly down an alley, hide amid trees and turn in their own length without touching the ground."

***Miami News*, March 29th 1958**

RE: in 1957, the *U.S. Army Transportation Research Command* called for tenders from U.S. industrial companies to provide utility vehicles capable of Vertical Take-Off and Landing (VTOL) for use in observation, liason and combat operations. They were to be operated at very low altitudes (5 to 12-feet) and were intended to be used over terrain such as swamps, lakes and rivers that would be inaccessible to regular land vehicles (i.e. jeeps). Operating speeds of approximately 70 mph were envisioned, desired payload was 1K-pounds and flight endurance was to be several hours.

247

Above L&R: caption: "Curtiss-Wright VZ-7, a Flying Jeep." This VTOL aircraft was designed for the U.S. Army by the *Curtiss-Wright Aircraft Company*. Two prototypes were delivered in mid-1958, but were not able to meet the Army's standards. The project was cancelled in 1960 and the prototypes were returned to Curtiss-Wright. One of them still exists today - in storage at the *United States Army Aviation Museum* collection.

248

249

The *VZ-6 CH* (above L&R) was the submission of the *Chrysler Corporation*. Without wings or rotors, the machine was to obtain lift from two 8.5-foot diameter, three-bladed, fixed-pitch, ducted propellers. They were powered by a single *Lycoming* engine providing 360 shaft horsepower. Two sets of hinged control vanes were mounted below the propellers to produce roll and yaw control. Pitch was to be controlled by inlet vanes mounted at each end of the aircraft above the propellers. The landing gear consisted of four castored landing legs; one on each side and one on each end. In its first tests the VZ-6 CH was tethered from below. It had ample power to obtain the desired lift, however, control was inadequate and the machine crashed on its first flight when only secured by a loose tether from a crane. The pilot suffered only a scraped elbow, but the VZ-6 CH was beyond repair. The Army stopped financing the program thus, the project came to an ignominious end.

250

"…A hovering, helicopter-like vehicle is expected to become an actuality yet this year as the result of a design, the Piasecki 59-K, being built by a Philadelphia concern for testing by the U.S. Army. Employing two flat, recessed rotors which cover only a slightly bigger area than already is occupied by the engine hood and trunk turtle of your automobile, it will rise a few feet off the ground and cruise forward at speeds up to 100 miles an hour…"

***Lethbridge Herald* (Lethbridge, Alberta, Canada), October 15th 1958**

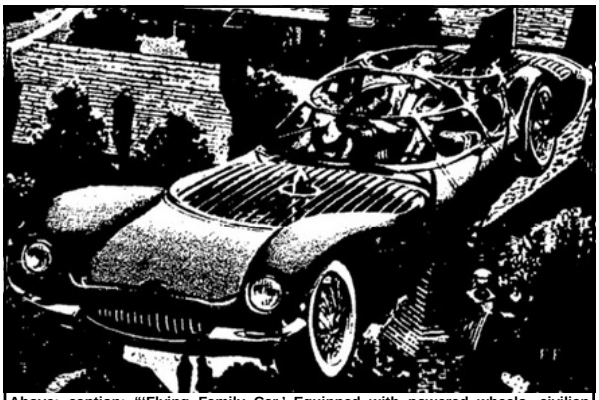
251

"…Piasecki Aircraft Corp. has a Sky Car in the works for the not-too-distant future. It will be an offspring of their 59-K, one of two Flying Jeeps being developed for the Army. The 59-K, which is 'well ahead of schedule,' according to the Army, is designed to combine the utility of ground jeeps with the hovering capabilities of small helicopters. The Sky Car will be the civilian version. It will have no wings or conventional propellers and will be powered by two horizontal three-bladed rotor-props, one at the front and one at the rear, which will support the craft on two columns of air…"

***Mechanix Illustrated,* October 1958**

RE: in 1957 *Piasecki Aircraft* was awarded an *Army Transportation Research Command* contract for the development of a VTOL-type "flying jeep" research vehicle capable of operating at extremely low altitudes. Piasecki, at that time a leader in vertical lift research and development, produced an innovative design dubbed the "Model 59K Sky Car." The craft was built around two tandem, three-bladed, ducted rotors driven by two 135kW *Lycoming* piston engines. Both power plants were connected to a single central gearbox so that both rotors would continue to turn even if one engine failed. The *Sky Car* had fairly conventional helicopter-type controls which provided directional stability through a series of hinged vanes mounted under each rotor duct. The craft had fixed tricycle wheeled landing gear and accommodated its single pilot and one passenger in seats sited between the two rotor ducts.

252



Above: caption: "'Flying Family Car.' Equipped with powered wheels, civilian counterpart of the flying jeep will land in backyard, drive into garage. The Army jeep has already been test flown." (November 1958)

253

Above: the first of two Model 59 examples ordered by the Army made its initial free flight in October 1958 and was renamed "Airgeep" (left). The machine was subsequently given the designation "VZ-8P" (P=Piasecki). Shortly after being accepted by the Army, the VZ-8P was fitted with a single 315kW *Turbomeca Artouste IIB* turbine engine. Its first turbine-powered flight took place in June 1959. The craft was subsequently loaned to the U.S. Navy for evaluation (as Model 59N) and, upon its return to the Army, its Artouste IIB was replaced by a lighter and more powerful *AiResearch* 331-6 turbine. The second VZ-8P incorporated several significant design changes and was, accordingly, dubbed the "Model 59H Airgeep II" and the VZ-8P (B) by the Army. A subsequent five man model was fitted with an ejection seat for the pilot and gunner (right). Though the Airgeep was able to hover near the ground or fly thousands of feet in the air and it surpassed its competition in terms of performance, the Pentagon felt it wasn't suitable for the modern battlefield and the project was cancelled.

254

"…Piasecki's Flying Jeep is a radically different ducted-fan VTOL. Intended for military hedgehopping it has exciting possibilities as the forerunner of a family car that can fly. It consists largely of two huge horizontal ducted fans in tandem, with the pilot-driver seated between them. He uses vanes in the ducts to deflect the air flow for maneuvering…"
Popular Science, September 1960

Above: caption: "Piasecki VZ-8p (1958) had two ducted 2.4 propellers each with its own engine (three engine improvements) with a linkage designed such that if one engine failed the other can drive"

255

"…Both rotor-props will be shielded for safety and the Sky Car will hold a driver and three passengers. It will be able to fly down narrow streets or get above heavy traffic. It will also have powered wheels to drive it in and out of the garage or congested areas. According to Piasecki, the Sky Car will cost little more than a high-priced motor car of today…"
Mechanix Illustrated, October 1958

Above: caption: "Piasecki VZ-8P." Although the *Piasecki Airgeep* isn't exactly what comes to mind upon hearing the phrase "flying car," this VTOL could both hover close to the ground and fly several thousand feet above it. Unlike the other machines, the Airgeep's lack of wings allowed it to fly between buildings, trees and other tight spaces. The *Airgeep II* (completed in 1962), was fitted with ejection seats, two *Artouste* engines and a tricycle undercarriage (for improved travel on land). In the end however, it failed to make a lasting impression.

256

257

Copter Cops

258

"Today's high-speed turnpikes require ground-bound traffic police to take to the air and graduate to the status of 'Copter Cops,' mounted in a vehicle that could speed safely above the car-choked roads and provide a bird's eye view of driving conditions and dangers. Such a vehicle could go far beyond the utility of the present patrol car. It could control traffic speed, clear jams at bottlenecks, perform emergency rescue work and provide fast aerial ambulance service, plus offering a more efficient pursuit of criminals…"
Mechanix Illustrated, **November 1958**

259

"…MI's paddy-wagon for Copter Cops is based on the Army's specifications for a compact, high-lift aerial jeep. It takes the form of a stable 'flying platform,' built around three ducted-fan units. Each of these is fitted with a pair of contra-rotating propellers spinning on a horizontal plane to drive a column of air downward. The force of this airstream provides the machine's lift. Power is provided by twin gas turbines. The vehicle is designed to carry three policemen, the minimum crew for efficient patrol work. In the event of a wreck, as shown, it lands on the central safety island with one of the crew clearing a space by directions called through an electric 'bull horn.' Upon landing, one of the men takes over traffic control while the other two place the injured on litters and lock them safely in place in the enclosed 'Utter wells' on either side of the copter's cabin…"
Mechanix Illustrated, **November 1958**

260

"…The pilot then takes off for the nearest hospital, leaving his mates to superintend activities at the accident scene. Upon the patrol vehicle's return, a cable is hooked to the wreck and it is dragged or lifted to a safe spot off the highway. With its inflated pontoon rim, MI's copter is capable of landing on land, water or in deep snow. A kit of emergency tools is carried and the crew is armed with rifles and submachine gun. Floodlights are set in the lower surface and a built-in loud speaker can be used to flag down an offending vehicle."
Mechanix Illustrated, **November 1958**

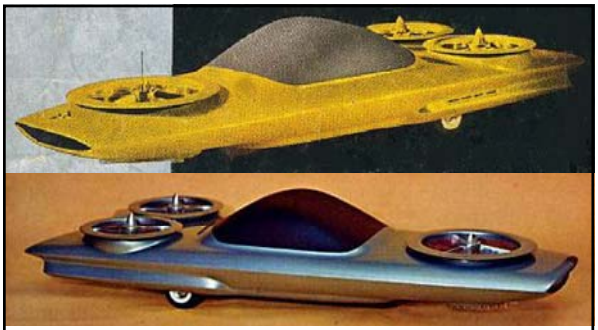
261

Curb Your Enthusiasm

262

"…This development isn't regarded with universal enthusiasm. One aeronautical engineer in Los Angeles, thinking about the Flying Jeep as he looked out his window at the car-choked freeway, said, 'God help us all if autos ever take to the air!..."
Popular Science, **September 1960**

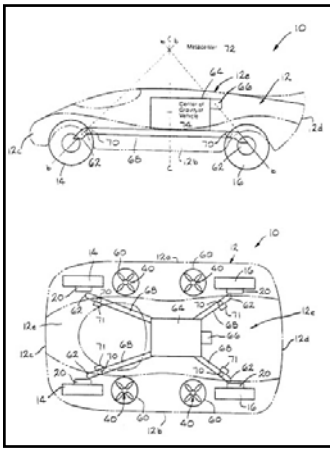
263



"…Ford also envisions what it calls an aero-car. Dubbed the Volante, the vehicle would be powered by means of three fan units arranged in a triangular pattern to provide lift and thrust somewhat like a helicopter…"
Mechanix Illustrated, **October 1958**
Above T&B: in 1958, Ford built several 3/8-scale concept car models, including the *Volante*. It was designed to use three ducted fans, each with their own motor, to levitate the vehicle from a parking place into the air.

264

265



"…The combustion engine is also geared to vertically oriented ducted fans (40) and a horizontally oriented ducted fan or propeller (76) for providing the vehicle with the capability of travel through the air. Pressure jets (62), supplied with compressed air from a compressor (66) driven by the combustion engine, augment the lift of the ducted fans and provide steering for the vehicle…"

RE: excerpt from U.S. Patent No. 5,141,173 (1991)

266

The Levacar

267

"…Ford Motor Co.'s experimental Levacar is expected to reach speeds from 200 to 500 mph. But, although it also slides on air, it can not be called a ground effect vehicle. In its case, a thin film of relatively high pressure air is used to hold it a fraction of an inch from guide rails…"

***Science and Mechanics,* June 1960**

Left: cover of the brochure explaining FMC's "Levacar" and "Levascooter"

268

The pressures used by levapads are low, usually ranging from 15 to 100 pounds per square inch. The surfaces on which the Levacar travels need be only moderately uniform, in fact, the smoothness required for any ground travel at high speeds is in all likelihood more critical than the requirement for levitation. Breaks in the surface are no obstacle since levapads will jump a one-inch space without difficulty. With some modifications it could be adapted to railroad tracks, though these are not ideal for the Levacar. The bottom of the Levacar has three levapads, each mounted on spherical bearings that permit the levapads to adjust to the contour of the highway. Jets of air through tiny holes in the levapads supply the pressure to levitate the vehicle.

269

The Levascooter is a demonstration vehicle capable of supporting two men. It can be used on any reasonably smooth floor. Since there is virtually no friction, the Levascooter moves about very freely. Riders feel a unique sensation in trying to mount or dismount the Levascooter since it tends to slide away from them. Riding on it is smoother than riding on ice.

270

271

272

Time and Travel

273

Within a few decades, the urge to travel at high speed has led man to develop the locomotive, the automobile, the airplane, and the rocket. Today he can travel through the air at speeds in excess of sound, and it is likely that he will soon land on the moon.

While the speed of air travel is advancing exponentially, such speeds have commercial disadvantages. The power requirement is high, and extensive landing fields are necessary.

But in spite of advances in highways and motorcars, land transportation has so far not been able to approach air speeds because of mechanical limitations of the wheeled vehicle, the human control factor, and the high cost of super-speed highways.

About 30 years ago, Dr. Andrew A. Kucher, now Vice-President of Ford Engineering and Research, proposed that a vehicle could slide along the ground using air as a lubricant. He called this vehicle the Levacar and the supports. 'levapads,' since the air actually supports or levitates the car. Since levipads do not have the limitations of wheels, they permit ground travel in the 200 to 500-mile-per-hour range.

274

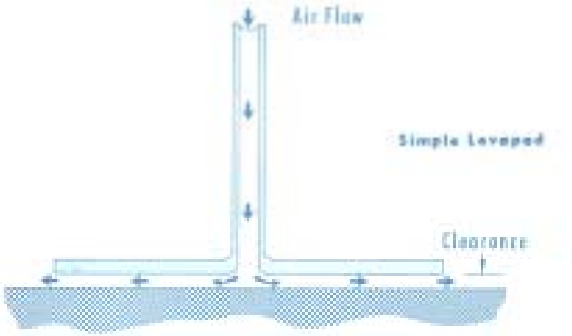
Investigation of travel in this speed range made some factors evident. In order to provide a comfortable ride, a comparatively smooth road is required. For this reason, concrete seems unattractive, and Levacar roads will most likely be made of steel. The width of concrete pavement is unnecessary; narrow strips of steel are sufficient. We have thus arrived at a rail, though perhaps of configuration different from the common rail of today.

It seems reasonable that a minimum trip of 100 miles may be necessary to justify the speeds under consideration. Since most people make such trips rather infrequently, the Levacar is not intended for a family car but rather for public transportation. Individual ownership might be a luxury similar to ownership of private airplanes, but public vehicles could be comparatively small and permit very frequent departures.

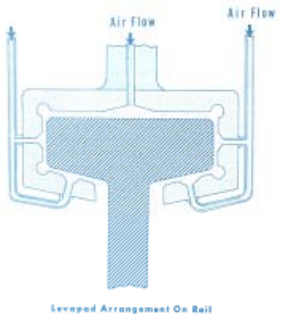
275

How it Works

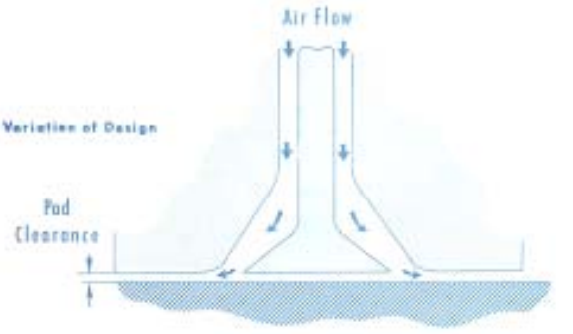
276



The Levapad is technically attractive because of its simplicity. In its most elementary form, it is merely a flat, round plate with a hole in the middle. Through a tube inserted in this hole, air is pumped between the plate and the ground, keeping them separated. The force exerted on the plate by the air pressure is used to lift the vehicle. 277



The support of a vehicle may require a number of levapads, which may be combined to serve several requirements. A typical configuration that might be used around a rail is shown in the adjacent sketch. The levapad at the top of the rail supports the load, the two levapads at the sides of the rail prevent lateral motion, and at the bottom are two grippers that prevent the slipper from leaving the rail. 278



Levapads may have more complicated shapes, as the on shown in the adjacent illustration. Here the center tube is flared and has a center insert to reduce its free volume. 279

Above: caption: "Where the 1959 Ford Mach I Levacar is going, it doesn't *need* roads." Shown at the *Ford Rotunda* in Dearborn, MI, in 1959, the single-seat wheel-less concept car touted a top speed of 500 mph. None were ever built.

Left: caption: "Standing by a working model of the Levacar, a wheel-less vehicle that travels on a thin film of air, is Andrew A. Kucher, Ford Motor Company's Vice-President – Engineering and Research, who first developed the concept of such a vehicle 30 years ago. In the background is a Levascooter with Levapads supporting it a few thousandths of an inch off the floor. Riding on it is David J. Jay, Senior Development Engineer of the project." 280

281

Without a Trace

282

"It was the beginning of a new decade and things were getting pretty exciting in every engineering field. I wanted to reach out into the future when the XPAK idea came to me, so I designed and built an air car, a car of the future."
George Barris
RE: the late 1950s and early '60s saw a surge of interest in ground-effect "air" (a/k/a "hover") cars. In 1960, famed California "Kustomizer" George Barris built the *XPAK 400* (featured on the March 1960 cover of *Car Craft* magazine, at left). 283

"In the following interview, George Barris discusses not only the practical aspects of his XPAK 400, but the factors which limit it as well. These good and bad points are inherent in all 'ground effects machines' built to date. They have to be overcome before this car-of-the-future becomes a serviceable, working reality. Barris has operated the XPAK 400 at a number of auto and cus-tom shows. He hopes to display it at the World's Fair…" 284
***Motor Life*, 1961**

$50,000 XPAK 400 CAR-CRAFT
MAGAZINE EXPERIMENTAL AIR CAR

Built by George Barris of North Hollywood, California, the air car has caused more talk in the transportation industry than anything since the development of the jet engine.

It is a "ground effects" machine and rides on a five inch cushion of air. It can ride on water as well as land, has no wheels, transmission or rear-end and has no frictional moving parts. Air is drawn in through the front and rear openings into the open plenum chamber with outlets, through a combination of peripheral jet inserts. A four inch polyethylene circular skirt is installed on the under portion of the body.

Frame construction is of 3/4 inch alloy round tubing. The air car's dimensions are: 12 feet long; 6 feet wide and 30 inches high. Its stabilizer fins have an 8 foot 7 inch wing span, 57 inches high. All panels are hand formed from 0.040 half-hard aluminum.

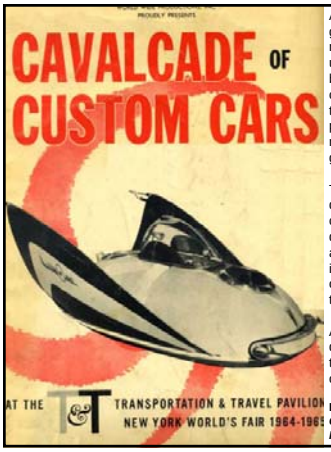
Its power source is 2 jet aircraft starter motors, 24 volts D.C., 4 h.p., that turn 40,000 rpm at 300 amps. This is then reduced 8 to 1 to absorb the amount of load horsepower. Balanced 20 inch cast aluminum fans push 11,800 C.I.M. free flow and under 7/8 inch static water pressure has 7,600 C.I.M.

Dry weight of the car is 422 pounds including all accessories. Movement is obtained by a revolving jet nozzle which has an air thrust to the right, left, forward, reversed and stop.

Scoop on top houses a penta-prism rear-view mirror which can be seen from inside the cab. Headlight is a curved fluorescent triple-tube which throws a clear light 100 feet ahead and causes no glare to approaching vehicles.

Air stream indicators are mounted on the grille to register speed while the car is moving through the air. Contoured body is of unbreakable fibre-glass and bucket seats boast a waist-high safety belt. Air foam cushions in the upholstery are mounted throughout for safety and the floor has white plush carpeting. There is also an impact-resistant adjustable air foam headrest on a gold coil spring. 285

RE: excerpt from *Cavalcade of Custom Cars* (at the *Transportation & Travel Pavilion*) – 1964/65 NYWF



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The air car also has Phono-vision, the new dial telephone with a TV screen to enable caller to see who he is talking to when dialing with the double-transistor TV camera and microphone. The 6 sq. inch TV screen is mounted on the dashboard and is operated on any wave length from a transformer.

A radar screen is also mounted on the dashboard, sending out waves to pick up the size of any obstruction on the highway or terrain.

RE: excerpt from *Cavalcade of Custom Cars* (at the *Transportation & Travel Pavilion*) – 1964/65 NYWF 286

The complete car is operated by sound waves and controls will be demonstrated by a small push-button box 50 feet away from it. Starting, stopping, right and left turns and operation of the neon and fluorescent lighting system is all handled by wireless remote control.

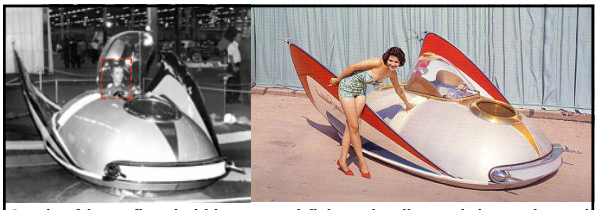
Body paint of nitro-cellulose lacquer consists of 35 coats using a million particles of a chromed aluminum called "Metalflake." The fins have 30 coats of imported Swedish pearl essence made of crushed fish scales and added crushed diamond-dust and then colored in kandy translucent red, white and blue.

This particular model was designed and built for public demonstration and is mounted on a guide rail for safety's sake.

All exterior trim has been gold plated for added beauty.

The engineering and styling on this car is a prediction of things to come in the auto industry.

RE: excerpt from *Cavalcade of Custom Cars* (at the *Transportation & Travel Pavilion*) – 1964/65 NYWF 287



A pair of huge fins, bubble top, real fish scale, diamond dust paint and gold-plated trim (plus a TV and telephone) made the *XPAK 400* a show stopper. Introduced at the 1960 *New York Auto Show*, Barris' creation was a crowd favorite that drew attention away from concepts by Detroit automakers. Barris' XPAK 400 levitated due to the a set of electric motor-driven fans (a skirt around its edge captured and concentrated air for increased lift). However, it did not have the lifting power to support a human passenger. Instead, a department store manequin (left) served as pilot for remote controlled demos at auto shows (right). After its auto show career ended, Barris put the XPAK 400 in storage. It mysteriously disappeared and hasn't been seen since. It seems to have disappeared without a trace. 288

Making the Grade

289

"…Steep inclines present another hazard, and the air cars developed so far have a very limited hill-climbing ability. Bertelsen's will take a 6% grade, while Bell's will climb 10%. If the car assumes the tilt of the hill, the lift vector is also tilted and has a strong downhill component which has to be overcome. So to climb a hill, the car has to out-tilt it, tilt opposite to the slope and climb on its own lift; the horizontal component of the lift vector is then in the uphill direction…"
***Science and Mechanics,* June 1960**

290

Blow-Back

291

"…Finally, the dust and spray created by the jet of air when the car goes over dusty surfaces or water present a bad problem. Hovercraft researchers, for example, found that during a two-hour operation over the sea, they got as much as 1/4-in. of salt on the cylinders of their engine from the spray. They have found, however, that the addition of spray rails to the base can solve this problem. To reduce the dust raised by overland operations, you can lower the velocity of air being blasted through the peripheral jets. But to do this, while maintaining lift and altitude, you have to move a greater quantity of air through wider jets…"
***Science and Mechanics,* June 1960**

292

Anybody's Guess

293

"…What's Ahead? Bell Helicopter says flatly that the future of air cushion vehicles is 'anybody's guess.' Dr. Bertelsen, however, is now working on a car of 300 to 450 hp (his present working model is 72 hp) which he expects will take him 'anywhere in Illinois over land or water under all weather conditions'…"
***Science and Mechanics,* June 1960**

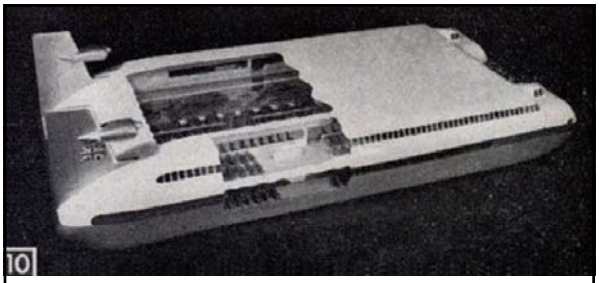
294

"…Rep. Overton Brooks (D, La.), chairman of the House Committee on Science and Astronautics, which has held extensive hearings on air cars, told S&M: 'We realize that much practical engineering work remains to be done, but there is every indication that a large number of revolutionary uses for such vehicles both in peace and war are about to become realities.' And a spokesman for National Research Associates, Inc., College Park, Md., a firm that has delivered the Pegasus I air car to the Marines and Army Ordnance for testing, says: 'It is strongly felt that ground cushion vehicles will carve a very definite niche for themselves in many transportation areas which are poorly served or not served at all by existing types of transportation'…"
***Science and Mechanics,* June 1960**

295

"…Along that line, Saunders-Roe, builder of the Hovercraft, plans to have four basic types weighing between 40 and 100 tons in service by 1963 for work-horse jobs:
• A 'flying truck' for operating overland in bush, tundra or desert.
• A 'snow freighter' with living accommodations for freighting or polar exploration.
• A 'tramp saucer' for coastal work in places where there are few harbors.
• A 'river rider' for transport and ferry work on frozen, unnavigable or fast-flowing rivers.
All of these vehicles will be enormously larger than the 7,500-lb. prototype car shown in Fig. 7…"
***Science and Mechanics,* June 1960**

296



"…The company also is projecting its hopes farther into the future with a suggested design for a 400-ton ferry (Fig. 10)…"
***Science and Mechanics,* June 1960**
Above: caption: "This suggested design for a mammoth car and passenger ferry is based on the prototype *Hovercraft* shown in Fig. 7. Its hovering height probably will be about 6 ft., with a payload of 800 passengers and 80 cars. Speed probably will be between 50 and 60 mph."

297

"…As mentioned, Curtiss-Wright is already offering two air cars for sale, and another large corporation is known to be considering sale of a lower cost model. Most likely, though, the first air cars you will see in every day use are the more efficient bigger ones, in use as trucks, freighters or buses. The smaller ones - carrying only one or two passengers - will be restricted for some time to off-highway uses (although not off-smooth surfaces)…"
***Science and Mechanics,* June 1960**

298

Air Boats (?)

299

"…One possible future application of the ground effect principle that has received relatively little attention is its use in boating. National Research Associates has carried out some tests, in which the air cushion was used to reduce drag rather than provide high mobility. Their tests were made with an 11-ft.-long boat, powered by a 5-hp outboard motor. An air cushion was provided by blowers driven by a separate 2-1/2-hp engine. Without the cushion, the boat had a top speed of 5 knots. With the cushion, the speed increased to 17 knots, and the boat gave a smoother ride over choppy water. More tests are now being conducted, and the air-cushioned boat seems to have a bright future."
***Science and Mechanics,* June 1960**

300

Look Ma, No Wheels!

301

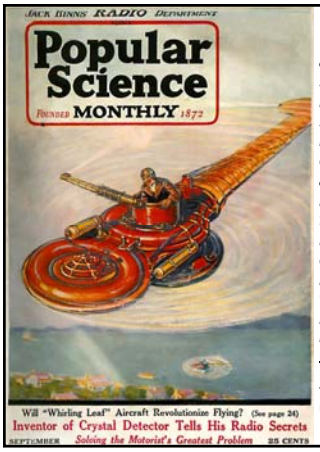
"…'Look! No wheels, mom!' may be the exclamation of small boys of the not too distant future when they see the new cars. A number of leading car makers have vehicles of this type under intensive study. They do not regard them as fantastic…"

Lethbridge Herald **(Lethbridge, Alberta, Canada), October 15th 1958**

302

An Enduring Dream

303



"…Today events in the realm of aviation are tumbling along at such a pace that we can almost imagine ourselves spending next summer's vacation touring the air roads…How soon we shall fly our own machines depends, experts agree, on how quickly foolproof machines can capture public confidence. Once that confidence has been gained and public demand created, quantity production and lower prices will be possible. The wonderful history of the automobile will be repeated in the air."

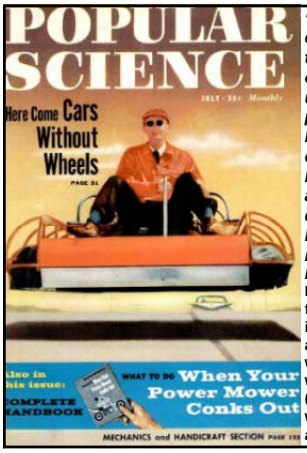
Popular Science, **November 1926**

Left: caption: "The Papin-Rouilly Gyroptere as depicted on the cover of the September 1922 edition of Popular Science"

304

There are various explanations as to why the flying car has not yet become an every day reality, but most plainly it seems to be a lack of incentive rather than imagination. In the heady days of the 1920s, the flying car was seen as a foregone conclusion. The November 1926 PS article detailed great strides in the machinery of flight that were bringing the technology down to the common man. But it was not to be. By the time WWII ended, the endless optimism of the 1920s had been thoroughly blunted, first by the *Great Depression* of the 1930s and then by the geopolitical struggles of the 1940s. Upon the post-war return to normality, a different kind of optimism reigned, tempered by rising *Cold War* anxieties. A military-industrial complex hungry for the best aeronautical engineers also fostered a new view of the sky not as a place to be cruised by the common man, but as an important strategic territory to be dominated by fearsome long-range bombers and rockets destined for outer space.

305



"Why is the airborne car such an enduring dream? There's something tantalizing about the freedom of a personal transportation device unhampered by roads or traffic, particularly in a world where gridlock and invasive airport-security checks have become the norm. If history is any guide, we'll be seeing a slew of new personal levitating devices in coming years - if nowhere else, then in the pages of this magazine."

Popular Science **(March 1926)**

RE: a *Popular Science* archive search for the phrase: "flying car," brings up 28 issues that contain the term. The articles reflect the eras in which they were written; wartime articles are filled with guarded optimism, mid-century (left) stories are filled with optimism while modern-day articles offer a more careful, analytical approach.

306

In post-WWII America, fuel was cheap and with a massive new interstate highway system connected all the places people wanted to go, the personal automobile became king. A series of hybrid car-plane designs (most were just planes with detachable wings) popped up during the 1940s and '50s, but without a clearly defined need for personal flying vehicles the concept was relegated to the purview of science fiction writers and futurists. By the mid-20th Century, personal flying machines went from feasible to fantastical. But the idea, though pushed to the fringes of invention, never quite died. Fictional futurism ranging from *Judge Dredd* to the *Jetsons* has relied on flying cars to set the scene. The opening sequence to *Futurama* takes viewers on a first-person drive through the congested "Skyways" of a crowded 31st-Century metropolis. Even *Back to the Future Part II*, the pop-culture icon, teased us all with flying car technology and several other predicted technologies that have since come to exist in some form.

307

Not for Everyone

308

"Originally I wanted the roll to be controlled by the rider shifting their body weight, like a motorbike…Most people can't parallel park, so I can't see most people owning one of these without killing themselves"

Chris Malloy, **Inventor of the *Hoverbike***

RE: costing $50K per unit, Hoverbike is an aircraft which is ridden like a motorcycle but has ducted fans at the front and back instead of wheels. It uses a computerized control system during flight.

309

Above: caption: "The Hoverbike, a flying motorcycle, during a tethered flight test. It's intended as a cheaper alternative to a helicopter for cattle-mustering."

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311

The People's Car

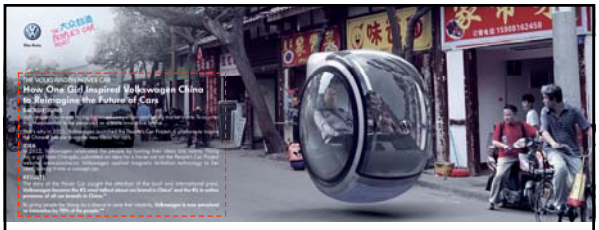
312

"One day, if we have room temperature superconductors, then our cars would float on a cushion of magnetism. Our roads would be made of this superconductor; to get our cars going, all we have to do is blow on them, and they start to move. It would solve the energy crisis, since much of our oil goes into overcoming the friction of the road."
Michio Kaku, **Theoretical Physicist**
RE: *Magnetic Levitation* (a/k/a "MagLev") uses the natural tendency of magnets with the same polarity to repel each other (i.e. MagLev trains). However, such vehicles would require an enormous infrastructure investment (i.e. a grid built over roads to provide the magnetic force). MagLev vehicles would rise just a few inches above the ground, tethered to the road network. As such, they would not be in the true spirit of the "flying car" ideal (free flight) but more in keeping with the spirit of the *Hovercar*.

313

"The days of the hovercraft are upon us. As Google's self-driving cars prepare to roll out onto the streets of Nevada, Volkswagen one-ups everyone with its concept design for a hover car. The Volkswagen hover car is a product of the 'People's Car Project' in China, which called upon customers to contribute design ideas for Volkswagen's model of the future…"
The Huffington Post, **May 8th 2012**

314

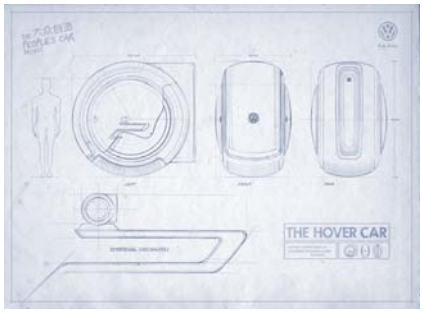


THE VOLKSWAGEN HOVER CAR
How One Girl Inspired Volkswagen China to Reimagine the Future of Cars
BACKGROUND
Volkswagen China was facing increased competition and falling market share. To counter this, they needed to be perceived as a more innovative brand. That why in 2011, Volkswagen launched the People's Car Project, a platform to inspire the Chinese people to create new ideas for cars.
IDEA
In 2012, Volkswagen celebrated the people by turning their ideas into reality. Wang Jia, a girl from Chengdu, submitted an idea for a hover car on the People's Car Project website, www.zooche.cn. Volkswagen applied magnetic levitation technology to her idea, turning it into a concept car.
RESULTS
The story of the Hover Car caught the attention of the local and international press. Volkswagen became the No. 1 most talked about car brand in China and the No. 1 in online presence of all car brands in China. By giving people like Wang Jia a chance to voice their creativity, Volkswagen is now perceived as innovative by 70% of the people.

315

"…The hovercraft uses electromagnetic levitation to float along its own grid above the regular road network; distance sensors keep the craft from colliding with other vehicles. The disc-shaped pod seats two people and is controlled by a joystick that offers amazing maneuverability. The car can move both back-and-forth and side-to-side and can even spin on an axis. To top it off, the concept car produces zero emissions…"
The Huffington Post, **May 8th 2012**

316



317

Part 6

Between the Wars

318

Ace's High

319

"Within the next two decades autos will be made with folding wings, so that when on a straight stretch of road they can be spread and the machine will take to the air. The present-day tendency to lighten the construction of automobiles through the extensive use of aluminum alloys, without sacrificing the safety factor, and the great progress made in airplane construction as the result of recent experiments with motorless gliders, as well as motor gliders, are the two factors that will make this possible…"

RE: excerpt from an article that appeared in the July 1924 issue of *Popular Science* magazine, written by *Eddie V. Rickenbacker,* entitled: *Flying Autos in 20 Years: An Expert's Visionary Picture of Motor Travel in the Future.* As early as 1924, WWI "Ace of Aces" and aviation pioneer *Eddie Rickenbacker* (left) predicted that the flying automobile would soon take to the air.

320

"…This combination automobile-airplane will have a body shaped similar to the present hydroplane hull, making it both a water and land machine. The wheels will protrude sufficiently to permit the machine to be driven on the highway after the wings have been collapsed, propeller disengaged and the automobile control mechanism applied, which in reality will give a three-in-one conveyance…"

RE: excerpt from an article that appeared in the July 1924 issue of *Popular Science* magazine, written by *Eddie V. Rickenbacker,* entitled: *Flying Autos in 20 Years: An Expert's Visionary Picture of Motor Travel in the Future*

Left: caption: "The German 'Auto-Launch.' It hits forty miles an hour on land or twenty knots on water" (April 1917)

321

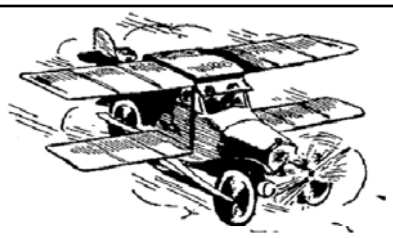
Imagine the Convenience

322

"…Imagine the convenience of being able to drive around in the city, as is done nowadays, and then when you start for some other town and get on a straight of way or enter a nearby pasture, to unfold the wings on the machine and take to the air! It will mean quicker transportation for the suburbanite, for people living at a distance from a large city, and for traveling salesman, who now uses the motor car and highways to cover his territory…"

RE: excerpt from an article that appeared in the July 1924 issue of *Popular Science* magazine, written by *Eddie V. Rickenbacker,* entitled: *Flying Autos in 20 Years: An Expert's Visionary Picture of Motor Travel in the Future*

323



"…Recent glider trials held throughout Europe have shown ways of increasing the lifting power, while reducing the spread of airplane wings. Further, it has been demonstrated that with properly constructed wings and properly designed motors it is possible to fly almost any type of fuselage…"

RE: excerpt from an article that appeared in the July 1924 issue of *Popular Science* magazine, written by *Eddie V. Rickenbacker,* entitled: *Flying Autos in 20 Years: An Expert's Visionary Picture of Motor Travel in the Future*

324

Fear of Flying

325

"…Today, flying is no more dangerous than motoring on the streets and highways – sometimes I think not as dangerous. However, people have a fear of flying that will have to be overcome just as they had to overcome their fear of traveling 20 miles an hour in the horseless carriage of 20 years ago…"

RE: excerpt from an article that appeared in the July 1924 issue of *Popular Science* magazine, written by *Eddie V. Rickenbacker,* entitled: *Flying Autos in 20 Years: An Expert's Visionary Picture of Motor Travel in the Future*

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Above L&R: *Eddie Rickenbacker* during his car-racing days

"…In the combined automobile-airplane I see a machine that is not greatly different from the present-day motor car, except in its decreased size. The body will be narrower and shorter, to reduce weight, and will be of a modified stream-line design. The engine will be made lighter and smaller, but with about the same horsepower as is used today through the use of a supercharger. The wings will fold back against the sides of the car when driving along the street and will have sufficient span to lift the car off the ground at a mod-erate 'take-off' speed. The 25-foot span that it is possible to build on the present-day motor-car – 12½-foot wings on each side – will be sufficient to lift the lighter and more efficiently built machine of 1940…"

RE: excerpt from an article that appeared in the July 1924 issue of *Popular Science* magazine, written by *Eddie V. Rickenbacker,* entitled: *Flying Autos in 20 Years: An Expert's Visionary Picture of Motor Travel in the Future*

327

Airborne Commuting

328

"…Consider what such a machine will mean to the man who works in the city. He could live several miles farther away from the heart of the city and spend less time getting to and from work, By flying, more speed could be made with a greater degree of safety than now is possible on the streets and highways…"

RE: excerpt from an article that appeared in the July 1924 issue of *Popular Science* magazine, written by *Eddie V. Rickenbacker,* entitled: *Flying Autos in 20 Years: An Expert's Visionary Picture of Motor Travel in the Future*

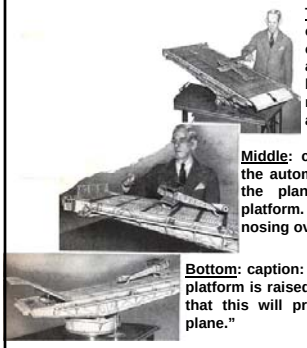
329

"…It would not take a great stretch of imagination to foresee municipalities regulating the height of buildings to uniformity, the streets to be bridged, in order to form one vast landing-field in the center of each city for flying machines. The landing-field or tops of the building could be connected with the street level by elevators so that a machine alighting could descend to the street and be driven about as an automobile. At the end of the business day it would be driven back to the elevator and lifted to the roof to take-off for the homeward flight…"

RE: excerpt from an article that appeared in the July 1924 issue of *Popular Science* magazine, written by *Eddie V. Rickenbacker,* entitled: *Flying Autos in 20 Years: An Expert's Visionary Picture of Motor Travel in the Future*

Left: cover of the October 1937 issue of *Mechanics and Handicraft* magazine featuring a rooftop airport that could swing into the wind

330



Top: caption: "J.H. Jones illustrates the operation of the new landing and take-off platform constructed so that it will automatically swing into the wind. The base of the platform is arranged in a manner similar to the landing deck on an aircraft carrier."

Middle: caption: "Here the inventor points out the automatic safety net which springs up after the plane has traversed two-thirds of the platform. This net is to prevent the plane from nosing over at the far end."

Bottom: caption: "The protection 'bank' at the rear of the platform is raised after the plane lands, the theory being that this will prevent a tail wind from upsetting the plane."

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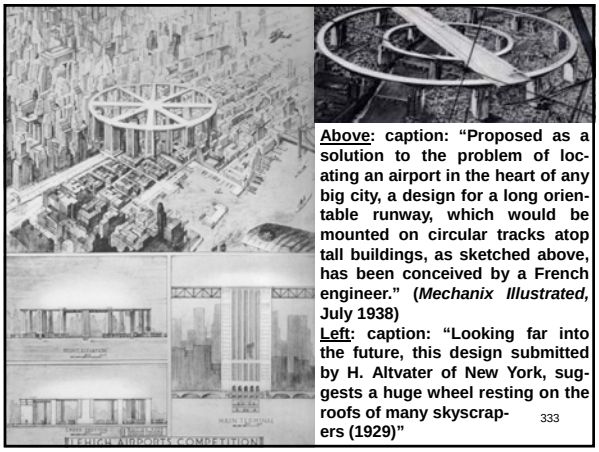
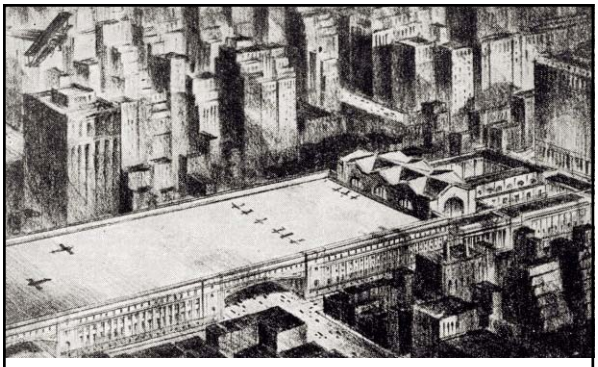
"Mounted on roofs of office buildings, rotary airports may solve the problem of creating adequate landing fields within the limits of large cities. Erected on a steel-girder foundation, the long, overhanging runway resembles the deck of a large naval aircraft carrier. Machinery housed within the supporting structure would turn the rotary airport so that planes would always be able to take-off or land into the prevailing wind."
***Popular Science,* January 1937**
Above: caption: "Model of a proposed airport that can be erected on the roof of a city building. The runway, supported by girders, turns to face the wind."

332



Above: caption: "Proposed as a solution to the problem of locating an airport in the heart of any big city, a design for a long orientable runway, which would be mounted on circular tracks atop tall buildings, as sketched above, has been conceived by a French engineer." (*Mechanix Illustrated,* July 1938)
Left: caption: "Looking far into the future, this design submitted by H. Altvater of New York, suggests a huge wheel resting on the roofs of many skyscrapers (1929)"

333



Above: caption: "Proposed landing platform over Pennsylvania Railroad Station and Post Office, New York City, 1929"

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335

More Than Pure Fancy

336

"…Such a forecast is more than pure fancy. It is founded on present progress in automobile and airplane design."
RE: excerpt from an article that appeared in the July 1924 issue of *Popular Science* magazine, written by *Eddie V. Rickenbacker,* entitled: *Flying Autos in 20 Years: An Expert's Visionary Picture of Motor Travel in the Future*
Left: caption: "April 17, 1950 cover of *Time* magazine." *Edward Vernon Rickenbacker* (1890-1973), with 26 aerial victories, was America's most successful fighter pilot of WWI. He was also a race car driver and automotive designer, a government consultant (on military affairs) and a pioneer in air transportation, particularly as the longtime head of *Eastern Air Lines.*

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338

It's No Trick

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"…By an odd coincidence, it was on the anniversary day of the Wright Brothers' first successful flight that I was in the office of Richard F. Hoyt, a leading Wall Street broker…Mr. Hoyt has found it convenient - and a lot of fun - to commute in a flying boat from his office to his home in the country…'But isn't it a bit hazardous?' I suggested. 'Don't you believe it,' he shot back. 'There's altogether too much said about accidents and crashes. It's no trick to drive a plane. The way they're building machines now, flying is no harder than driving a car; about the only difference is that you drive in three dimensions instead of two'…"
RE: excerpt from an article that appeared in the March 1926 issue of *Popular Science* magazine, written by *Edgar C. Wheeler,* entitled: *Folks Who Fly Their Own Planes*

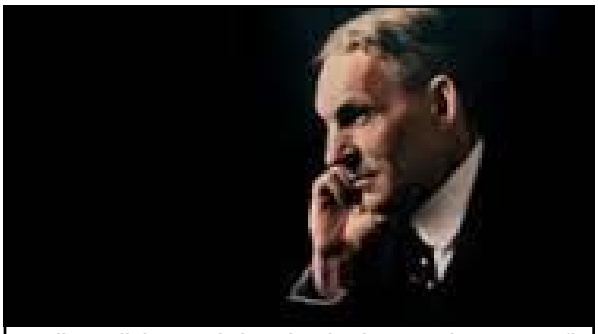
340

20/20 Foresight

341

"…There is another side of the story, however – one not, so encouraging to those of us who have dreamed of flying some day from our roof tops or back yards – as I soon learned when I visited the Curtiss Field, Long Island. There I talked with C.S. Jones – 'Casey,' as he is popularly known to fliers, general manager of the Curtiss Flying Service, Inc. 'I don't like to be discouraging,' said he, 'but it is my opinion that airplanes will not compete with the pleasure automobile. Rather, the airplane is the competitor of the railroad train and the motor truck. Unlike automobiles, airplanes are restricted by the necessity of flying fields and well-equipped service stations. At the present time practically all the planes we sell are purchased for commercial purposes, for passenger and express service, for air mail, and for aerial photography. Private individuals who purchase machines are in the main young men who come to our aviation school…some seek careers as commercial pilots; others just the sport of flying; others become Gypsy Fliers, wandering from place to place and making trips for hire; and still others learn to fly because they see a big future for aviation…"
RE: excerpt from an article that appeared in the March 1926 issue of *Popular Science* magazine, written by *Edgar C. Wheeler,* entitled: *Folks Who Fly Their Own Planes*

342



"We'll put all the people into the air whenever they want to fly. Aviation is bigger in possibilities than anything else in the world. In a motor car, you can go wherever land exists; in an airplane, you can go wherever man can breathe."
***Henry Ford* (Fall 1925)**

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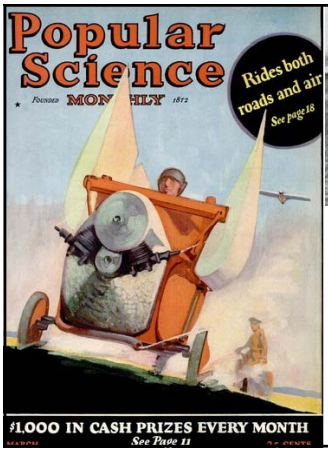
344



Above, inventor *J.H. Maykemper*, of Frankfurt, Germany, poses with his creation – a combination "flivver" airplane - in its monoplane manifestation, with propeller in place and wings unfolded. At left, the March 1926 cover of *Popular Science* depicts the machine in use as an automobile, with wings folded and propeller removed for road travel.

345

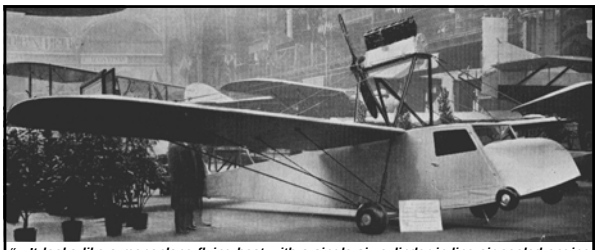
346

Ugly Duckling

347

"M. Lepere's previous designs were ancestors of which his latest progeny is not worthy. The only aeroplane on this stand has obviously never flown, will probably take off quite successfully, but has little to justify it when it does…"
***The Aeroplane*, December 3rd 1930**
RE: excerpt from an article entitled: *On the Aero-Show in Paris* (a description of the 1930 *Paris Air Salon* held in the *Grand Palais* starting in 1917). Called an "Aeromobile," it was an aircraft mixed with the concept of a car (the magazine's reporter objected to an aircraft that looked somewhat like a car). Critics called it a "deliberate attempt to imitate a motor-car" and panned the design when it was introduced in 1930.

348



"…It looks like a monoplane flying-boat with a single six-cylinder in-line air-cooled engine supported above the hull in the Rohrbach-Dornier-Saro manner. It is not, however, a flying-boat of any sort and has four air-wheels on permanent structures to prove it. The engine is at present a dummy and seems like the advance notice of a Renault type, at present non-existent. The fuselage is of steel tube, covered with fabric. In the extreme nose is a side-by-side cabin with a large door on each side, a wide rectangular front window, a skylight, one set of controls, and a seat exactly similar to that of an ordinary motor-car. The rudder is operated by pedals very similar to clutch and brake pedals, and the careful concealment of everything aeronautical from the notice of passengers leads to the belief that the machine was a deliberate attempt to imitate a motor-car. The size of the aeroplane suggests that its top speed and landing speed alike will be low…"
The Aeroplane, December 3rd 1930
RE: excerpt from an article entitled: *On the Aero-Show in Paris*

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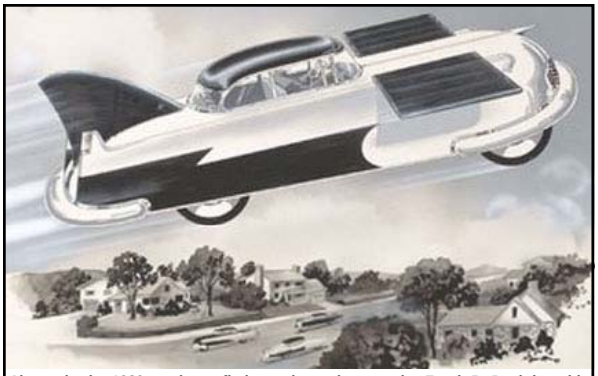
"…Two Dunlop airwheels are mounted on normal under-carriage members with spiral springs on the shock-struts, and two smaller ones are mounted on rigid axles forward as an anti-capotage device. The height of the engine probably explains this precaution. A tail-wheel is also fitted. All surfaces, including the wings, are wire braced top and bottom, and the main wings have lift and landing wires supporting them at two points, one nearly half way out along the span and another nearer the tips. They consist of stranded cables bound to the edges of streamlined wooden fairings. The front of the fuselage is sheet metal and the airscrew is mounted behind the uncowled engine as a pusher."
The Aeroplane, December 3rd 1930
RE: excerpt from an article entitled: *On the Aero-Show in Paris.* The drag developed by this design would make it a rather slow aircraft and the high center-of-thrust would tend to lower the nose when power was applied. However, there are a number of successful flying boats that overcame this problem by re-designing the tail-boom to provide more clearance and lowering the height of the engine pylon. A fairing for the engine would have helped to increase air speed as well.

350

Ahead of His Time

351



Above: in the 1920s, science fiction artist and cartoonist *Frank R. Paul* drew his interpretation of a flying car. Cars of the 1920s were boxy and, for the most part, painted black. Paul's concept of a futuristic flying car appears to be something out of the 1950s.

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(Not) Worth Waiting For

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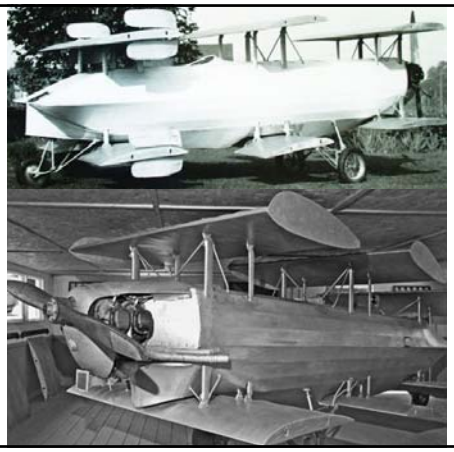
Designed in the 1920s, built in the 1930s (1935) and tested in the 1940s, '50s and '60s, the *Skroback Roadable Airplane* (above) was the brainchild of a retired industrial technician from upstate New York named *Frank Skroback.* Powered by a tractor engine, Skroback's flying car had a 21-foot tubular steel and linen fuselage with six (7-foot) fixed wings in a bi-plane configuration. Based on the *Flying Flea* (a French aircraft design-ed by *Henri Mignet*), the Skrobach Roadable (tested in 1945) never got past the prototype stage (when Skroback tested it on the highways of his hometown of Syracuse, NY, he found it lacked "rudder authority"). In 2010, Skroback's prototype was sold at auction for $65K.

354



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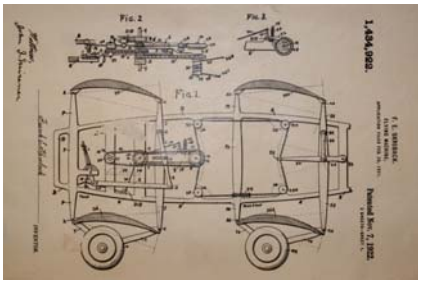

356

Expedited Take-Off

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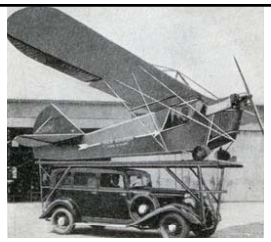

"Fugitive criminals stand little chance of escape when the Oregon State police take out after them. They are hunted down from the air by a plane that takes off from the top of an automobile, which then goes after the felons on the ground. How the scheme works is illustrated above. The small plane rests on a platform on the top of a sedan and has folding wings to facilitate storage. When an alarm comes in, the wings are unfolded, the motor car speeds up to 25 miles per hour, and the ship takes to the air in search of the fugitives. Dick Rankin, Portland, Oregon, aviator, is the originator of the stunt."
***Modern Mechanix and Inventions,* August 1933**
Above: caption: "When alarm comes in, Oregon state police pursue fugitive criminals in this small plane, which takes-off from platform mounted on top of touring car"

358

Training Day

359

"So that a student pilot may learn the feel of the controls of a glider or airplane before he risks his first solo flight, a foolproof training machine has been designed by a Beaver Falls, Pennsylvania, inventor. Seated in the cockpit of a captive plane, the pilot may send his craft through the maneuvers of diving, banking, and zooming; but the worst that can befall him if he should crash is a gentle bump on rubber-padded cushions…"
***Popular Science,* Oct. 1933**

360

"…For a training lesson, an instructor takes his place at the wheel of a motor truck that carries the machine, and starts it across the airport field. As soon as the car reaches a speed of twenty-five miles an hour, wind pressure, aided by a coil spring serving as counterweight, is sufficient to raise the captive plane and its pilot into the air. While the pilot puts his craft through its various evolutions, the instructor checks up on his ability and his weak points. If a sudden gust strikes the machine or if the pilot jams over his controls too suddenly, snubbers curb the maneuver and springs come into play to absorb the jolt. The instruction the student receives is identical with that he would get if the machine were actually flying but he learns without running the danger of a crash."
***Popular Science*, October 1933**

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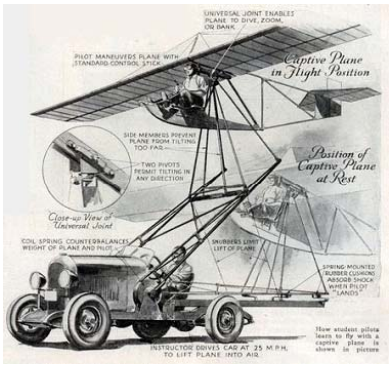


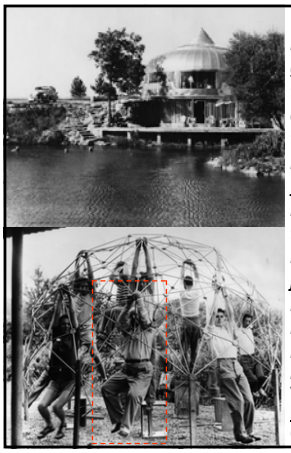
362

Bucky's Folly

363

"As the designer R. Buckminster Fuller liked to tell it, his powerful creative vision was born of a moment of deep despair at the age of 32. A self-described ne'er-do-well, twice ejected from Harvard, a failure in business and a heavy drinker, he trudged to the Chicago lakefront one day in 1927 and stood there, contemplating suicide. But an inner voice interrupted, telling him that he had a mission to discover great truths, all for the good of humankind. That was the pivot on which, he claimed, his life turned. The onetime loser entered a period of such deep reflection that he was struck silent, then emerged bursting with creativity as he developed the 'Dymaxion' inventions: technologies that he promised would transform housing, transportation, urban organization and, eventually, the human condition. From 1927 on, Fuller seemed utterly self-assured, even messianic, as he developed innovations like the geodesic dome, equal parts engineering elan and poetry…"
***The New York Times*, June 2008**

364



"If somebody kept a very accurate record of a human being, going through the era from the Gay '90s, from a very different kind of world through the turn of the century - as far into the twentieth century as you might live. I decided to make myself a good case history of such a human being and it meant that I could not be judge of what was valid to put in or not. I must put everything in, so I started a very rigorous record."
R. Buckminster Fuller
Top: Dymaxion House (1947)
Bottom: Geodesic Dome (ca. 1960)

365

"…For all his creative energy, Fuller's legacy is slippery. By conventional measures he accomplished little. The efforts to mass-produce his houses, though written about widely, failed. His project to develop his efficient three-wheeled autos collapsed after an accident killed the driver of one…"
***The New York Times*, June 2008**
RE: the *Dymaxion Car* was a vehicle designed by Fuller, featured prominently at Chicago's 1933/34 *Century of Progress* World's Fair
Left: caption: "The Dymaxion car, ca.1933, artist Diego Rivera shown entering the car, carrying coat."
Right: caption: "Car No. 2, complete. Headlights are recessed in the body, providing air intake."

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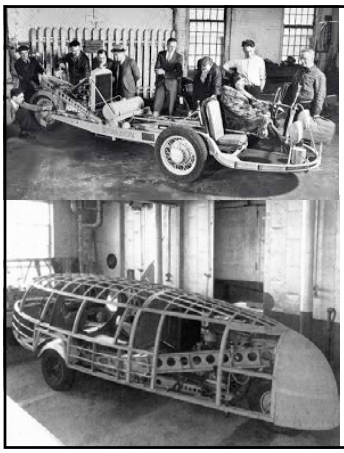

"With such a vehicle at our disposal, Fuller felt that human travel, like that of birds, would no longer be confined to airports, roads, and other bureaucratic boundaries, and that autonomous free-thinking human beings could live and prosper wherever they chose."
***Lloyd S. Sieden,* Author**
RE: the *Dymaxion Car* was not strictly an automobile. Instead, it was the "ground-taxing mode" of a vehicle that would be able to fly, land and drive (an "Omni-Medium Transport"). The first prototype was sold to the *Gulf Oil Co.,* who showed it off at the 1933 *Century of Progress Exposition* in Chicago. All three wheels turned, making the car excellent for parallel parking, but its V-shaped bottom tended to make it lift off the pavement at about 90 mph (its rear wheel lifted from the ground, as it was supposed to in Fuller's original auto-airplane conception)

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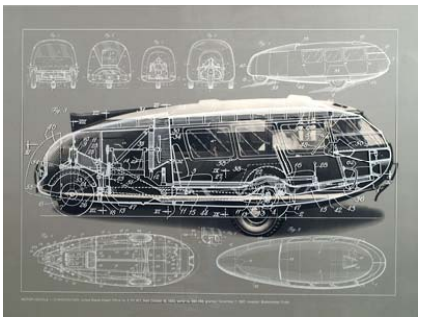

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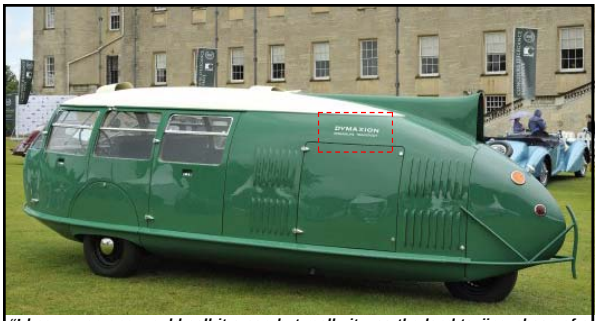
Fuller formed the *Dymaxion Corporation* and built three prototypes. The bodywork was aerodynamically designed for increased fuel efficiency and speed, featuring a lightweight chromoly-steel hinged chassis, rear-mounted V8 engine, front-drive and three-wheels. The vehicle was steered via the third wheel at the rear, capable of 90-degree steering lock. Able to steer in a tight circle, the Dymaxion often caused a sensation, bringing nearby traffic to a halt. Shortly after launch, in October 1933 a prototype crashed after being hit by another car, killing the Dymaxion's professional driver (the car turned over, killing *Francis T. Turner* and injured two potential investors). The other car was driven by a local politician and was illegally removed from the accident scene, leaving reporters who arrived subsequently to blame the Dymaxion's unconventional design (investigations exonerated the prototype as the cause of the crash). Fuller later crashed another prototype, this time with his daughter; Allegra, aboard. However, the *Dymaxion Car* was hardly without faults (i.e. inadequate windshield wiper coverage and an awkward periscope that replaced a rear-view mirror). Unable to interest automotive executives, Fuller used his family inheritance to finish the second and third prototypes. After selling all three prototypes, Fuller dissolved *Dymaxion Corporation*, maintaining the Dymaxion Car was never intended as a commercial venture. Only one of the three original prototypes survived.

369

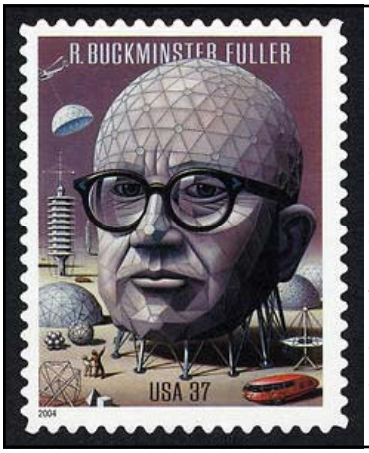


"I knew everyone would call it a car, but really it was the land-taxiing phase of a wingless, twin orientable jet stilts flying device."
***R. Buckminster Fuller,* 1960**
Above: the surviving prototype. Fuller associated the words *Dynamic*, *Maximum* and *Tension* in much of his vocabulary to sum up his overarching goal of: "maximum gain of advantage from minimal energy input." In fact, he did not coin the word "Dymaxion." A marketing executive took note of Fuller's extensive use of the three words and combined them to form a new word representative of Fuller's broad ideas: *DyMaxIon.*

370

"Young man, you amaze me! I cannot conceive anything I have ever done as having the slightest practical application, but you appear to have found practical applications for it"
Albert Einstein
RE: his response after reading the manuscript for Fuller's first book, published in 1936. Realizing that, as physical beings, humans understood things best when explained using physical materials (i.e. models), such "artifacts" helped Fuller to explain complex metaphysical principles and how they could best be applied to benefit humanity. The success of Fuller's life is indisputable:
• Granted 25 U.S. patents;
• Authored 28 books and published thousands of articles;
• Received 47 honorary doctorate degrees;
• Presented with hundreds of awards;
• Circled the globe 57x, working on projects and lecturing, and;
• Presented an average of 100+ "Thinking Out Loud" lectures per year (ranging from two to six-plus hours in length, even when he was in his eighties).

371



"…As Mr. Katz put it, 'Fuller's greatest invention was not a house or a car or a dome. It was himself.'"
***The New York Times,* June 2008**
RE: living as a "global citizen," Fuller was able to learn by contemplation and teach by example, demonstrating with both his successes and failures that each of us possesses tremendous potential that can help to create, as he put it: *"A world that works for everyone."* Most important was his demonstration of the importance of the individual human being in the grand scheme of human evolution.

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"Whenever I draw a circle, I immediately want to step out of it"
R. Buckminster Fuller

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Half & Half

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Above: caption: "Half auto and half plane, the front wheel of this new vehicle leaves the ground as machine hits high speed." *Professor T. Edward Moodie* invented the *Roadplane* in 1934. Strictly speaking, however, it wasn't a "flying car." When the three-wheeled vehicle reached sufficient speed, its front wheel lifted off the ground in what can only be described as a "wheelie." While the car balanced on two rear wheels, the driver used a yoke to control the car's rudders. The Roadplane was an unconventional design (to say the least), which is probably why it never got past the prototype stage.

375

Joy Riding

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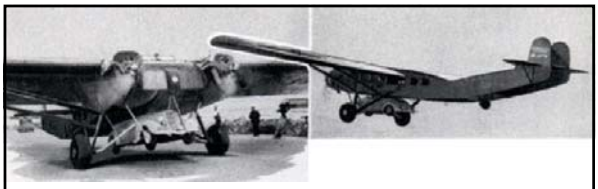

"A spectacular 'first time in history' - an automobile actually taken for a mile high joy ride - recently astonished onlookers at Floyd Bennett Field, New York. The plane was a giant Uppercu-Burnelli transport. With a 12-foot wide cabin, there was more than enough room between the wheels of the landing gear to strap on a standard 1935 automobile…"
***Modern Mechanix and Inventions,* May 1935**
Above L&R: caption: "'Auto Strapped to Plane is Tested One Mile Above the Earth.' Suspended beneath landing gear of this giant Uppercu-Burnelli transport plane, this automobile recently was given a starting test by Zeke Meyer, racing driver, at altitude of more than a mile. Temperature was zero, speed 130 m.p.h."

377

"…The thrilling adventure was an aviator's dream come true - a practical realization of the 'Flying Tank' pictured on the July, 1932, cover of Modern Mechanix and Inven-tions. Heralding the intro-duction of new war time practices, transport planes could secretly land armored cars or radio controlled tanks behind enemy lines at night. Even light artillery or ambulance cars might be moved by air in this manner…"
***Modern Mechanix and Inv-entions,* May 1935**

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"…How formidable a weapon the flying tank will be in actual warfare…Tanks can land almost directly on protected enemy territory, shed their wings, and plunge into action with their 75 millimeter guns blazing…"

***Modern Mechanix and Inventions,* July 1932**

RE: in 1932, an American engineer named *Walter J. Christie* designed a "Flying Tank." Christie's two-man tank (right) was a four-ton armored vehicle equipped with a 1K-hp engine, a tractor propeller and detachable wings. After landing, the tank's operator would pull a lever releasing its wings enabling it to go directly into battle. The British and the Japanese also had similar projects (the British and Russians managed to get their tanks flying with the help of a tow from a multi-engined heavy bomber). However, both Great Britain and the Soviet Union abandoned their efforts when the realization set in that it was easier to carry a light tank in a glider (or push it out of an airplane with a parachute) than to try and fly it into battle. Even so, some original thinking was demonstrated to solve a very challenging problem.

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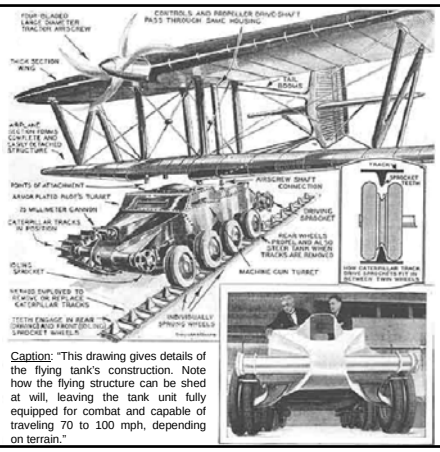

Caption: "This drawing gives details of the flying tank's construction. Note how the flying structure can be shed at will, leaving the tank unit fully equipped for combat and capable of traveling 70 to 100 mph, depending on terrain."

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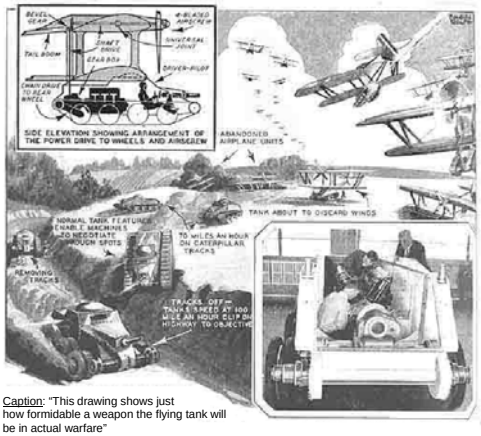


Caption: "This drawing shows just how formidable a weapon the flying tank will be in actual warfare"

381

One tank of Christie's design was actually built (above), but not the airframe. However, the Russians bought at least one of the tanks he created and applied his original thinking to their airborne tank initiative in 1940.

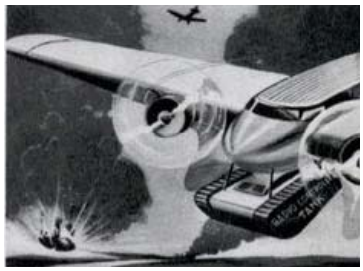
382

"Combination of a high-speed tank and a fast plane is the new war machine being developed by Walter J. Christie. In military service, the tank would be attached to the fuselage of the plane to be transported to any point desired. Upon landing, the tank would be detached, free to advance on enemy positions. The possibility of whole fleets of these tanks which may be moved quickly from one sector to another is being studied by military experts. A convertible high-speed tank invented by Christie is now under construction by the U.S. war department. With the caterpillars attached for operation in rough country, the tank is capable of sixty-five miles per hour and without caterpillars, ninety-five miles per hour. The higher speed, on the open road, would facilitate movement to a new vantage point."

***Popular Mechanics,* May 1936**

Above L&R: caption: "'Fast Tank-and-Plane Latest War Machine.' Left, composite photo showing how tank-carrying plane would appear in flight. Right, latest high-speed tank which travels ninety-five miles per hour when caterpillar equipment is removed."

383



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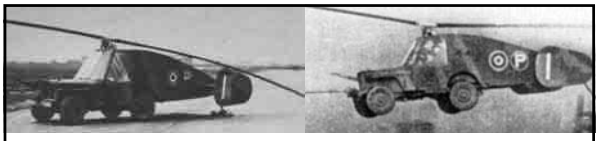

Tanks weren't the only military equipment the British designed to fly during WWII - they also developed a flying Jeep. Designed in 1940 by *Raoul Hafner*, the prototype (left) was built in 1942 using a *Willys MB* (a/k/a "Jeep") and tested over the next two years at the *Airborne Forces Experimental Establishment* at Ringway, Manchester. In addition to an autogyro (consisting of a 46-foot 8-inch diameter, two-blade rotor), a streamlined tail fairing (with twin rudderless fins) was also attached to the Jeep. The camouflaged "Hafner Rotabuggy" (its official name) - carrying RAF roundels and a prototype "P" (right) was tow-tested behind a supercharged *Bentley* automobile and achieved gliding speeds of up to 65 mph. The first flight was made on November 16th 1943. In September 1944, a Rotabuggy was towed in the air behind an *Armstrong-Whitworth* bomber. After release, the Rotabuggy reached a speed of 65 mph at an altitude of 400-feet. Like tanks, there were easier ways to deploy a Jeep in battle thus, the Rotabuggy never got past the testing stage. 385

Of Odd Design

386

"…That if some manufacturer could produce a foolproof airplane in large quantities and market it at a low figure, a new phase of the aircraft industry could be developed"
***Eugene Vidal*, Director - *U.S. Bureau of Air Commerce* (BAC)**
RE: in late 1933, Vidal initiated a competition to encourage designers to come up with safe, reliable and inexpensive aircraft that the average person could fly. On October 18th 1934, the BAC awarded a contract for fifteen aircraft to the *Hammond Aircraft Company* of Ypsilanti, MI. During the course of 1935, the BAC contracted for five other aircraft to be purchased. Among these, Waldo Waterman's *Arrowplane* had been delivered and was undergoing service tests. The Arrowplane was unique not only because of its tailless design but also because it was the only aircraft awarded a construction order from an individual (all the others were from existing aircraft corporations). Ultimately, out of the thirty entrants in the BAC's contest, the Arrowplane was one of only two that took prizes. Ironically, the winning Hammond design (for which fifteen examples were ordered) failed to meet the specifications, but the one-off Arrowplane was the first aircraft to meet the BAC's specifications. Later, the Arrowplane was refined into the *Arrowbile* and then the *Aerobile*. 387

"A 'Foolproof' flivver plane, first of fifteen similar craft ordered by the U.S. Department of Commerce in its effort to develop types suited for private flying, recently underwent trials before Government officials. According to the designer, Dean B. Hammond, it can be flown by anyone who can drive a car. Landing, principal bugaboo of a beginning pilot, is made easy. Merely holding back the control stick brings the craft gently and safely to earth from any altitude, and a novel arrangement of landing wheels prevents any chance of nosing over."
***Popular Science*, October 1935**
Above: caption: "Flivver plane in flight during trials before officials of the Department of Commerce. At right is a top view of the aircraft, showing the landing gear which makes it impossible to nose over when landing." 388

What is it?

389

In the late 1920s and early '30s, two men; *Jack Northrop* and *Waldo Waterman*, were independently working on the concept of a "flying wing" aircraft design within a few miles of one another. While Northrop was doing his work at Burbank, Waterman set up shop nearby at the *Los Angeles Metropolitan Airport* (today known as the *Van Nuys Airport*). The two men had very different motives for pursuing such a radical design. Waterman thought that the configuration held promise for a "flivver" - a small "every man's" airplane which was as easy to operate as a car. Northrop was driven by the desire to refine aircraft design to achieve the lowest possible drag thus, he saw a tailless wing as the ultimate solution to the problem. Northrop's design first flew in 1928; Waterman's wing flew in 1932. Construction on the *Whatsit* (NX12272) started in 1929 and included a number of notable design innovations, including the first documented use of "elevons" (for both roll and pitch control). A trim plane, which was adjustable on the ground, protruded on short booms in front of the nose. The wings featured a 15-degree sweep and the tips supported small rudders. Unlike most planes of the era, the Whatsit used tricycle landing gear complete with a steerable nose wheel.

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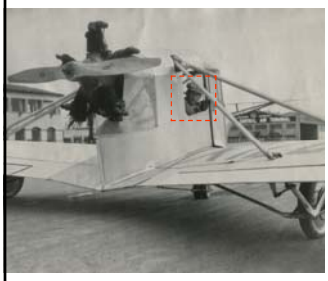

Left: caption: "'A New-Type Plane Makes Debut.' Because everyone who has seen it fly has gasped, 'What is it?.' Waldo D. Waterman, ex-Air Mail pilot and aeronatuical veteran of Santa Monica, California, named his unique new flying wing plane just that, 'Whatsit.' The novel two passenger tailess craft, which travels more than one hundred miles an hour, powered with a small radial air-cooled engine, appears to be one answer to America's need for a low priced, simply and economically constructed everyman's flivver plane. Photo shows *Waldo D. Waterman* in cockpit of his new plane at the Grand Central Air Terminal, Glendale, CA (2/17/1934)."

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Above: caption: "The Waterman Whatsit after being rebuilt in 1932, complete with a canard mounted on the nose." Announced in the May 1934 issue of *Popular Aviation* magazine as: "A New Aspirant for the $700 Class," made reference to the canard-type, pusher-prop light plane built by *Waldo D. Waterman* of Santa Monica, CA. This two-passenger, Kinner powered, swept-wing design was the predecessor to the *Arrowplane* purchased by the BAC.

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Work on the *Whatsit* was completed in May 1932 and Waterman commenced taxi tests at LA Metropolitan. After several abortive flight attempts which ended in several minor incidents, Waterman finally got the plane airborne in July 1932 (although he quickly found that it was somewhat unstable in pitch). This was due to the close-coupled vertical relationship between the pusher engine's thrust line and the wing's *Center-of-Pressure*. This relationship affects an aircraft's longitudinal static stability and, while it is less noticeable in traditional fuselage/tail aircraft designs, it is especially critical in tailless swept flying wing designs (even modern designs struggle with such problems). In October 1932, the aircraft was almost destroyed in a landing accident. Discouraged, Waterman shelved the project and took a job as an airmail pilot for *Transcontinental & Western Airlines* (TWA). In late 1933, Waterman took leave from TWA to work full time on the Whatsit. Waterman realized that a number of aspects of the Whatsit design fit the requirements of the BAC's challenge. Thus, flight testing resumed in February 1934, with only minor modifications. However, the pitch instability remained, and it quickly became apparent that such a sensitive aircraft was not consistent with what was needed for a novice pilot. Thus, Waterman completely redesigned the plane, adapting a high-wing design (a change that solved the pitch stability problem by putting the wing's Center-of-Pressure more in line with the engine's line of thrust), which became the *Arrowplane*, produced under the auspices of the newly incorprated *Waterman Arrowplane Corp*. The plans for the new aircraft were submitted to the BAC during 1934. Waterman then received a contract to build one prototype Arrowplane.

395

Waldo Waterman's *Arrowplane* was completed in May 1935. Still not a "flying car," its flight characteristics were good enough to give Waterman cause to now think about adapting roadable features. The Arrowplane was turned over to the BAC in July 1935. *John Geisse*, Chief of the BAC's Development Section, took delivery of the craft in California and with only 35 hours of flying experience, flew it to Washington, DC. Waterman was concerned about Geisse's lack of experience but was told by *Eugene Vidal: "If John Geisse can fly and successfully handle the airplane, that alone is sufficient proof of its meeting our goals."* On August 12th 1935, Geisse completed the transcontinental flight without any difficulty. Geisse commented in his report, which appeared in the September 1935 issue of *National Aeronautic Magazine*, *"...In this trip across the Continent, which was my first transcontinental trip alone and which included landing on many strange fields and my first night landing, I was impressed by several features of this airplane. Probably the most striking feature is that associated with the three-wheel landing gear which permits almost any kind of landing and the immediate and full application of the brakes at any time. The other features were the excellent visibility and the fact that the airplane could not be stalled even with the control in a full back position...The feature peculiar to the Waterman airplane is, of course, the lack of the customary tail. In such airplanes the problem of longitudinal stability may be a serious one and everyone who has flown this airplane has been pleasantly surprised by its longitudinal stability..."

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"As the Waterman Tailless airplane came to a landing at the Washington, DC airport, at the conclusion of a flight from California, it marked the near end of man's long struggle, since the first days of flying to find a flivver plane that could be manufactured cheaply enough to let every average working man own and fly one…"
***Popular Aviation,* November 1935**

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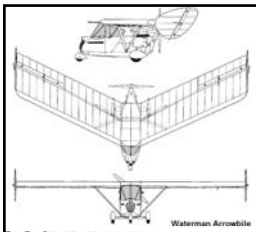

Waterman Arrowbile

Type-Two-Seat cabin tail-less monoplane.
Wings-Back-swept high-wing braced monoplane. Wooden structure with fabric covering. Movable surfaces at the wing-tips act as ailerons or elevators. Small vertical fins and rudders at wing-tips. Rudders operated independently and can be deflected inwardly, simultaneously, to act as air-brakes.
Fuselage-Enclosed nacelle for crew of two.
Undercarriage-Three-wheel type. Two main wheels behind the centre of gravity have oil-spring shock-absorbers with 12 in. travel. Small front wheel under nose of nacelle has similar springing, with 8-in. travel.
Power Plant-One h.p. Menasco four-cylinder in-line inverted air cooled-engine at the back of the nacelle and driving a pusher airscrew. Fuel tank (26 U.S. gallons) above and behind engine, with gravity feed through short pipes.
Accommodation-Enclosed accommodation for two in nose of nacelle, which is designed to provide comfort and accessibility of an automobile. Baggage compartment for three suit-cases below engine.
Dimensions-Span 40 ft. (12.2 m.), Length 18 ft. 6 in. (7.64 m.), Height 8 ft. (2.44 m.).
Weights-Weight empty 1,310 lbs (595 kg.), Weight loaded 1,900 lbs. (863 kg.).
Performance-Maximum speed 110 m.p.h. (176 km.h.), Cruising speed 95 m.p.h. (152 km.h.), Initial rate of climb 700 ft./min. (213.5 m./min.), Range 350 miles (560 km.).

"…The Waterman, a two-place monoplane, is at present powered by a four cylinder inverted, air cooled aviation engine of 95 horsepower (a Menasco furnished by the Bureau). Its distinctive feature, of course, is the absence of a tail. Control surfaces are at the trailing edges, and tips of the wings, which sweep back from the nose of the fuselage. It is a pusher, with the engine in the rear, which materially augments forward and down from the pilot's seat. The undercarriage is of the three wheeled type with the main wheels to the rear, to prevent ground loops and nosing over. It has a top speed of 114 miles per hour. Its simplicity of con-struction makes the Waterman partic-ularly adaptable to production in qua-ntity with prospects for a low sales price and maintenance cost…"
***Popular Aviation,* November 1935**

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Left: caption: "Secretary of Commerce Rope and Assistant Secretary Jonson look into the Arrowplane after John Geisse (right) had just landed at Washington's airport after his transcontinental flight"
Right: caption: "Waldo Waterman cuts a dashing figure with his driving cap and pipe in the cockpit of the Arrowplane"

399

"I do not see the necessity of this Department proceeding with a somewhat ballyhooed program of fixing up a new design of plane to be sold more cheaply on its initiative when there are dozens of manufacturers of ample experience doing this already on private initiative. To date I am not Impressed with the Department's results as all I have seen is the revival of the pusher type plane which we found, over twenty-five years ago, was highly unsafe and undesirable from many standpoints. I do not believe it offers a single desirable feature for the private owner. I also venture to predict that the cheap, safe, private owner plane will come from the industry and not from a government department."
***Grover Loening – National Aeronautics Magazine,* September 1935**

400

Arrowbile

401

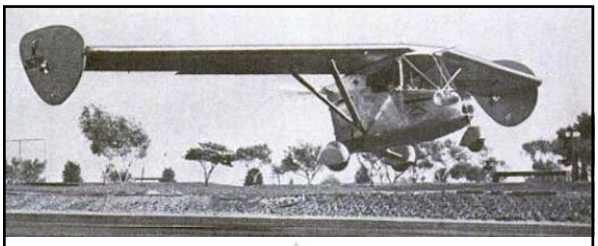
Once the airworthiness of his *Arrowplane* tailless design had been proven, Waterman turned to the task of adapting the design for road use. Thus late in 1935 Waterman incorporated the *Waterman Aeroplane Corporation* and set up a factory in a former Buick dealership in Santa Monica, CA. Expecting to build at least 1K Arrowbiles annually, Waterman proceeded to set up a large organization. He was also determined to use automotive mass production methods. In order to keep costs down he searched in Detroit for a stock automobile engine that could be used to power the plane. He selected a new engine from *Studebaker* in the 90 to 105-hp range. Studebaker would provide fifty engines in exchange for stock in the company. However, technical problems in adapting the Arrowplane for road use were monumental. The landing gear required an entirely new design in order to incorporate the road drive. They had to determine how to drive the propeller at half the speed of an automotive engine. The engine needed to be kept as low as possible for best *Center-of-Gravity* and still leave nine-inches of ground clearance for the prop tips. The final decision was to position the engine very low, right above the rear axle and use six V-belts controlled by a clutch pulley connecting the engine drive shaft to the propeller shaft. As many standard automotive parts as possible were used. Even a standard Studebaker radiator and battery were used. Other automotive parts included brakes, drums, parts of differential gears, headlights and the steering wheel. Legally, the Arrowbile was classified as a motorcycle (since it had only three wheels and weighed less than 1,450 pounds). Thus they were able to use only a single headlight an a small motorcycle license plate.

402

Waterman set a goal to raise $250K - the amount calculated to produce 1K aircraft annually. He also looked forward to the prospect of having every *Studebaker* dealer nationwide selling them for only $3K. In early 1937 the first *Arrowbile* (X262Y) was completed and ready for test flying. First flying the plane on February 21st 1937, Waterman was very happy with its performance. He then prepared for promoting the plane with its first public appearance at the *National Pacific Aircraft Show* in Los Angeles on March 13th 1937. Waterman hoped to sell the plane for $3K (an overly optimistic figure). Materials were ordered for ten aircraft and construction began on six. Waterman received a prize for the best display at the show and better than that, Studebaker announced at the show that they would purchase five Arrowbiles and display them an the *Cleveland Air Races*. As part of the deal, Waterman would have to modify the planes to accept a radiator grill matching Studebaker's 1938 model line.

403

Above: caption: "Waldo Waterman's red and white flying wing, the Arrowbile"



Above & Left: caption: "Detachable wings enable a vehicle of odd design to travel on the ground as well as in the air. Capable of attaining a speed of 110 mph while flying and 55 on the ground, the novel craft is powered by a standard six-cylinder automobile engine. Above, the auto-plane making a landing; Left, the auto-plane with wings detached for use on ground as a car"

404

Above & Left: caption: "The 1937 Waterman Arrowbile." *Waldo Waterman* modified a six-cylinder upright, 100-hp Studebaker engine to build this flying car in 1937 (it carried two people). Only three Arrowbiles (a/k/a *Arrowplane*) were ever produced, though Waterman later attempted to produce roadable versions in the 1940/50s.

405

"The Waterman Arrowbile marks an important milestone in the development of private flying. Future historians may well rate the Arrowbile as the pioneer of a type of aircraft to revolutionize the use of small planes by the general public, for this unique hybrid auto-plane, incorporating a host of novel features, has proved thoroughly practical in extensive tests both as a road car and an airplane."

***AVIATION* magazine, May 1937**

RE: the *Arrowbile* construction was of metal, the nacelle being of welded steel tubing covered with duralumin sheeting. The wings were of two spar construction with spars of routed spruce, formed dural ribs and steel tube drag bracing (cloth covered). AVIATION magazine listed the cruise at 105 mph and the range as 400 miles. It had a fuel capacity of 24 gallons in its single fuselage mounted tank.

406

Left: caption: "Waldo Dean Waterman with his Arrowbile, 1937." Waterman was an accomplished aircraft designer who had worked for *Curtiss Aircraft* (by 1937, he had been working on flying cars for twenty years, including the famous 1917 *Curtiss Autoplane*). The *Arrowbile* was only 20-feet long with a 38-foot wingspan. Its 100-hp *Studebaker* engine propelled it at 56 mph on the ground and 112 mph in the air.

407

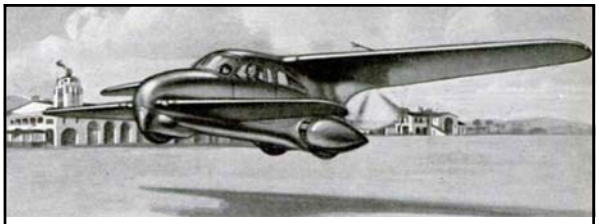
A total of three machines were completed in time for the *National Air Races* in Cleveland. From Cleveland the three ships toured the eastern and central U.S., gathering much publicity along the way. In fact the August 1937 issue of *LIFE* magazine devoted an entire "Photopage" to the *Arrowbile*. The fourth and fifth Arrowbiles were under construction when monetary problems hit Studebaker, curtailing financial support to Waterman. Almost as suddenly as the Arrowbile had become a reality, its promising future turned bleak. With the completion of the fifth airplane, the makeshift factory was forced to close. In 1958, the sixth machine was modified and completed with a *Tucker* automobile engine as the *Aerobile*. The Aerobile was flown many times before joining the *Whatsit* in the *National Air and Space Museum* collection.

408

409

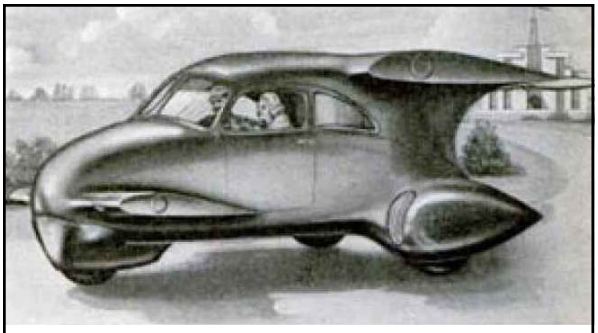
Aerobile

410



Above: caption: "A hybrid land-and-air machine, with wings that can be shed on landing, is proposed for quantity production by a Dayton, Ohio inventor and manufacturer. The machine, called by its designer an 'Aerobile,' is said to have passed wind-tunnel experiments although no actual flying tests have been attempted. The body of the craft forms a three-wheel torpedo-shaped car for road driving after the wings have been removed. The machine is driven by a pusher propeller when it takes to the air." (Dec. 1940)

411



Above: caption: "'Detachable Wings Turn Plane into a Three-Wheeled Car.' The combination automobile-airplane on the road with detachable wings removed" (Dec. 1940)

412

Begun in 1947, the *Aerobile* (span 38 ft; length 20 ft; height 8 ft 11 in; weight 1,710 lbs.) was fabricated from parts of Waterman's earlier designs. Completed ten years later, it was test flown in May of 1957. Its engine was mounted in the rear of the fuselage and power was transmitted to the pusher propeller and/or the two rear wheels (the propeller was not removed for ground operation). The tailless fuselage and quickly detachable wings allowed three-minute conversion from flying to road configuration. Ailerons and wing-tip rudders were interconnected (turns were made by turning the wheel, there were no rudder pedals). The three-wheel (tricycle) landing gear configuration allowed registration as a motorcycle in California. Top speed was about 70 mph on the ground and 120 mph in the air. It was noted that spins were nearly impossible and the Aerobile was very difficult to stall. One proposal was to sell the car and rent wings at local airports. Waterman based his Aerobile design on two previous efforts; *Whatsit*, a tailless plane of 1932 and *Arrowbile*, delivered to the *Department of Commerce* in 1935 as part of the "Safe Airplane" competition.

413

Like its inspiration – the *Curtiss Model 11 Autoplane* of 1917, Waldo Waterman's 1937 *Arrowbile* (a three-wheeled roadable monoplane) had an engine and pusher propeller mounted in the rear. Two decades later, Waterman unveiled the *Aerobile* as an upgrade to the Arrowbile. Five Aerobiles were built and two flights (from Santa Monica, CA to Ohio) were completed, however, nobody bought them. Eventually, one of the Aerobiles ended up on display at the *Smithsonian Institution*. The Aerobile has the unfortunate distinction of being named one of *TIME* magazine's "50 Worst Cars of All Time."

414

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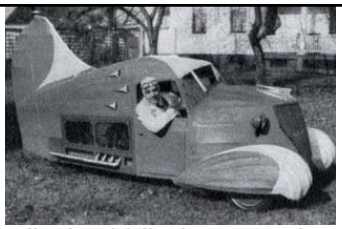
416

Streamline Moderne

417



"Highly streamlined and following accepted aeronautical design in construction, a novel aerocoupe developed by Richard Crossley, of East Haven, Conn., has a top speed of 75 m.p.h. The cabin resembles an airplane fuselage, featuring longerons, braces, etc. For traction, the vehicle is equipped with three airplane-type wheels."

***Modern Mechanix*, March 1937**

Above: caption: "Resembling an airplane fuselage in design and construction, this automobile carries its designer, Richard Crossley, of East Haven, Conn., at 75 m.p.h. Engine is at rear of cabin."

418

Above L&R: *Theodore Parsons* "Ted" *Hall*, an aeronautical engineer, designed the *Hall XCP-1 Autoplane* (a/k/a "Southernaire Roadable Flying Car") in 1939. In 1940, he demonstrated its flying abilities at the *Linda Vista Airport* in San Diego, CA. Hall then sold the rights to his roadable aircraft to the *Southern Aircraft Corporation* and took a job with the firm, allowing him to continue working on the product's development. Three prototypes were produced but, due to a lack of funding, the project was dropped before commercial units were built.

419

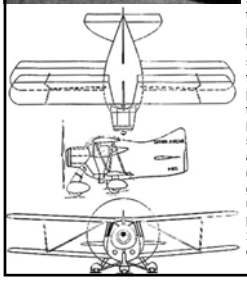
The Model-T of the Air

420

It was the opinion of *Joseph M. Gwinn, Jr.* – a WWI aviator and former Chief Engineer at *Consolidated-Vultee Aircraft Corp.,* that the major problem keeping the driving public from becoming the flying public was the need for the pilot to coordinate the operation of both the wing control surfaces and the tail control surfaces. He conceived a design while at Consolidated-Vultee that would solve the problem, but when the company decided not to sponsor it he resigned and formed this own company in 1935; the *Gwinn Aircar Company* of Buffalo, NY. Subsidized by the U.S. Government in 1937, Gwinn's resulting design was the *Aircar*. The Aircar was designed to be as fool-proof an airplane as possible, making it easy, simple and safe to fly since it would neither stall nor spin in. After its first flight in early 1937, it received a CAA Approved Type Certificate (No. 682)

421

422



With its wooden-frame, 24-foot wide wingspan and a metal semi-monocoque fuselage, the *Gwinn Aircar* (left T&B) was among the first designs to have a tricycle landing gear arrangement. It also had side-by-side seating for two, a steering wheel on the top of a control stick (in front of the left-seat pilot that worked the wing-length ailerons) and two throttles (one a pedal on the floor for driving and take-off and a traditional throttle intended for cruise flight. The design also had no rudder and had limited function of the elevators. The Aircar's wings consisted of four panels, each 3'- 6" x 10' in size. They were bolted to fittings on the fuselage so they could be removed and stored in a garage or hangar when it was to be used for road travel (it required two men to carry one panel). Power could be supplied to the wheels when the Aircar was used on the road by disconnecting the propeller gear box and hooking up the hydraulic system that supplied power to the wheels. Gwinn was able to built two prototypes of his Aircar. The first (NX1271) had a 90-hp British *Pobjoy Niagara* - a geared, air-cooled radial engine (Gwinn later had it upgraded to a130-hp Niagara V-7 engine). The second prototype (NC16921) was built with the same 130-hp engine and featured several other upgrades.

423

"It will not spin and it will not stall…With only an hour or two of instruction any average person (even the intelligentsia) can fly our ship…A development that should go down in history as the greatest aviation contribution since the advent of the Wright Brothers."

***Frank M. Hawks*, Air Racing Pilot**

RE: in 1933, Hawks set the west-to-east transcontinental airspeed record in his *Northrop Gamma*, flying from Los Angeles to *Floyd Bennett Field*, (Brooklyn, NY) in 13 hours, 26 minutes and 15 seconds. In 1937, Hawks retired from speed competition, holding as many as 214 point-to-point speed records in the U.S. and Europe. In order to lend respectability to the *Aircar* design, Gwinn offered Hawks the position of vice-president in charge of sales of his fledgling company. Gwinn hired another pilot, *Nancy Harkness Love*, to tour the country demonstrating the aircraft. Hawks and Love flew the Aircar to airports throughout the Eastern seaboard, pitching the plane to potential customers.

424

<u>Above</u>: caption: "Left-to-right: Joseph Gwinn, Nancy Harkness and Frank Hawks, ca. 1937-38"

425

"The plane lifted in the air and Hawks tilted it 50 feet above the ground to enable it to pass between two tall trees. As he passed out of sight it looked as though he had not been able to gain sufficient altitude and was trying to bring the plane down."

Edmund P. Rogers

RE: on the afternoon of August 23rd 1938, Hawks and his friend, *M.R. Carlin*, landed on the polo field of Edmund P. Rogers. Hawks offered to take Rogers and/or any of his guests for a ride. *J. Hazard Campbell*, 37, a NYC stock-broker and director of Gwinn's corporation, climbed aboard. Rogers recounted how Hawks was flying against a crosswind when the plane's wheels struck telephone and power lines, caught fire and was hurtled, nose-over-tail, to the ground (onto an adjoining polo field) and exploded. Onlookers pulled Hawks from the controls of the burning wreck and dragged Campbell from beneath a crumpled and burning wing. Three hours later, at the hospital in Buffalo, Frank Hawks died. Campbell also died of the injuries he sustained in the crash. The resulting bad publicity spelled the end for the company and the Aircar. *Joseph Gwinn* closed his factory and went back to work for *Consolidated-Vultee.* The surviving prototype would later be used by C-V in developing the *Convair Model III* (1946) - a roadable aircraft.

426

427

Part 7

The War Years

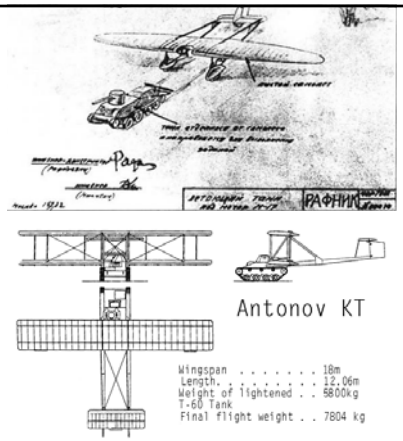
428

In Harm's Way

429

Above: the *Antonov KT* was developed in 1940 by a designer of weight-carrying gliders; *Oleg Konstantinovich Antonov*. The aim was to test the viability of supplying partisan forces behind enemy lines with light tanks. The unit was towed by a heavy bomber such as the *Petlyakov Pe-8*. A model *T-60* light tank provided the fuselage of the unit (the unlocked tracks were the landing gear). Upon landing, the flying surfaces (i.e. wings, tail boom etc.) were to be detached and abandoned.

430



431

432

When Fancy Beckons

433

"…But if fancy beckons you beyond the point where the road ends, you will simply unfold your wings and fly. Fantastic? Recognizing that the perfect compromise is not yet practical between car and plane, one leading aircraft manufacturer is working on two separate and distinct versions of this idea. First is the 'flyable automobile,' a good, serviceable road car, capable of taking-off for short hops at low flying speeds. The 'roadable airplane,' on the other hand, is to be a good, serviceable plane with a top speed of 150 miles an hour, able to land and roll on to its destination at a road speed of about 30…"

***Popular Science,* March 1943**

434

Genius at Work

435

"Bill Stout, the genius of Dearborn, Michigan, has been responsible for more revolutionary innovations in the design and construction of automobiles and airplanes than has any other man, living or dead. Yet he has found time to create such minor novelties as the first gasoline-driven railroad car, the first Diesel-electric streamlined train, a streamlined motorbus lighter and faster than any then manufactured, a brick conveyor which saved thousands of dollars in building construction, an improved theater seat, an air-conditioned bed, and, among other things, a staggering number of mechanical toys. He has been credited with more technical inventions than any man since Edison…"

***Modern Mechanix,* November 1943**

Left: caption: "Genius at work; Bill Stout working on a model of his 'Aerocar,' an automobile with detachable wings, which he designed for Consolidated-Vultee Aircraft for post-war manufacture."

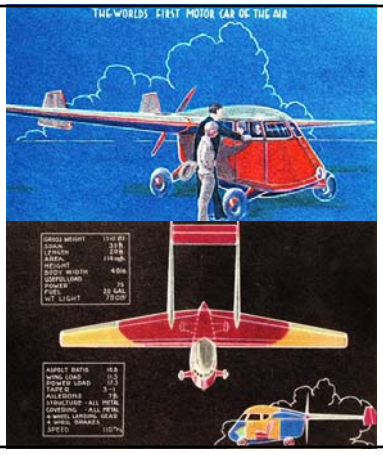
Right: caption: "One of Stout's more startling designs was the Scarab automobile, a teardrop car with engine in rear. Most of its more radical features were adopted."

436

"…Now Bill Stout is in the news again, making the 'experts' sneer and popping the eyes of the public. This time he has designed an 'Aerocar' and a 'Helibus' for Consolidated-Vultee Aircraft Corp. The Aerocar is an automobile with detachable wings which can be 'parked' - in the garage or at the airport when the Aerocar is being used on the road. Many technical noses will be lifted at Stout's design - but in the end, you can bet, we will all be riding in some contraption very similar to it. For all of Bill Stout's inventions follow the same routine: 1. Derision by the 'experts,' and, 2. Final adoption for general use a few years later. A character and a legend in the auto-motive and airplane industries, he has been conducting a crusade against adherence to tradition and the formulae of the past since he graduated from the University of Minnesota thirty-five years ago…"

***Modern Mechanix*, November 1943**

437



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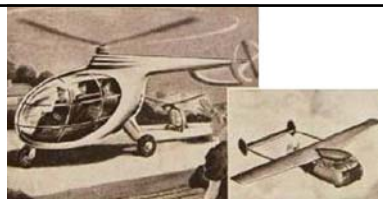
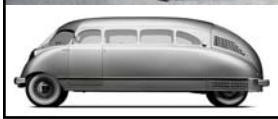


"…It has just been announced he has joined Consolidated-Vultee to work on research for light planes to be built when this war has ended. Stout sees a future of flying autos and trucks, planes which fold their wings on alighting and run along highways on their four-wheeled landing gear. He sees helicopters of new design which will fly straight up, forward, backward, and sideways, landing on rooftops, lawns, tennis courts and parking spaces…"
***Modern Mechanix,* November 1943**
Left: caption: "Stout's design for a helicopter looks like a teardrop on a stick. Its actual operation is similar in many respects to that of a Sikorski helicopter."
Right: caption: "The Stout Aerocar is actually a Scarab-type automobile with detachable wings which 'clip' on to it and can be 'parked' when not being used"

439



"…Consolidated-Vultee has already presented for public consideration three models: the Aerocar, or flying automobile for family tours and trips; the Roadable airplane, for distance flights coupled with short trips on the ground; and the Helibus a new type of helicopter, so versatile that in addition to moving in any wanted direction it will stand still in the air and land on a tennis court…"
***Modern Mechanix,* November 1943**
Top: caption: "The Stout Aerocar is to be equipped with 'hook-on' wings, shown being installed"
Bottom: caption: "1936 Stout Scarab"

440

"…Stout believes that the greatest progress in automotive and plane construction will come, postwar, from the aviation industry, which is not, like the automobile industry, bound down and hampered by a tremendous investment."
***Modern Mechanix,* November 1943**

441

The Roadable Plane of Tomorrow

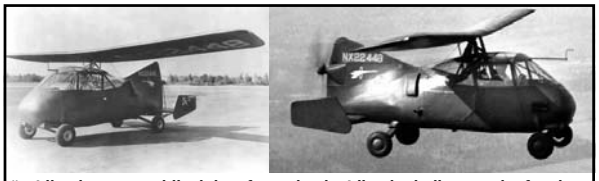
442

"Since the Wright Brothers skimmed over the Kitty Hawk Dunes, men have guided their flying machines with ailerons, elevators and rudders. A break from these traditional controls. A break from these traditional controls is introduced by George Spratt, whose unconventional plane is steered through its three-dimensional sphere by a control wheel that tilts, pivots and banks its wings. Mr. Spratt is an engineer in the Stout research division of Consolidated-Vultee Corporation. His unique craft may be the father of the roadable plane of tomorrow…"
***Popular Mechanics*, June 1945**
RE: starting in 1895, *Dr. George A. Spratt* and later, with his son *George G. Spratt*, experimented with and built a large number of successful gliders, flying boats, land planes and even a flying automobile as a joint venture with *Bill Stout*. All were aimed toward stable aircraft and safer aircraft control systems and all of them used control wings.

443

"In the early 1940s an article written by Wayne Morris came to the attention of Bill Stout who quickly saw the potential of the Controlwing as a roadable aircraft. In 1944 the project was moved to the Stout Research Division of Consolidated-Vultee (later to become Convair) at Dearborn. Designers came from all directions; they mathematically redesigned all the components – the wing was 'improved' from 80 pounds to 200 pounds, a ratio that held for most of the other parts. As heavy as it was, it actually flew…The next summer the Stout Research Division was moved to Nashville…an entirely new structure was built including the wing attachment. Now nearly 200 pounds lighter, performance was much better…the roadable was completed in 1947…"
***George G. Spratt* (1974)**
Top: caption: "First flight of the aircraft, also known as the Convair roadable controlwing, above Elizabeth City, N.C. in 1945"
Bottom: caption: "Convair roadable after rebuilding (San Diego, 1946)"

444

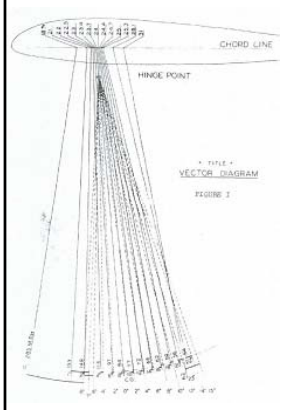


"…Like the automobile, it has four wheels. Like the helicopter, its fuselage is suspended beneath its wing – which turns, but does not rotate. Maneuvering is simple. Pull back on the control wheel to lower the trailing edge of the 26½-foot wing and the plane climbs; a turn of the wheel to the right or left drops or lifts a wing tip and pivots the wing, turning the ship. The air-cooled engine is at the rear. A shaft extending through the stabilizer assembly juts the propeller from the abbreviated tail…"
***Popular Mechanics,* June 1945**
Left: caption: "Convair 103 (NX22448). Also known as Spratt-Stout 8 Skycar"
Right: caption: "Convair 103 (NX22448). The Spratt Controllable Wing is successfully test flown at Consolidated-Vultee Aircraft Corporation's Stout Research Division, Dearborn, MI. Steering wheel takes care of all controls by changing position of movable wing mounted on a universal joint."

445

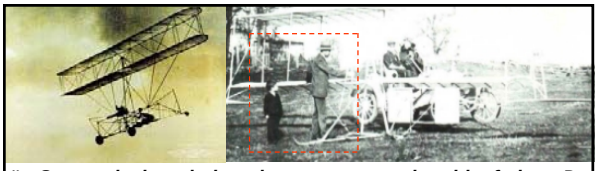
"…The revolutionary method of control is expected to make small planes safer and easier to handle. Since the pilot must move the wing by manual strength, there are no present plans to adapt it to larger planes. The front wheels steer with the wing and eventually the plane may be adapted for highway travel. But Consolidated-Vultee does not contemplate building the plane commercially until it has had exhaustive tests. It has been flight-tested at 6,000 feet…"
***Popular Mechanics,* June 1945**

446



Left: caption: 'In normal flight the resultant aerodynamic force of the wing must pass through the hinge, thus holding the wing at the correct angle of attack. Any tendency for the wing to increase its angle is met with a rearward movement of this force vector and conversely a decrease in angle causes a forward movement of the vector. Regardless of any disturbance, the wing always tends to maintain the desired angle of attack. This action can be better understood by a careful look at the vector diagram, Figure 1."

447



"…Spratt designed the plane to prove that his father, Dr. George A. Spratt, was right when he told the Wright Brothers that aircraft could be steered with a controllable wing. Spratt cannot fly a conventional airplane, but has flown 100 hours in his own craft."
***Popular Mechanics,* June 1945**
RE: an aeronautical engineer, *George G. Spratt* spent most of his long and distinguished career in aviation developing controllable wing aircraft, a concept originally conceived by his father at the turn of the century
Left: caption: "This is an early model of the steerable wing plane flown in 1934 by its developer, George Spratt. His father, an aircraft pioneer, had advocated the movable wing principle in 1902."
Right: caption: "Dr. George A. Spratt and his son, George G. Spratt, with their glider in 1909"

448

The End-User Knows Best

449

"…We asked the private flyers of tomorrow to write their own ticket. The analysis of 3,345 contest entries shows what they are looking for…The vote on 'roadability,' as it is called, ran even lower than that on rotating-wing aircraft…"
***Popular Science,* March 1945**
RE: in the fall of 1944, *Popular Science* magazine ran a contest asking readers to submit designs for their ideal post-war private planes. In the March 1945 issue, an article entitled: *The Plane You'll Fly After the War,* which provided an analysis of the 3,345 entries, revealed that only 10% of those surveyed wanted "roadable aircraft." The vast majority of people preferred low-wing monoplanes or planes with pusher props (reason being, they favored safety over novelty). As well, only about 14% of flying cars designers preferred foldable over detachable wings.

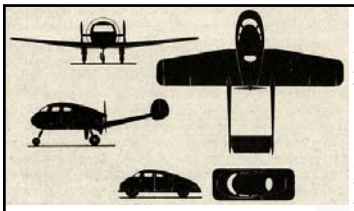
450

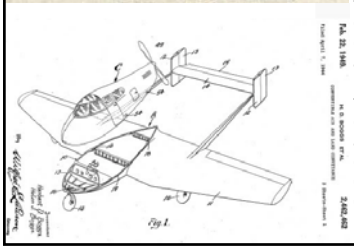
"…Nevertheless, some novel road-able-plane designs showed up. H.D. Boggs, of Omaha, Neb., for instance, drew up a fuselage that could shed its wings and be cradled in an automobile chassis for highway use. For flight, the fuselage was lifted from the chassis and fitted with wings. A single engine, both for the road and for flight, was mounted in road and for flight, was mounted in the fuselage…"

***Popular Science,* March 1945**

Left: caption: "This tailless model was developed by Ray Ring, of Framingham, Mass."

451





Designed by *Helen* and *Herbert Boggs*, the *Boggs Airmaster* (top) was a unique flying car design that was never realized. However, it did receive a U.S. Patent in 1944 (bottom). The craft came complete with a separate airframe, separate automobile frame and an interchangeable cabin complete with engine (the cabin was transferable, as required, from car-to-plane mode and vice-versa). While the concept was innovative, changing from one mode to another would be quite challenging, to say the least. No development work was ever done on this conceptual design.

452

"…Then there was the vote on amphibians. The amphibian is a sort of jack-of-all-trades. If a smooth landing surface is available on the ground, the amphibian can use its wheels. If it can't find smooth ground, or if the pilot simply chooses to use a water surface by preference, it can be put down on a lake, a river, or the protected blue water of a cove. The pilot who likes to operate off water makes an interesting discovery when he begins exploring the surface of continental United States: it is pitted with depressions full of water. One pilot using an ordinary seaplane flew all the way across the northern tier of states from the Atlantic to the Pacific and never lacked a landing place…"

***Popular Science,* March 1945**

Left: caption: "The versatile personal plane seen at left in drawings by A/S Perry S. Clark, of La Junta, Colo., was among the 20 percent of professional entries favoring land-and-water craft, as against 16 percent of the 'NP' class. It serves not only as an amphibian plane but also as an open car, closed car, and boat."

453

The Pregnant Guppy

454

In 1938, *Consolidate-Vultee* received a prototype *Gwinn Aircar* from *Joseph Gwinn*. During WWII, development was on-going thus, in 1945, the *Convair Model 111 Air Car* was introduced (left). The Model 111 was a roadable, side-by-side, two-seat, all-metal, low-wing (cantilever) monoplane with engine and pusher propeller located at the rear. The sole prototype was tested in a wind tunnel revealing significant aerodynamic deficiencies which gained it the nick-name, "The Pregnant Guppy." In the spring of 1946, additional testing was conducted accompanied by a series of failures. As a result, the project was terminated.

455

456

Part 8

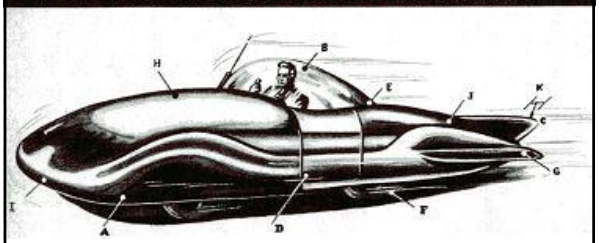
Post-War

457

Off to a Good Start

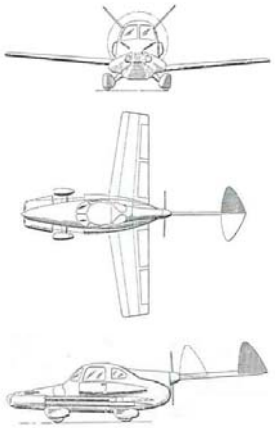
458

LA VOITURE DE DEMAIN



Above: in 1953, to launch a new French science fiction magazine, what better way than to display a schematic of the "Car of Tomorrow" (it was a flying amphibious car). The vehicle became airborne in less than 25 seconds, zooming along at a very reasonable 240 mph, 170 mph on the road and a very respectable 75 mph on the water. It had a bevy of additional futuristic gadgetry including a front photo-electric sensor that would detect obstacles two-feet away and a set of antennae (lifting off from the rear center fin) that would not merely communicate with the office, but allow driving/flight in the dark using radar. An atom-powered turbo-reactor provided the horsepower.

459

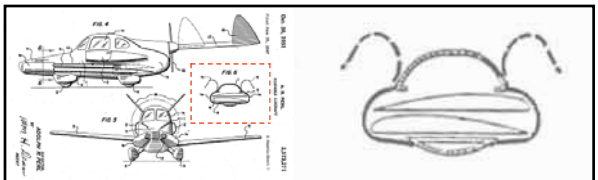


"My invention relates to a roadable aircraft, more particularly to an aircraft having folded multiple wings and retractable tail boom, and the objects of my invention are…"

RE: June 30th 1947 patent application for the roadable aircraft of *Adolph R. Perl* (U.S. Patent No. 2,573,271 - October 30th 1951)

Left (top-to-bottom): front, plan and side view/s of the *Perl Roadable Aircraft*

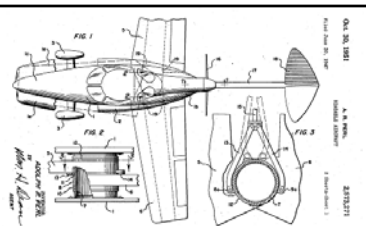
460



First, to provide an aircraft of this class which can be very readily and very quickly converted from an aircraft to a roadable vehicle;
Second, to provide a roadable aircraft of this class in which the wings are foldable into the body of the fuselage longitudinally thereof, presenting an overall breadth of the roadable aircraft at the fuselage portion thereof substantially equal to the chord of the wings when in folded position;
Third, to provide a roadable aircraft of this class in which the center of gravity thereof is changed by the pivotal movement of the wings when folding, whereby forward movement of said center of gravity is changed to the desirable position for roadwork and is proper with respect to the wing when the wings are in an extended position for flight;

RE: June 30th 1947 patent application for the roadable aircraft of *Adolph R. Perl* (U.S. Patent No. 2,573,271 - October 30th 1951)

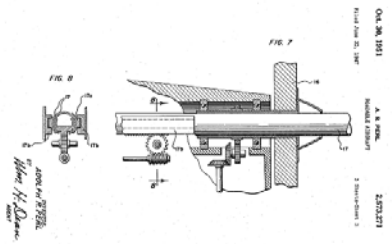
461



Fourth, to provide a roadable aircraft of this class having a retractable tail boom which greatly reduces the overall length of the vehicle when operated on the ground;
Fifth, to provide an aircraft having novel folding wings which are retractable into the fuselage of the said aircraft;
Sixth, to provide a roadable aircraft of this class having a novel airscoop in connection with the doors of the fuselage thereof for directing air backwardly into the engine at the rear of said fuselage;
Seventh, to provide a roadable aircraft of this class which is properly balanced when in various operating conditions and in which the wings thereof are foldable in super-imposed relationship to each other for attaining such balance;

RE: June 30th 1947 patent application for the roadable aircraft of *Adolph R. Perl* (U.S. Patent No. 2,573,271 - October 30th 1951)

462



Eighth, to provide a novel means for folding aircraft wings into superimposed relationship with each other whereby a very compact roadable aircraft may be produced;
Ninth, to provide a roadable aircraft of this class having four wheels which operate equally as well on the ground or in connection with the aircraft when taking-off or landing, and;
Tenth, to provide a roadable aircraft of this class which is very simple and economical of construction in accordance with its utility, efficiency in operation and which will not readily deteriorate or get out of order.

RE: June 39th 1947 patent application for the roadable aircraft of *Adolph R. Perl* (U.S. Patent No. 2,573,271 - October 30th 1951)
Above: details of power train assembly

463

Above: caption: "Aerauto PL.5C Autoplane (1946-1953)." *Luigi Pellarini*, an aeronautical engineer, designed the *Aerauto PL.5C*, which was built by *Carrozzeria Colli* in Milan, Italy. Using the roadable aircraft with folding wings concept, Pellarini built the first roadable aircraft that relied on the same airplane engine for both flight and road travel.

464

Getting In on the Act

465

***Norman Bel Geddes* was a highly respected theatrical and industrial designer of the pre-WWII era. Most noteworthy was his design for the GM's *Futurama* exhibit at the *New York World's Fair* of 1939/40. He drew this concept (above, dated 1954) for a flying automobile, but no development work was ever done on it.**

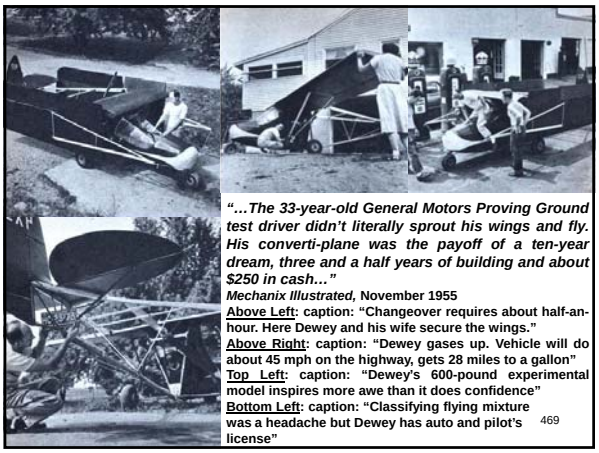
466

A Man Named Dewey

467

"Dewey Bryan and his auto-plane contraption are equally at home on the highway or in the air. When the Highland, Mich., inventor becomes annoyed with Sunday drivers he simply pulls into the nearest airport, rigs his wings and takes off into the wild blue yonder, just as easy as you please…"
***Mechanix Illustrated*, November 1955**
Left: caption: "Converti-plane's 40-hp Continental engine and tail section were taken from sports plane"

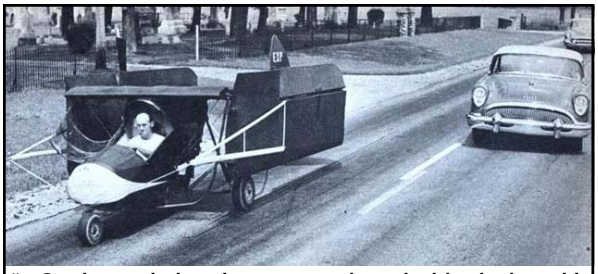
468



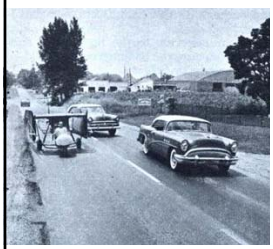
"…The 33-year-old General Motors Proving Ground test driver didn't literally sprout his wings and fly. His converti-plane was the payoff of a ten-year dream, three and a half years of building and about $250 in cash…"
Mechanix Illustrated, November 1955
Above Left: caption: "Changeover requires about half-an-hour. Here Dewey and his wife secure the wings."
Above Right: caption: "Dewey gases up. Vehicle will do about 45 mph on the highway, gets 28 miles to a gallon"
Top Left: caption: "Dewey's 600-pound experimental model inspires more awe than it does confidence"
Bottom Left: caption: "Classifying flying mixture was a headache but Dewey has auto and pilot's license"
469

"…Dewey began his unique craft with the motor and wings from a crashed plane. He assembled the mechanism in his basement and was laughed at when he putt-putted his flying machine into the Pontiac Airport. But a half hour later, when he was in the air, airport employees were scratching their heads in wonderment…"
Mechanix Illustrated, November 1955
Above: caption: "When the strange looking contraption is airborne, it is capable of about 60 mph"
470

"…To go from driving to flying, the wings of the craft must be lifted out of their side brackets and attached to the body of the plane. This takes about 30 minutes. The machine flies at about 60 mph and lands at 25 to 30…"
Mechanix Illustrated, Nov. 1955
Left: caption: "'Car's' wings are lifted from side brackets and attached to the body for flight"
471



"…On the road, the wings are neatly tucked back alongside the 'car' and have a somewhat shattering effect on fellow motorists. As one of Dewey's neighbors says, 'I'm afraid to follow Dewey too close for fear of what the other drivers will do after seeing him'…"
Mechanix Illustrated, November 1955
Above: caption: "Dewey Bryan and his auto-plane have a somewhat shattering effect on other drivers"
472



"…State officials were puzzled at first as to how they should classify the contraption. Was it a car or a plane? Finally Dewey got auto plates for highway travel and another license for flying operations…"
Mechanix Illustrated, Nov. 1955
Left: caption: "Weird looking contraption usually gets the once over when Dewey putts along highway"
473

"…In flight the Bryan plane has the look of an early Wright or Bleriot flying machine because of its uncovered fuselage. Like the first Wright plane it is a pusher - has its prop aft of the wings…"
Mechanix Illustrated, Nov. 1955
Left: caption: "Craft is pusher type with propeller behind wings, like Wright Brothers"
474

"…Roadable airplanes have been designed and flown before but Dewey believes his single seater is the first to carry its wings down the highway. Others must leave them at the airport or haul them in a trailer, which is cheating slightly, Dewey feels. 'What I'm trying to build,' Dewey says, 'is a plane that will make flying practical and economical for everyone.'"

***Mechanix Illustrated,* November 1955**

475

Buick test-driver/technician (at GM's *Milford Proving Grounds,* in Michigan) *Leland Dewey Bryan* built three versions of his metal-bodied *Autoplane* (starting in 1953). The wings were designed to fold in two places thus forming a protective cage around the propeller (which also powered the Autoplane when driven on the road). Bryan drove all three versions +1K miles, achieving a top speed of 60 mph. He flew the second version (*Model II*, above L&R) for a total of 65 hours. Bryan rebuilt the Model II to create the two-seater *Model III* in the 1970s, changing each wing so that it would fold once to an upright position (rather than twice to form a rectangle). It was powered by a *Continental A-75* engine with a pusher-propeller configuration, had a wingspan of 22-feet and an all-metal twin-boom tail. He died in the crash of the Model III at an air show in 1974, reportedly because a wing warning light didn't alert him to the fact that one wing had not been locked in place for flight.

476

The Road More Traveled

477

<u>Above L&R</u>: *Bruce K. Hallock* of Fenton, Michigan, designed and built the "Road Wing" in the 1950s as an update of a tailless pusher and roadable created by *Waldo Waterman* in 1935. It was evolved from the Waterman design, but with a more powerful (145-hp) *Continental O-300* aircraft engine. After fourteen years of design/construction, the *Road Wing* first flew in Flint, MI, in 1957. The body and wings were built of wood and the cabin could carry four people (rather than two, as in Waterman's design). The wings could be folded back in about fifteen minutes and the whole unit driven down the road (very much like the *Aerocar*). The Road Wing was designated the "HT-1 Road Wing" (HT= <u>H</u>allock <u>T</u>ailless). It flew very well and had about the same performance as a small *Cessna 170*. In cruise flight, its speed was about 120 mph.

478

"When the wings were folded there was not enough room to run the prop. There was no other transmission of power to the wheels on this airplane, but he never really actually ran it on the road with the wings folded behind. His plan was to make a special folding prop which would be smaller when folded, and that would allow it to run between the wings. This never developed. Only the body (fuselage) was ever driven on the streets. I believe this was the same as the Waterman aircraft…"

***Don Hallock* (Bruce's son)**

479

"…The Road Wing was really a better airplane than a car. My dad gave up the concept of roadable airplanes because there was too much of a trade off in weight, and there were power transmission problems. The airplane was eventually put into a garage and stored for over 40 years. A couple years ago my parents sold the house where the plane was kept in Austin, Texas and we moved the Road Wing into my hangar at the Smithville airport nearby. My plans are to restore this unique roadable aircraft to 'cosmetic' condition only. It will not fly again."

Don Hallock

480

A Real-Life Tom Swift

481

If the general public cared anything at all about personal airborne transportation, they longed for a true flying car - not a convertible airplane; nothing with wings, no fumbling with landing gear or airport runways. Basically, they wanted a flying carpet in the shape of a *DeSoto* sedan, In the summer of 1957, *Stanley Hiller* lit up the "tinkerer press" with an astounding vision. The "Hiller Aerial Sedan," as depicted on the cover of the July 1957 issue of *Popular Mechanics* (left), it came in many varieties; from a flying crane to a military all-purpose Jeep to a handy over-the-treetops vehicle for Mr. and Mrs. Commuter. Billed on the cover as "Your Flying Car for 1967," the artist drew a standard 1957 sedan body with two horizontal ducted fans (mounted inside a cowling so they would provide more thrust than an unenclosed helicopter rotor – two in front and two more in the rear. The four fans lifted the car straight off the ground while a push of a lever changed the angle of thrust and moved the car forward or brought it to a halt.

482

483

Editors of tinkerer magazines around the world seized the concept, including a twin nacelle version on France's *Science et Vie* (above) and *Meccano Magazine* (left), who used PM's cover art for their November 1958 issue

484

Stanley Hiller, Jr. (left), would eventually hold forty patents. Still in his teens in 1942, Hiller's innovative co-oling process for casting aluminum was being used to supply parts for jet aircraft. Helicopters remained unstable at the start of WWII, necessitating a tail rotor to offset the yaw produced by the main, overhead, rotor. Hiller placed two rotors spinning in opposite directions (a/k/a "co-axial rotors") on top of a model copter to solve the problem. He called it a "Hiller-Copter."

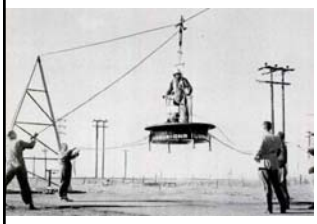
485

Flying Pie Pans

486

In 1940, *George de Bothezat* connected co-axial rotors to a body frame (left). Hiller later adapted it into a safer and more controllable "flying platform" (above).

487



In 1955, the U.S. Navy and Hiller Helicopters were busy with its 'flying pie pan.' Instead of jets it used two contra-rotating fans installed horizontally to thrust downward (the pan's two engines generated 100-hp). Should either engine fail, *"the thing will fall like a brick,"* said a *Popular Science* article, stating further, *"When that is overcome, pie-pan commuting from the back yard to the office may be a possibility."*

488

Jackass-Style

489

"…His first major invention, a flying boogie board he called the Hummingbird, came from the realization that getting lift isn't really hard. Push air down, and up you go. So he built a fan, pointed it at the ground and shot up into the air. To steer, he leaned right or left. The whole thing was so easy to assemble and such a breeze to fly, Yoeli says, that he became nervous about releasing it to the general public. He had planned to make his fortune from it, but when most of the 1,600 people who replied to his first ad sounded like 'Jackass-style' daredevils, he decided he had to first find some way to make the Hummingbird safer…"
***The New York Times*, September 26th 2004**

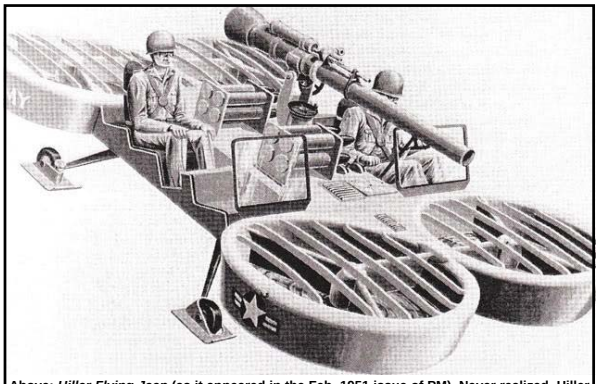
490

<u>Left</u>: in the 1990s, Israeli inventor *Rafi Yoeli* created the "Hummingbird." It was inspired by Stanley Hiller's original concept for a flying platform. The design was based on the use of a ducted fan powered by four *Hirth F33-15A* internal combustion engines. The operator, standing on top, controlled the VTOL platform by merely shifting their weight. An emergency parachute unit was available as an optional extra. Maximum speed was 40 knots with a height ceiling of 5K-feet. With a fuel capacity of 4.8 gallons, it could stay airborne for 30 minutes.

491

Fancraft

492



Above: *Hiller Flying Jeep* (as it appeared in the Feb. 1951 issue of PM). Never realized, Hiller went back to making helicopters for a while, then went into business as a corporate turnaround specialist. In 2002, he won the Smithsonian's *National Air and Space Museum Trophy for Lifetime Achievement. Stanley Hiller, Jr.* died in 2006.

493

"…Yoeli figured that he could make a stable, hovering, untippable flying platform by bolting two Hummingbirds together. 'I've been involved in vertical takeoff and landing all my life,' Yoeli says. He was an aerospace engineer in charge of a design team for Israel Aircraft Industries before going to work for Boeing; later he returned to school for a Ph.D. in artificial intelligence. He started his own aerospace consulting company, which built prototypes of unmanned vehicles and helicopters, but once the idea of a flying car came to him, he sold his share in the company to devote himself to it full time…"

***The New York Times*, September 26th 2004**

494

"…Yoeli was deep into the construction of CityHawk, which looked a little like an Everglades airboat and a lot like Luke Skywalker's landspeeder, when the terrorist attacks happened on Sept. 11. That should have put an end to his flying-car fantasy right there - there was no way anyone was now going to be allowed to drive through the air in a jet-propelled Subaru. And didn't the police have enough trouble without suspects taking wing during a high-speed chase? Just when Yoeli was finally clearing the technological hurdles, his dream of the future had become stuck in a world of the present…"

***The New York Times*, September 26th 2004**

495

"…But Yoeli saw things differently, as any man who builds full-size aircraft in a second-floor apartment would. A year before the attacks, and purely by coincidence, Yoeli imagined CityHawk responding to exactly the kind of downtown disaster he had witnessed on TV on Sept. 11. 'Operation close to buildings will be no restriction for the CityHawk, and it will in fact be able to rescue trapped people inside high-rise buildings by hovering close to a window and allowing a person to step on to the platform,' he wrote in an April 2000 press release…"

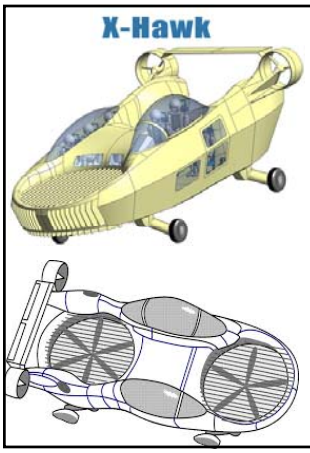
***The New York Times*, Sept. 26th 2004**

496

"…CityHawk would be a life-saver, not a menace; from the start, Yoeli had designed it for inner-city police patrols navigating urban canyons. It was precisely because of terrorist threats and the emergence of street-by-street urban warfare that flying cars were now inevitable, Yoeli insisted. He contacted high-ranking American and Israeli military friends and asked if they would be interested in a superfast aircraft with a vertical range from mere inches to 12,000 feet. The response, he says, was a unanimous 'How soon can we get it?'…"

***The New York Times*, September 26th 2004**

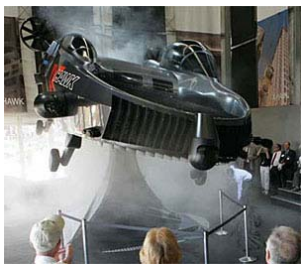
497



"…Once Yoeli saw the military interest in CityHawk, he immediately began working on a far more powerful version, the X-Hawk. X-Hawk's propulsion comes from ducted fans, two encased propellers that push air downward. Yoeli's special innovation was installing hundreds of small vanes at both ends of each ducted fan, like the slats of venetian blinds. By adjusting the pitch of the vanes, Yoeli says, X-Hawk can make minute adjustments in any direction and instantly adjust to wind gusts. And unlike a helicopter, he stresses, X-Hawk can hover inches from a building because the propellers are encased…"

***The New York Times*, September 26th 2004**

498



499

"…Yoeli is also in a race against time. To stay afloat, he needs to start selling X-Hawks within the next few years. But he has one enthusiastic and well-financed partner lined up now. STAT MedEvac, an emergency-rescue company based in Pittsburgh, can't wait to get its hands on the first F.A.A.-approved X-Hawks. 'This can be a very profitable investment for us,' James Bothwell, the STAT MedEvac C.E.O., says. 'When it comes to using helicopters in cities and suburbs, we're extremely limited in the places we can land, so a paramedic unit on the scene would have to transport a victim two or three blocks to meet the chopper…"
The New York Times, September 26th 2004

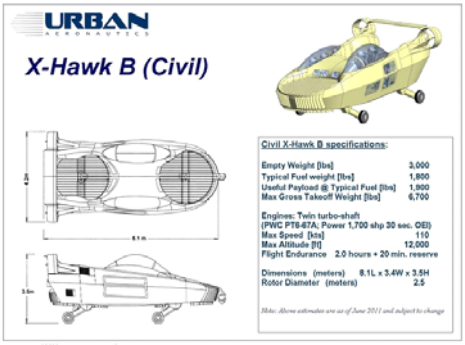
500

"…With X-Hawk, Bothwell estimates, his pilots will be able to fly at least 1,000 missions a year that would otherwise be impossible due to weather or ground conditions. 'I'm always a hopeful kind of guy,' says Bothwell, who has been in regular contact with Yoeli's design team for the past two years. 'By 2010, I can see us having five or six X-Hawks in our fleet.' But by then, Yoeli reckons, you may already have one in yours…"
The New York Times, September 26th 2004

501

"In early 2007, Urban Aeronautics announced it'd have an 'air jeep' flying car dubbed the X-Hawk ready for flight by 2009. The future's now, and while the X-Hawk isn't quite ready, the test mule almost is, and this is it…"
Jalopnik.com, June 2009

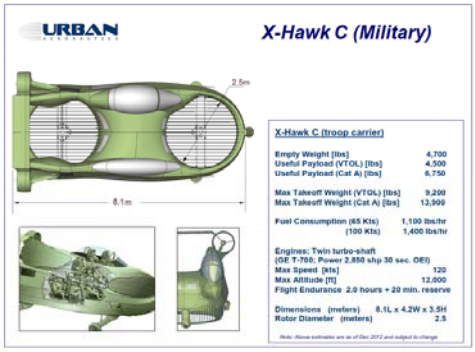
502



503

"…The Urban Aeronautics concept for a flying car, or 'fan-craft' as they like to call it, centers on a ducted fan concept which was tested by the U.S. military long ago with unacceptable results. Fast forward several decades and add much larger control surfaces, high-power and more reliable hardware, much better controls logic combined with the magic of modern computer processing speeds and the concept is no longer so far-fetched…"
Jalopnik.com, June 2009

504



505

"…The Israeli company currently has a proof of concept scale prototype which runs on electricity, but they're in the final stages of completing a full scale test mule powered by a pair of gas turbine engines which will supposedly be ready for its maiden voyage in about two months. When fully developed, the craft should be able to achieve vertical takeoff, hover, rotate 360 degrees at a standstill, reach speeds up to 115 MPH and drop vertically into a tight urban landing zone. Currently envisioned uses include ambulances and general rescue vehicles, 'air jeeps' for military usage, since the vehicle would be able to get into places no helicopter would dare..." 506

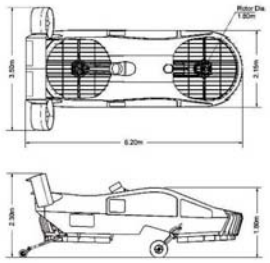
***Jalopnik.com,* June 2009**

AirMule

"Urban warfare demands close-quarters combat, which often begs for a more subtle approach to military machinery. Medevac helicopters, a soldier's lifeline on the battlefield, are but hindrances in an urban setting. Narrow alleyways and wide rotors don't mix. AirMule, an unmanned flying ambulance capable of vertical takeoff and landing in extremely close quarters, has been in development for a few years. When the Israeli firm Urban Aeronautics released its initial concept art in 2008, it was easy to dismiss those futuristic, colorful pods out of hand. But last month, Urban Aeronautics announced that AirMule had successfully completed a series of fully automatic test flights…" 507

***Popular Mechanics,* January 2014**

AIRMULE Parameters



SPECIFICATION (Arriel 2 Equipped AirMule II UAS):

Weights		
Empty Weight	1,700 lbs	(771 Kg)
Max Load (Fuel + Payload)	1,400 lbs	(635 Kg)
Fuel Consumption (65 Kts)	290 lbs/hr	(132 Kg/hr)
(100 Kts)	360 lbs/hr	(163 Kg/hr)
Max Gross Takeoff Weight	3,100 lbs	(1,406 Kg)
Performance		
Engine Power (Turbomeca Arriel 2)	940 SHP	
Max Speed (Dash)	> 100 Kts	(180 Km/hr)
Max Altitude	12,000 feet	
Flight Endurance	Up to 5 hrs	
Dimensions		
Fuselage size	Feet	22.3L x 7.1w x 5.9H
(Thrusters Removed	Meters	6.2L x 2.15w x 1.8H
Rotor Diameter	5.9 Ft (1.8m)	

Note: Above estimates are preliminary and subject to change.

508

"…The current incarnation of AirMule is drab and car-shaped, with enclosed rotors that keep the hovercraft aloft. These recent test flights revealed that AirMule is significantly quieter - and stealthier - than a helicopter, and capable of landing in tight spaces with ease. Urban Aeronautics hopes that its unmanned hovercraft will serve not only military medics but also their civilian counterparts…"

***Popular Mechanics,* January 2014**

509

"…Unmanned flying ambulances could rescue patients injured by natural disasters, or deliver food and supplies to isolated populations. The single aircraft cost $2.5 million to build, and another prototype is due to appear later this year. Urban Aeronautics plans to release its first ambulance drone before 2020, pending additional test flights and increased demand from buyers. AirMule requires neither runway nor helipad, but only future test flights can determine whether the hovercraft is battle-ready." 510

***Popular Mechanics,* January 2014**

Jeep-O-Plane

511

"A new concept of the flying machine is needed to bring aviation to its promised fulfillment. While military, commercial and business flying has advanced steadily, aviation for the majority of people is still a distant dream. It has been said that a cheaper airplane is the answer, but this is only partially correct. The major consideration is UTILITY. The need is for a roadable, amphibious airplane that can go anywhere. Furthermore, it should land at 25 mph, take off at 30 mph, and cruise at approximately 150 mph. It should be able to operate out of small, unprepared fields and roads; not just confined to airports. AT LAST such a plane has been developed. It has a new wing design that can increase its lifting power to 3 times its normal capacity without adding weight, power, cost or complexities. It has a true variable-lift wing. Scientific placement of two airfoils, incorporating flaps of a new design, creates tremendous lift for short-field take-offs and snail-like landings."

RE: excerpt from a 1950s brochure for the Geraci "Jeep-O-Plane" (left T&B)

512

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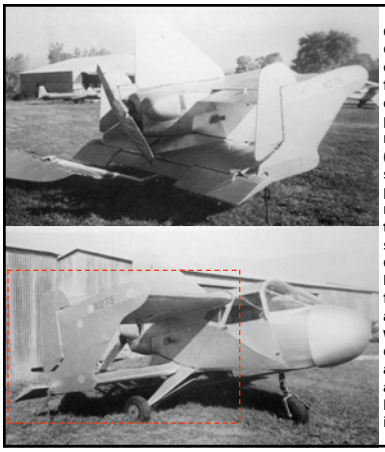


Conceived and built by *Al Geraci* and *William Simonini* of Algonquin, AZ, their flying, fully-roadable (powered by the rear-mounted pusher propeller on the road). With foldable wings (top), the *Jeep-O-Plane* had a severe "stagger-wing" (a bi-plane with one wing mounted ahead of the other). In this case, the longitudinal separation of the wings was quite pronounced (bottom). It achieved outstanding performance when taking-off and landing (since the front wing flew in the ground effect of the back wing). Aviation enthusiasts consider it a well designed aircraft, however, it never went into production.

514

515

Helicopters for Everyone!

516

Stanley Hiller **won a series of impressive prizes for his helicopter controls during and after WWII, leading to *Hiller Industries* (founded by his pilot/inventor father) building popular models whose claim to fame was that a student could learn to pilot one in a matter of minutes. A helicopter that anyone could fly and afford sent out futuristic vibrations that hit the same brain synapses as those for the flying car, perhaps with a stronger signal since the concept of a helicopter worked even better as a device to whisk one over the traffic to reach their destination efficiently. It wasn't surprising therefore that the years after WWII saw a steady stream of tinkerer magazine articles espoused the conveniences a personal helicopter could/would afford to get you where you wanted to go.**

Left: cover of *Science and Invention* magazine (1923)

517

518

"Jess Dixon, of Andalusia, Ala., got tired of being tied up in traffic jams, so he designed and built this novel flying vehicle. It is a combination of automobile, helicopter, autogiro, and motorcycle. It has two large lifting rotors in a single head, revolving in opposite directions. It is powered by a 40 h.p. motor which is air-cooled. He claims his machine is capable of speeds up to 100 miles an hour."
Mechanix Illustrated, **November 1941**

519

Above: a June 1943 rendering of a personal helicopter by *Alex S. Tremulis*

520

"Back in the 30's, a Seattle aeronautical engineer named Horace T. Pentecost became convinced that he could design a set of personal wings. As an engineer and student of aviation history, Pentecost was well aware of the shortcomings of man-made flapping wings, so he gave the problem an entirely different solution. In place of rosy pinions, he substituted the whirling blades of the modern helicopter. His first machine, designed for army paratroopers, was intended to supplant the clumsy and uncontrollable parachute. Strapped to the wearer's back, it was christened 'Hoppicopter' because the trooper literally hopped off and landed on his own two feet. It consisted of little more than an engine, rotors and control stick, mounted on a tubular frame that was strapped over the flier's shoulders and back. The Hoppicopter's dependence upon human legs as landing gear proved its ultimate undoing. Landing on rough terrain, the wearers frequently stumbled and fell, smashing the whirling vanes against the ground. This was not only embarrassing but expensive…"
Mechanix Illustrated, **January 1951**

521

Left: caption: "Mechanical 'Wings' with which the inventor hopes he will be able to fly, are the work of 36-year-old Horace T. Pentecost of Seattle. In his right hand he holds the flight control stick: its handle is the throttle, regulated by turning. The 'Hoppicopter,' as the inventor calls it, has a 2-cylinder, 20-hp motor and weighs sixty pounds plus." (*Mechanix Illustrated,* Aug. 1945)

522

"…The next model boasted a light tube-and-canvas seat and three landing wheels arranged in a triangle, supported on spindly, insect-like legs. In flight, the pilot felt somewhat more at ease, not as though he were hanging in space like a fish on the end of a line. The working parts were unchanged, however. A hot, noisy motor still nestled coyly against the back of the pilot's neck. The gas tank was suspended directly above him with no fire protection…"
***Mechanix Illustrated,* January 1951**

523

Above: caption: "Second version of the Hoppicopter design had a tripod landing gear with motor mounted behind the pilot's head. It was better than the original 'back strap' model but weight distribution was unsatisfactory."

524

"…The third model has corrected some of the above mentioned faults. The engine now is slung under the seat directly beneath the center of gravity. This warms the pilot in cold air and improves the machine's balance. The model at present is being tested. There still remains, however, the sense of insecurity - of riding a flying swivel chair with no visible means of support. Pentecost and his associates are perfectly well aware of this natural reaction and have planned a weatherproof enclosure for the machine…"
***Mechanix Illustrated,* January 1951**
Top: caption: "Penetecost prepares to start his engine by spinning it with a starter cord in the flywheel's base"
Bottom: caption: "Present model, the third, has the engine situated under the pilot's seat. This gives it better stability."

525

"…In the illustration one version of such a streamlined housing is shown. With this addition, our Hoppicopter becomes a vehicle of true utility. Such a machine would be practical, cheap to buy and maintain and could easily be the answer to the demand for a 'Model T' helicopter."
***Mechanix Illustrated,* January 1951**

526

With titles like "Post-War Travel: The Autoist Will Also Take to the Air," "Helicopters for Everybody," "Family Flivver-Copter," "Coming: Rooftop Airports" and "Helicopter in Every Garage?, predictions of flying commuters took root. However, the image that most resonated most appeared on the cover of the February 1951 issue of *Popular Mechanics* (left). It featured a suburban commuter backing his helicopter up his driveway to his cozy ranch-style home, showing how easily the copter fit into the garage built for a car, rotors and all. By that time, no reader would have been surprised to learn that the tiny, two-person ramjet-powered helicopter "coupe" was the brainchild of *Stanley Hiller, Jr.*

527

"…This concept for a high-speed personal helicopter was an early expression of what would become in the years immediately after World War II an extremely popular vision of the future. To many observers, the helicopter seemed to promise wings for city dwellers who might land atop their apartments or office buildings. Unfortunately, helicopters were - and remain - difficult to fly, relatively unsafe, noisy, and energy inefficient…"
RE: excerpt from *Yesterday's Tomorrows: Past Visions of the American Future*

528

Home Grown

529

The *Simcopter* was a one-of-a-kind homebuilt helicopter-car which combined a *Simca* automobile with a 300-hp *Lycoming* aircraft engine and a welded super-structure. It designed, constructed and piloted by *David Dobbins*, who was employed by various aeronautical companies including *Hughes*, *North American* and *Hiller*. Dobbins was born in China where his father was the *Dean of Engineering* at the *University of Tientsin*. A short time after his birth, his family moved to San Francisco. In the 1950's, the family moved to Guadalajara, Mexico, where David taught math at the American School. There, he designed, constructed and piloted the Simcopter. The Simcopter utilizes a 42-foot set of rotor blades to provide the nec-essary lift. The automobile part of the vehicle is a 1948 Simca *Topolino*. Dobbins believed that the Simcopter was capable of speeds up to 100 mph. On August 15th 1957, Dobbins flew his creation to a height of 5-feet. It appears the Simcopter did not perform to Dobbins' expectations. It was observed that after the short flight, Dobbins climbed out, walked away and never flew it again. This fine example of a homemade flying car is on display at the *Wings of History Aviation Museum* in San Martin, California (left T&B).

530

531

Rotocar to Aerocar

532

Above: caption: "Wagner FJ-V3 Aerocar by Alfred Vogt, 1965." This 4-wheeled, rotary-winged flying car (with a 4-seat cabin) was based on the 2-seat *Wagner Rotocar* (1960) and the *Wagner Sky-Trac* helicopter (1965). After several successful tests in the late 1960s, the design was sold to *HTM*, which abandoned the project in 1971.

533

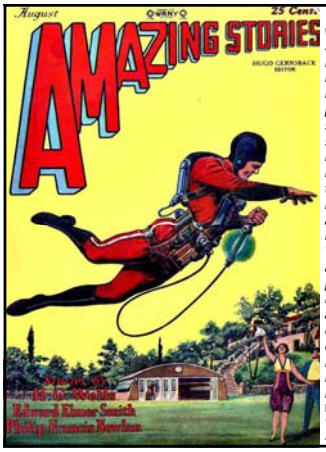
534

Rocketmen

535

"Man's age-old dream of flying like a bird, free of clumsy machinery, may be nearer than we think…"
***Popular Science,* December 1958**
RE: the *jetpack, rocket belt* and/or *rocket pack* are names given to a number of different devices worn on the back that use jets of escaping gas to allow a person to fly. Such technology has been featured in movies, TV, novels, short stories and comic books for a very long time. Despite advances in technology, jet-packs have not turned out to be not very practical as a mode of personal transportation. The earth's atmosphere and gravity (as well as limitations of the human body) have thus far hindered the use of jetpacks by both the military and general public.

536



"…Laughing merrily, the four made their way to the testing shed, in front of which Seaton donned a heavy leather harness, buckled about his shoulders, body and legs; to which were attached numerous handles, switches, boxes and other pieces of apparatus. He snapped the switch which started the Tesla coil in the shed and pressed a button on an instrument in his hand, attached to his harness by a small steel cable. Instantly there was a creak of straining leather and he shot vertically into the air for perhaps a hundred feet, where he stopped and remained motionless for a few moments. Then the watchers saw him point his arm and dart in the direction in which he pointed. By merely pointing, apparently, he changed his direction at will; going up and down, forward and backward, describing circles and loops and figures of eight. After a few minutes of this display he descended, slowing up abruptly as he neared the ground and making an easy landing…"
RE: the fictional character *Anthony "Buck" Rogers* first appeared in the August 1928 issue of *Amazing Stories*

537

Left: original *Hughes Industries* poster from the *1939 New York World's Fair* featuring "Rocketmen" taking flight with a futuristic Jetpack (above)

538

Germany took the first successful steps towards building a working jetpack during WWII. The "Himmelsturmer" ("Sky Stormer") was based on the same Schmidt pulse jet system at the core of the V-1 "buzz bomb" that terrorized London (at least one German jetpack was delivered to *Bell Aerosystems* after the war). The flier strapped one pulse tube to his back for forward flight and the second, less powerful unit equipped with hand grips, on his front-side for steering. By 1949, the U.S. public was being distracted by *Rocket Man*, a character that appeared in a number of movie serials through 1955. However, unlike previous Rocketmen whose power was derived from "Inerton" or "Element X," Rocket Man's jetpack was, appropriately, atomic powered.

539

The *Himmelsturmer* (left) was the result of experiments in the latter days of WWII. The device employed two low-power rockets which were strapped to the chest and back of the pilot enabling him, in theory at least, to fly 180-feet in the air. It was hoped it would allow engineering units to leap across rivers or minefields and was not designed for regular troops. Flights, (actually jumps), were measured in seconds. The device shut-down once the throttle was disengaged, thus it was simple to operate. Testing for the "Sky Stormer" went well, with no reported injuries.

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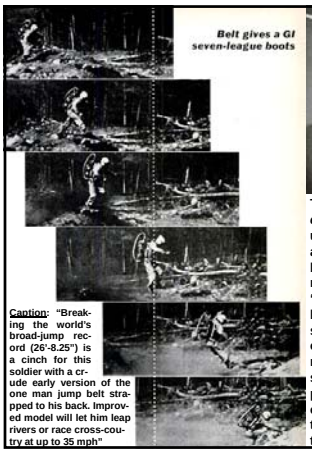

Caption: "Breaking the world's broad-jump record (26'-8.25") is a cinch for this soldier with a crude early version of the one man jump belt strapped to his back. Improved model will let him leap rivers or race cross-country at up to 35 mph"

The December 1958 issue of ***Popular Science*** contained photos of two previously unseen jump belts. The images at left shows a "crude early version" of the one-man jump belt (shown assisting a soldier to a world record broad jump). Above, the five-canister "jump belt" was built from off-the-shelf hardware. Each canister could be burned separately for several seconds, or all at once for full power and would last about a minute (if the canisters were burned in sequence). The propellants would not explode if dropped or punctured and new cans of propellant could be snapped in to replace spent canisters in less than a minute.

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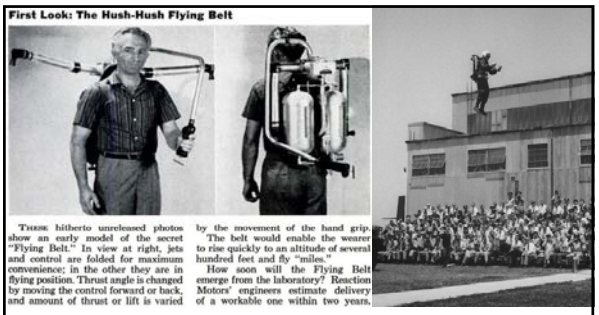

Left: this article appeared in the same December 1958 issue of ***Popular Science*** featuring the jump belt/s (it's an early prototype of what would later become known as the "jetpack"). This "flying belt" prototype was built by ***Reaction Motors***.

Right: on June 8th 1961, ***Harold Graham*** demonstrated ***Bell Aerosytems*** "Portable Army Rocket" for the first time to an incredulous public. Graham flew over a truck at a height of 15-feet and landed 150-feet away after 14 seconds.

542

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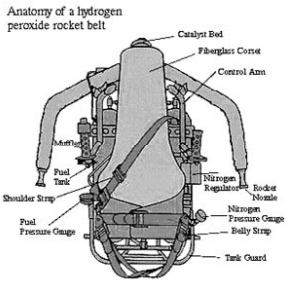

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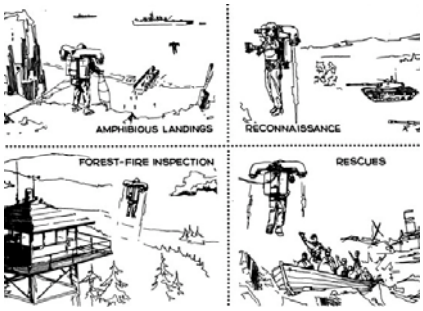

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Left: in 1984, NASA used its version of the jetpack; the 24-nozzel nitrogen-powered *Manned Maneuvering Unit* (MMU), on three space shuttle missions. After an uneventful first test, the MMU nearly caused a satellite to careen out of control during an improvised recovery mission. The MMU performed better in its third mission, helping astronauts capture two satellites and return them to the orbiter payload. After the 1986 *Challenger* disaster, the MMU system was determined too risky and replaced by SAFER (*Simplified Aid for EVA Rescue*). SAFER, developed by the *Robotics Division* of NASA at the *Johnson Space Center*, was first flown in 1994. It functioned as an emergency, self-rescue apparatus in case an astronaut became separated from his tethers during a space walk. In 2000, two astronauts used the nitrogen-powered SAFER to perform a "gentle fifty-foot flight" while tethered to the shuttle.

548

Above L&R: in November 2006, Yves Rossy (a/k/a "Jet Man") strapped four, Kerosine-fueled *Jet-Cat P200* jet engines to a pair of semi-rigid carbon-fiber wings and rocketed himself Superman-like for a full six minutes and nine seconds.
Left: in 2008, Rossy hit a descent speed of 189 mph over the Alps and in 2010 he dropped from a hot-air balloon at 7,900-feet and proceeded to fly for a total of 18 minutes before landing by parachute (wings folded). He also flew his powered wing over the *Grand Canyon*.

549

Flying Saucers for Everybody!

550

"It is a bright morning in 1965. At precisely eight a.m. Joe Lees emerges from the back door of his lakeside cottage, only 75 miles from his job in the city. In the graveled center of his backyard his jaunty new plastic saucer rests lightly on three tiny balloon tires. Greeting his neighbor who rides with him, Joe lifts a flush flap in the saucer's rounded nose. He turns a recessed locking handle and throws back the bubble-like windshield. Spring loaded, like the hoods of today's cars, the enclosure lifts easily. As it does, the interlinked nose cone swings down to form a handy step. Joe's neighbor steps up over the low instrument pedestal and then across the folded pilot's seat to his perch in the rear. Joe follows, slams the windshield shut and turns the starter key. The two men fasten their safety belts as the engine comes to life…"
***Mechanix Illustrated,* March 1957**

551

"…As the fan-like inductor begins whirling with a high-pitched whine, the automatic servo-flaps pop open and a torrent of air is drawn inward over the circular wings. Faster and faster it flows, building up the lift pattern of a racing, fixed-wing take-off. For a moment, the trembling saucer remains stationary. Then, slowly and smoothly, it rises vertically into the air like an elevator ascending an unseen shaft. At 450 feet per minute, the saucer climbs to the southbound traffic lane and the engine's pulsing torque is shifted to the pusher propeller at the machine's tail. As the prop takes hold, the inductor fan gradually slows to a halt and the servo-flaps clamp shut. Functioning now as a fixed-wing airplane, our saucer banks around and heads south at a comfortable 165 mph cruising speed…"
***Mechanix Illustrated,* March 1957**

552

"…As it tools toward the city, other saucers join the parade and there is a thick stream of aerial traffic. Soon, the downtown towers of the metropolis loom on the horizon and a whole complex of distant traffic lanes converge from the four corners of suburbia. Over the business district, Joe turns out of the main stream and heads for the company's building. He throttles back his prop, shifts to the air inductor again and slowly descends to the landing pad. It is now 8:30 a.m. The 75-mile flight took only 30 minutes…"
***Mechanix Illustrated,* March 1957**

553

"…MI's saucer was conceived by Peter Nofi, an officer in the Merchant Marine. Nofi, a dedicated student of aerodynamics, has combined the downward jet thrust of the ducted-fan with the proven principle of the high-lift air-foil We know that the fan will work because using it, men and machines have been lifted bodily into the air by the modest power of outboard engines. Nofi's arrangement is inherently simple. He has merely taken the straight airplane wing and pulled the ends around to form a circle with the leading edge facing out. In the center hole of this doughnut-shaped airfoil, he has mounted a ducted-fan which sucks a high-speed airflow in over the wing and, in the form of a compressed air jet, blows it out through the bottom of the hole. According to Nofi, the negative (upward) pressure created by the passage of air over the top of the wing, plus the reaction (upward) pressure of the air jet, add up to a total lift ample for vertical flight…"
***Mechanix Illustrated,* March 1957**

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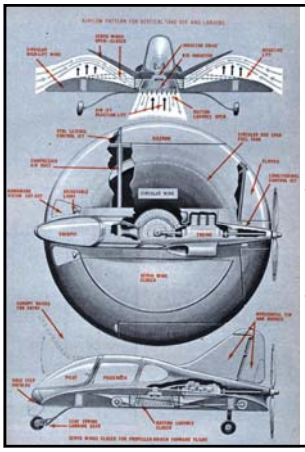

"…The other unique feature of Nofi's saucer is the pair of semi-circular servo-flaps hinged to the top of the wing root on either side of the fuselage. These open automatically to permit inward airflow when the ducted fan is operating, then close to form the top curve' of a large fore-and-aft airfoil when the machine is in forward flight as a fixed-wing airplane. A twin control system is employed to provide for the differing conditions of vertical and forward flight. For vertical take-off and landing, compressed air from the inductor is piped to the aileron and flipper areas and expelled through differentially operated jet nozzles. These are built into the conventional control surfaces used in forward flight and are operated by the same wheel column…"
***Mechanix Illustrated,* March 1957**
Left: caption: "Simplicity of Peter Nofi's unusual, low-cost saucer is shown in the diagram at left"

555

"…In line with his low cost philosophy, Nofi plans to have the top and bottom surfaces of his saucer stamped out on a press, using a plastic material reinforced by glass 'flock.' This technique, now successfully employed by small boat builders, will also be used on the servo-flaps, fuselage and other components. Cemented together with the internal gas tank spar, plumbing, etc., in place, the hollow wing will then be filled with a foamed plastic compound which cures into a rigid, air-filled sponge. This replaces expensive interior structure and converts the wing into an unsinkable life-ring for emergency water landings. Mass produced, the plastic saucer should cost no more than today's medium-priced cars. Could be that by 1965 you'll have one flying out of your backyard, too!"
***Mechanix Illustrated,* March 1957**

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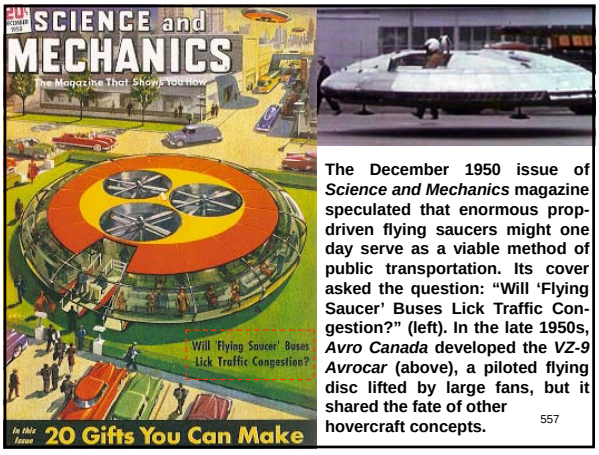
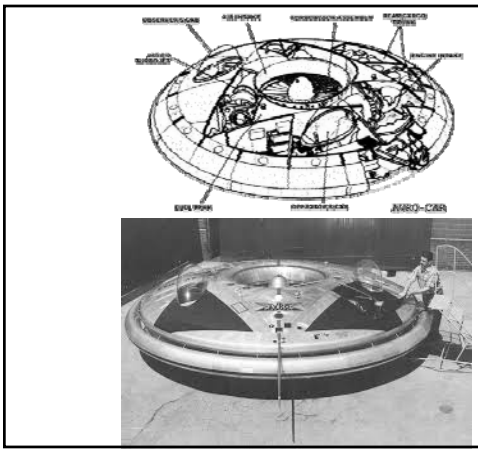


The December 1950 issue of *Science and Mechanics* magazine speculated that enormous prop-driven flying saucers might one day serve as a viable method of public transportation. Its cover asked the question: "Will 'Flying Saucer' Buses Lick Traffic Congestion?" (left). In the late 1950s, *Avro Canada* developed the *VZ-9 Avrocar* (above), a piloted flying disc lifted by large fans, but it shared the fate of other hovercraft concepts.

557



558

(Moller Flying Car Prototype)

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Fly & Drive

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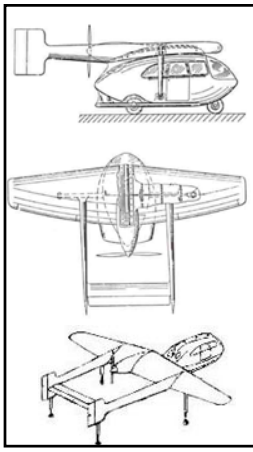

In 1952, ***Edward M. Nye*** and ***Alphonse Poisson*** were granted patent rights to a design for a combined aircraft and automobile (top & middle). The unique feature of the invention was their method of joining a self-contained three-wheeled road vehicle to an airframe (the airframe also had its own engine, complete with pusher prop). By unlatching the wing struts where they joined the fuselage and pulling the struts down, they now served as vertical supports for the wing (bottom). Additional supports for the rear of the airframe were telescoped out of the rudder fins (they could be cranked down to hold up the tail section). The action of disconnecting the struts automatically disconnected the automobile from the airframe. "Fly & Drive" took on a whole new meaning.

561

Left: an undated photo of ***Joe Halsmer*** in front of the ***Halsmer Aircar***, a roadable aircraft built in 1958-59. Halsmer was also the inventor of the ***Halsmer Safety Twin*** and a push-pull airplane with fore and aft propellers. He also claimed several records, including one for the fastest turbo-prop trans-Atlantic flight.

562

The RoadAir

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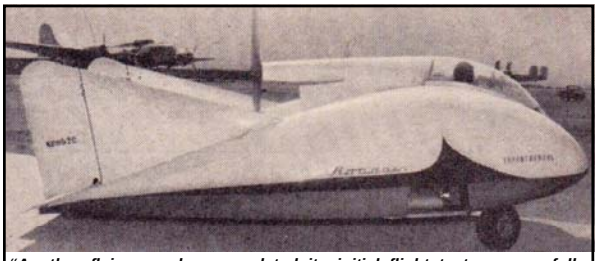

"Another flying car has completed its initial flight tests successfully. Called the Roadair, the car has a body 15 feet long and 7 feet 10 inches wide. As an auto, it rides on a tricycle gear, the single rear wheel driven by a small gasoline motor. As an airplane, the wings fold out from the body to a 25-foot wingspread. A 75-horsepower airplane engine drives the single pusher propeller. Twin rudders and elevator are located in the rear. Expected retail price: Approximately $10,000."

Popular Mechanics, **(ca. 1960)**

Above: caption: "Estimated cruising speeds are 90 miles per hour in air and up to 75 on ground. FAA experimental license has been issued."

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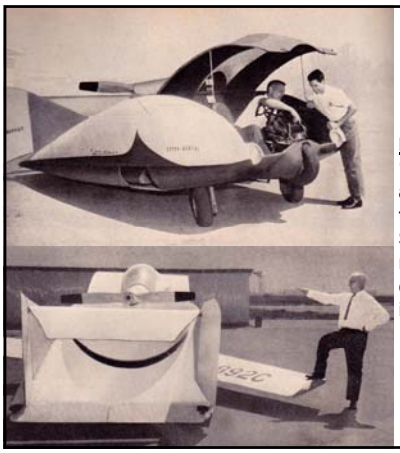

Left T&B: caption: "Roadair operates as auto or plane from same controls. Same action moves rudders and wheels. Wings fold up inside body."

565

The *Trautman RoadAir* (left) was a "lifting body" design that also incorporated a channel wing. This channel, along with an 85-hp flat-four, air-cooled *Continental O-190* engine and pusher propeller placed directly aft of the pilot, provided additional lift to the aircraft (the engine drove both the propeller and the rear single wheel). A sleek design, the RoadAir had wings stored in the lower portion of the fuselage. Small doors on each side were opened to access the wings which were pulled out and then locked in place. This arrangement provided a total wingspan of 25-feet. A fourth wheel was added in front (presumably for extra stability when driving). The V-type stabilizers were replaced by a more conventional pair of uprights, joined by a horizontal stabilizer. Pedals in the cockpit controlled not only the rudders when airborne, but also the pair of wheels under the passenger compartment when driving (the pilot gained access to the controls by lifting the front hood and climbing into the cockpit (right).

566

567

Designer and builder *Herbert Trautman* not only received a design patent (drawings at left), but actually built a full-scale prototype. In 1959, *Trautman* did some taxi tests with the prototype. He then turned the machine into the wind and, at about 90 mph, it lifted about three-feet off the ground. While the design did provide enough lift to make the aircraft fly, it became readily apparent that it was unstable in flight. Trautman allowed it settle to the ground, climbed out and never flew his creation again. He had planned to sell the *RoadAir* for $10K per unit.

568

569

Adaptable for Highway Use

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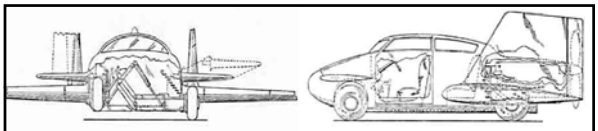
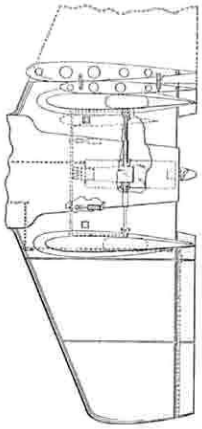


On March 5th 1968, *Robert O. Schertz* of El Paso, Illinois was granted patent No. 3,371,886 for his "Aircraft Adapted for Highway Use" design (above L&R). The vehicle had a canard configuration with removable forward horizontal stabilizers and rear foldable wings. It also had a side-opening cabin door (between the stabilizers and the wings). The purpose of this arrangement was to allow access in the normal manner of a two-door (coupe) automobile without having to climb over the wing structure. The engine was at the rear over the wings providing power to the prop for flight and to the rear wheels for road travel. All four wheels could be retracted when the vehicle was in flight. Controls were designed for use in both flight and/or driving mode/s. 571



<u>Left</u>: the wing design was unique. Each of the wings extended from a wing-root structure at the rear of the fuselage where a vertical stabilizer and rudder were mounted on each side. Outboard from that assembly, each wing consisted of two panels. The first step in folding the wings was to unlock the panels and fold the outer one in on top of the inner panel. Next, the two were folded up beside the vertical stabilizer to create a kind of panel sandwich. One of the removable canards could then be stowed inboard of each of the vertical stabilizers (they could also be stowed behind the rear seats in the cabin, if preferred). 572

<u>Part 9</u>

Back to the Future

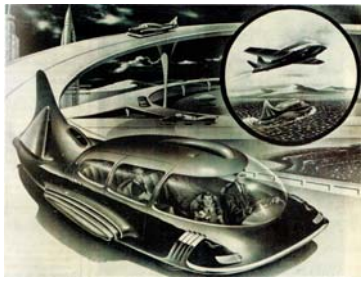
573

Flightless

574

"Look at your car sitting there in the driveway - sad, squat, all four tires on the pavement. You should feel sorry for your car for the same reason that you should feel sorry for yourself: You are both flightless. Optimistic drivers of the past imagined a future in which the stubby tail fins of their cars morphed into broad wings. According to the car companies at the World's Fair of 1939, your driveway was destined to become a runway, the highway a skyway, and the only speed limit the speed of sound…"
***Popular Mechanics*, September 2009**

575



576

"…Why have so many talented dreamers failed to make the flying car a reality? The answer: physics. Cars and airplanes operate in very different environments, so building a car that doubles as an airplane results in an inferior version of both. The challenges are so intractable that flying cars have become a cultural punch line, a metaphor for technological promises that never come true…"
***Popular Mechanics,* January 2011**

577

Under the Hood

578

"…The difficulties of engineering a flying car are also found under the hood...The driver of a land-based vehicle frequently accelerates, stops and turns. The engine's revolutions per minute (1,000 to 6,000 rpm) and power curve aren't broad enough to accommodate this speed range, which is why a car engine is fitted with a transmission. A small airplane's engine runs at a lower but relatively constant 2,000 to 3,000 rpm and, unlike a car engine, generates nearly maximum torque at full load for most of its operation…"
***Popular Mechanics,* January 2011**

579

"…Some recreational pilots use car engines for aircraft, but adapting them is complicated. The pilots need to figure out ways to dump heat, since the thin air and high load make an engine in flight work harder than one in use on the ground. To increase reliability and to prevent overspinning of the prop, the repurposed car engines are configured to run slower, and the bearing clearances are enlarged, which increases oil flow and helps cool the engine..."
***Popular Mechanics,* January 2011**

580

"…Due to the differences in performance and operating temperatures, powertrains adapted for both flight and road work tend to be heavier, more complex, less reliable and more expensive than single-use engines. Engineers are aware of the problems that trade-offs can cause…"
***Popular Mechanics,* January 2011**

581

The Car of the Future

582

"…The first attempts at creating flying cars were fairly simple - install an airplane engine and two wings on a regular car. The first attempts were also disastrous. Henry Ford's 'sky flivver' flew in 1928, but production was nixed after an unlucky pilot died in a crash. In 1956, Moulton Taylor, an engineer who earlier had helped develop the cruise missile, unveiled the Aerocar. In default mode this 'plane-mobile' could cruise on the highway at 65 mph, towing a tidy trailer that contained wings, tail and propeller. Once the wings were attached, the little yellow Aerocar could leap from the highway at 55 mph and cruise up to 100 mph at around 12,000 ft. with a range of up to 300 miles. After landing, you could park the car-plane in the garage (just remember to take off the wings first). The Aerocar worked fine conceptually, but it was too impractical for everyday use - a business deal for full-scale production fell through in the early 1970s. The only remaining Aerocar prototype was purchased by a fan who saw it advertised in the classifieds…"
***Popular Mechanics*, September 2009**

583

"The aeroautocraft of the future will roll on the road, cleave through the water, fly through the air. Its owner will start from his garage or hangar, travel streets or roads at will, cross streams or lakes that lie in his path, rise in the air and fly over a hill, a valley, or woods, to another road, all at his pleasure…"
***Illustrated World*, April 1917**

584

"…This is not the prediction of a dreamer, but the logical development of present day tendencies. With the memory of Morse's first forty miles of line less than a hundred years ago and comprehension of the network of cables and wires which enmesh the earth today - with recollection of Bell's toy in the Philadelphia Centennial, and a long distance call three thousand miles long an accomplished fact forty years after – recalling Edison's first inefficient electric light, now lost in the dazzling rays of the present day electrical illumination - is it hard to believe that the motor car of today, a fact - the aeroplane of today, another fact - the motor boat of today, a third fact, may be - nay, must be, combined to form the universal vehicle of the not far-distant future?..."
***Illustrated World*, April 1917**

585

"…Already the aeroplane and the motor boat have coalesced. We had hydroplanes before aeroplanes, although hydroplane meant then only a motor boat which rode on, rather than in, the water. The flying boat - or hydroaeroplane, as it is called - which can soar or swim is an everyday fact in 1917. What's more logical than the addition of the automobile, that the three modes of travel known to man may be combined?..."
***Illustrated World*, April 1917**
Above: caption: "'The Hydroaeroplane of Today.' This versatile machine flies or skims the waves with equal ease."

586

"…To visualize the product is not especially difficult; even its structure and details can be supposed with but a minimum chance of error. The body will be a combination of the lines we now know only in separate entities. It will have the enclosed glass top of the pleasure car, the stream lines of the best yachting practice, and the lightness and strength of the aeroplane fuselage. Attached to the top will be a pair of not too large monoplane wings from which will be evolved a nose or prow, which streams into the body. On either side of this prow will be hinged pressure rudders, designed to swing outward. If the one on the right is pushed forward, even a little, air resistance will be increased and the craft will swing to that side. Elevation and depression in the air will be managed by tilting the monoplane wings, exactly as in the aeroplanes of today…"
***Illustrated World*, April 1917**

587

"…In the water, the planes will be tilted just enough to make the aeroautocraft ride high in the waves. Steering, whether in the water, on the land, or in the air, will be controlled always by the vane rudders forward. For land travel the aeroautocraft will have four wheels also, to be used for alighting from the air, or for crawling out of the water on to a difficult beach. These will be infinitely lighter and probably smaller than familiar automobile wheels. They will be subject to comparatively little stress, because at speed on land, the wings will take most of the weight from them. Moreover, the wheels will be mounted on elevating arms, so that the touch of a button in the driver's reach will swing them up and out of the way when a water expedition is in prospect. As the wheels are for support and rolling only, and have no steering or power function, this is a mechanical possibility about the feasibility of which there scarcely can be any discussion…"
***Illustrated World*, April 1917**

588

"…It is possible that the front wheels may be mounted upon the familiar steering knuckles, at least on those aeroautocraft which are to be used in city traffic, in order to provide for easy steering at very low speeds. Ordinarily, mechanical steering will be unnecessary. All that will be necessary to turn a corner will be the slight elevation of the monoplane edge, the touch of the button which pushes forward the right resistance vane, and the consequent swinging of the whole vehicle, the front wheels an inch or so in the air, about any corner or turn in the road…"
***Illustrated World,* April 1917**

589

"…Propulsion for all three modes of travel will be effected by an aerial propeller in front. More effective design of propeller blades, the possibility of super-speed and all the power needed, will increase the efficiency of the aerial propeller's pull and at the same time decrease its noise. Moreover, by the elimination of all differentials, gear-boxes, heavy gasoline motor and the heavy rigid steel chassis of the present cars, a degree of lightness will be attained which will make aerial propulsion more efficient than present rear wheel traction. The aeroautocraft will know neither hills nor skidding, and the principal talking point will be, not the grades it can climb, but the minimum coasting angle at which it will descend with the power shut off…"
***Illustrated World,* April 1917**

590

"…The aeroautocraft will have no gas, water or oil tanks, 110 gasoline motor, starter, gear shift or steering wheel! A lap-board attached to a flexible cable, will place a series of buttons in front of the operator, who will control every action of his means of transportation with a finger touch…"
***Illustrated World,* April 1917**

591

Above: caption: "The Aeroautocraft will banish these fuel troubles"

No Such Thing

592

"…The present trouble makers on aeroplanes, boats and automobiles will be no more. There will be no brake in the future - the two steering vanes together will stop the aero-autocraft in two lengths. There will be nothing to oil, save a few ball bearings twice a year. Tires will wear for thousands of miles - probably fifty to a hundred - because they will get so little wear. There will be no such things as traffic congestion in cities, because streets will be used only for landing and starting - travel will be overhead! There will be no speed laws - instead, there will be speed levels, the slower near the ground, the faster ones higher up. And lastly, there will be no accidents, save such as are due to faulty construction of the aeroautocraft itself, for, no matter how many may flit through the air, there will be room, always, up above!..."
***Illustrated World,* April 1917**

593

"…Structurally, the aeroautocraft will be light, but strong. It will have a steel-braced aluminum frame, unless some method of tempering aluminum to the strength of steel be found. But because it will have the minimum of machinery and avoid the road shocks and stresses which the present automobile must withstand, it will not need to have the weighty and massive strength of the chassis of today. Its body will be weather-tight, of course, and its conveniences remarkable in their simplicity. It will not look inside, like the engine room of a U-boat, but like a pleasure house. Nor will it be difficult to drive, for automatic stabilizers - a fact today - will prevent upsets, and as power failure will be impossible, danger will be nil. Power? Electricity! The propeller will be driven with a light electric motor of sufficient capacity to do anything demanded. And the source of the current which the motor uses will be falling water!..."
***Illustrated World,* April 1917**

594

Unthinkable?

595

"…In the age when this aeroautocraft dots the landscape, rides the lakes and rivers and darts through the air, every waterfall 'in the land - indeed, every waterfall the world over - will be harnessed, and will deliver wireless power to the ether. Whoever will, may tap this constant stream of power, and use it as much, as often, and as long as he likes. Unquestionably the use will be limited by law, and a fee paid by every operator of any wireless power craft, proportioned to the size of his motor. But because the stream of power will be constant, there can be no circumscribing a journey by time, distance or lack of supplies…"
***Illustrated World,* April 1917**

596

"…If the reader has followed this prediction to this point without finding any impossibility in the proposed structure, let him not lay down this article in disgust merely because while we have automobiles, motor boats and aeroplanes, we have not, as yet, wireless power. Let him recall the enthusiastic ridicule given Marconi when he proposed wireless messages from continent to continent, and the nonchalance with which these same skeptics read their wireless-informed newspaper on shipboard or sell stocks in London via wireless from New York, today. Let him remember that it was mathematically demonstrated that a heavier-than-air mechanism never could fly - but it does! Let him recall the famous prediction of a world-renowned scientist, before a scientific congress, that 'it was axiomatic that man could never know the composition of stars or sun because he couldn't get to them, or them to him.' Then came Fraunhoffer, the spectroscope, and now we know as much about what composes the most distant stars as we do about what composes the earth!..."
***Illustrated World,* April 1917**

597

"…But if it appeals as a poor argument that because the impossibility of one year is the fact of the next, let him consider this fact. We already transmit power by wireless - wireless telegraphy and telephony were otherwise impossible. When it is demonstrable that nature can accomplish anything, it is reasonable to suppose that man can accomplish the same thing. For years the argument 'well, birds fly, but man can't' was the answer to this. It is so no longer. And if nature can show us that power - vast, irresistible, boundless power, is conveyed through the ether, there is nothing whatever unthinkable in the idea that we can learn to transmit power through the ether. Heat - which is power - comes to us in unthinkable amount, via the ether. Is wireless-power, man made, so unthinkable?..."
***Illustrated World,* April 1917**

598

"…The aeroautocraft of the future will have a wireless power receiver upon the upper surface of the monoplane and will draw its ability to fly, to run, to swim, from the power currents sent out from countless central stations, very much as the trolley car of today takes its power from its central station anywhere on its line. The difference will come in the elimination of the wire!..."
***Illustrated World,* April 1917**

599

Through the Ether

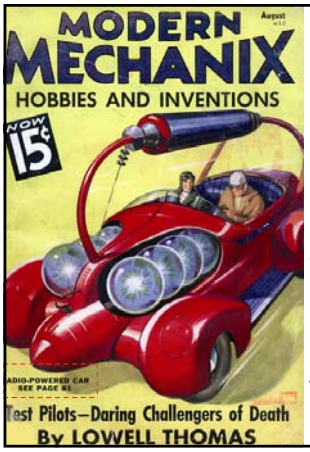
600

"…Is it hard to conceive? If so, it is because of the habit of thought which makes what isn't harder to comprehend than what is. If it were possible to bring any of the great and intelligent thinkers of the past, back to the present - Plato or Hero or Socrates or Euclid, and ask him which he would consider more difficult - to project the human voice through the air a hundred miles, or power to lift a man's weight or kill a dog through the same distance - what would he answer? If you told him he might accomplish both with or without a single strand of fine wire strung on poles, would it alter his inability to answer by so much as a single thought? Of course not! But today we know power is transmitted only mechanically, by belts, or electrically, over wires, and never think that to send ten thousand horsepower through two slender copper cables is no whit less astonishing than to send the same through the ether!"
***Illustrated World*, April 1917**

601

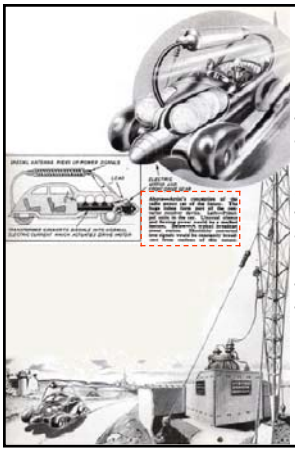
Radio Highways

602



"Autos operated on radio fuel may become a reality if the present consumption of oil continues and no new oil sources are discovered. One engineer boldly suggests a network of 'radio highways' consisting of huge broadcast transmitters capable of sending out signals which would be converted into motive power. Provided with special radio energy converters automobiles would be put into motion, eliminating starters, noise and dangerous carbon monoxide gas. Fortunately, science has delved into the fuel problems and found a solution for a matter which has for years been on the verge of confronting automotive engineers."
***Modern Mechanix*, Aug. 1936**

603



Left: caption (highlighted): "Above – Artist's conception of the radio power car of the future. The huge tubes form part of the converter receiver device. Left – Principal units in the car. Unusual silence and flowing power would be a marked feature. Below – A typical broadcast power station. Electricity converted into signals would be constantly broadcast from stations of this nature."

604

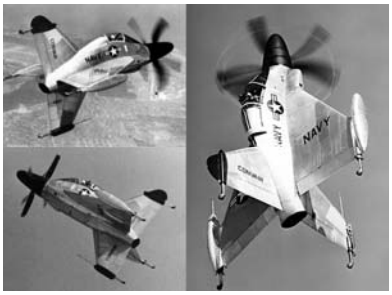
The Aeromarine

605

"The great advances in aircraft design of the past 15 years have had little effect on the looks or performance of the small private planes now being built; you could have landed any of them at a small airport in the mid-30's without scaring anybody. But with Skeets Coleman's Aeromarine design the field of private plane building may begin to catch up with the times. The Aeromarine, which is still in the workshop stages, will be a high performance plane that can be operated from land or water or driven like an automobile - making it ideal for the all-around weekend sportsman…"
***Mechanix Illustrated*, June 1956**

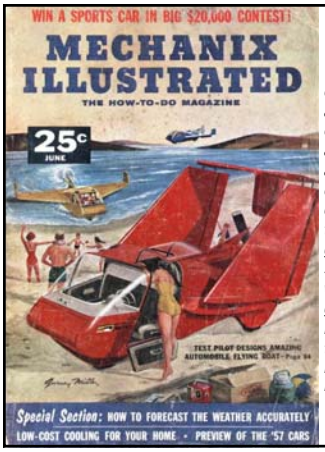
606

"…Compared to the many hybrids of this type that have preceded it, the Aeromarine has a convincing, unified look that you would expect from a man of Coleman's background and that takes it clean out of the Rube Goldberg class. Its modified delta wing structure in particular reflects Coleman's recent experience as test pilot on the Navy XFY-1 Convair Pogo, the vertical takeoff fighter. For his achievement in making the first-ever flights in this radical type of plane Coleman won the 1955 Harmon Trophy…"
Mechanix Illustrated, June 1956
Left: caption: "Convair Test pilot 'Skeets' Coleman with Z-type flight suit in 1954. In this image the test pilot is climbing on the VTOL aircraft XFY-1 POGO (Convair)." 607



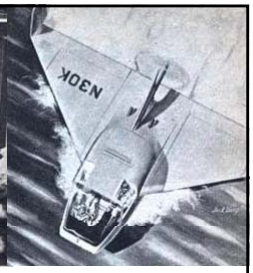
608

Above: caption: "The Convair XFY-1 'Pogo' was a vertical takeoff and landing (VTOL) fighter that could operate from any deck, not just an aircraft carrier."
Left: caption: "Harmon Trophy winner Coleman with a model of his 225-mph Aero-marine" 609



"…In his design Coleman has concentrated on creating a go-anywhere airplane - which meant cutting down on its performance as a car or boat. As a car it will be a power tricycle with a top speed of 50 mph. Power for humming down the highway will be fed to the rear wheels of the landing gear; steering will be through the single front wheel. As a boat - well, it'll float fine. If you want to go up the lake for more bait, why not let down the hydro-ski under the hull and make a short hop of it?…"
Mechanix Illustrated, June 1956

610



"…But as a plane the Aeromarine is expected to show considerable class. It will have a range of 800 miles on 80 gallons of gas, a top speed of 225 mph. Cruising speed, with five aboard, will be 200 mph. It will take off with a run of 800 feet, land at 57 mph. Simple controls and instruments, plus the stability and no-stall char-acteristics of the delta wing, will make flying easy for anyone…"
Mechanix Illustrated, June 1956
Left: caption: "As a car it will be a medium performer with an estimated top speed of 50 mph"
Right: caption: "Ability to operate off water should ensure Aeromarine's popularity among sport flyers" 611

"…One device designed just for the amateur pilot is a miniature delta wing mounted on a fulcrum on the nose of the Aeromarine. This 'radiator ornament' will tell the pilot at a glance if his plane is in a safe altitude in relation to airspeed and wind - the most important thing to know when flying a delta wing. An extremely advanced feature for high lift on takeoff and landing will be a system for sucking boundary air off the leading edge of the wing. This will be an aid rather than a necessity; if the system conks out it will still be quite simple to land or take off safely."
Mechanix Illustrated, June 1956
Above: caption: "Aeromarine's rear-mounted engine and prop will mean an unusually quiet cabin" 612

The Event

613

The March 1998 issue of *Air Sports International* reported that *Mathias Klug*, an aircraft instructor from a small town in western Germany, had developed the only vehicle in Europe to gain a road license as well as an aircraft license. Called the "Skyline Event," it flew like a conventional ultra-light aircraft and drove like a car. With just a few adjustments, the pilot could install or remove the light wings from the two-seater plane and start flying or driving, respectively. Klug put a protective cover over the rotor blades and made some other changes (i.e. headlights, turn indicators). An 8-hp scooter engine allowed the *Skyline Event* to reach a speed of 50 kmph on the ground. In flight mode, a 64-hp engine made it possible for the Skyline Event to reach an air speed of 129 kmph.

614

What's Past is Prologue

615

"…Major automakers don't let them through the door, nor do they get any respect from the earthbound drivers they hope to liberate from traffic…But that was the world of the past, before a troubled freeway system and new security concerns prompted NASA to start taking the flying-car dreamers more seriously. Over the past few years, NASA has quietly shifted some of its attention from space exploration to the space right over our roofs. Not only is NASA developing its own flying cars, but it's also working on a collision-deterring navigation system that could make skyways safer than highways…"

***The New York Times Magazine,* September 26th 2004**

616

"As motorways become more and more clogged up with traffic, a new generation of flying cars will be needed to ferry people along skyways. That's the verdict of engineers from the U.S. space agency and aeronautical firms…"

***BBC News,* September 22nd 2004**

617

SATS

618

"…If you are averse to purchasing dangerous relics listed in obscure newspaper ads and you still want to acquire a flying car, the solution may be to let NASA take care of it. That's right, NASA gave us gooey foam pillows, dehydrated ice cream and those shiny space blankets, and now it's about to fork over the flying car, too. NASA scientists working on the Small Aircraft Transportation System (SATS) project made in-roads on the two main problems holding back personal air travel on a massive, nationwide scale: midair collisions and complicated piloting mechanisms…"

***Popular Mechanics*, September 2009**

Left: caption: "SATS 2005: A Transformation in Air Travel is the result of five years of research conducted by NASA's SATS project, the National Consortium for Aviation Mobility (NCAM) and the Federal Aviation Administration (FAA)"

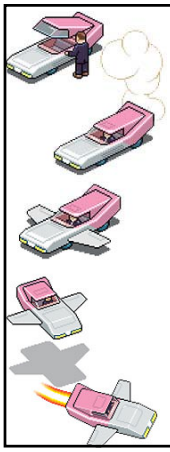
619

"…You can say our goal is to make the second car in every driveway a personal air vehicle…"

***Andrew Hahn*, Analyst at NASA's *Langley Research Center* in Hampton, VA**

Above: caption: "NASA is preparing to fly the latest small plane technologies to demonstrate the advantages of a Small Aircraft Transportation System (SATS). This Lancair Columbia has recently been added to the research fleet of aircraft at NASA Langley Research Center. As envisioned, SATS would support prop and jet aircraft for business and personal transportation for on-demand, point-to-point trips, as well as scheduled service."

620



"…NASA eschews the term 'flying car,' preferring 'personal air vehicle' instead. Nevertheless, NASA has imagined and researched flying cars that would humiliate George Jetson. Until their vehicle program was eliminated in 2005, the folks at Langley Research Center planned to roll out three prototypes in sequence: A small, almost conventional prop plane that would tuck its wings in on the highway (it shouldn't cost any more than a Mercedes-Benz); a two-seater with rear propeller drive; and for tight parking spots, a car capable of rising straight up into the air like a helicopter for a vertical takeoff. Merely providing the vehicles is not enough, however; if everyday people are to use them, scientists must know how to track thousands of these car-planes. And knowing is half the battle…"

***Popular Mechanics*, September 2009**

Left: caption: "NASA engineers are committed to a 15-year time line for three successive generations of flying cars. The first will resemble a compact Cessna with folding wings that converts to road use. The second is a two-person pod with small wings and a rear-mounted propeller. The third will rise straight up."

621

"…Recently, NASA scientists discovered that most people love to play video games but hate to die in fiery airplane crashes; they are capitalizing on this common sentiment by designing air vehicles that are controllable with simple, video-game-like joysticks. Automatic collision-avoidance technology and self-correcting flight controls should allow just about anyone to master his or her own personal air vehicle…"

***Popular Mechanics*, September 2009**

622

"…With radar, automatic transmissions and Global Positioning System navigation, there's no reason a flying car can't be as easy to handle as any VW, maybe even easier: your car can't help you merge on the freeway, but according to Andrew Hahn of NASA, most flying smart cars will be controlled by a simple joystick and come preprogrammed with anti-collision technology and self-correcting flight controls…"

***The New York Times Magazine*, September 26th 2004**

623

Above & Left: developed in the 1980s, Boeing's three-wheeled *Sky Commuter* VTOL was equipped with a gasoline turbo engine. It was carried forward by the thrust of the nozzle in the tail (highlighted above). It was necessary to use an electronic joystick (highlighted, at left) for driving as well as flight.

624

"…'We don't want someone to look at the dash panel and say, 'Oh, my God!' and get right out,' Hahn says. 'With single-lever acceleration, pilots won't have to go through such rigorous training to get accredited.' Hahn estimates that training on flying smart cars could be done in five days for about $1,000 - about what it now costs a 15-year-old to complete driver's ed. Automated flight controls will be unnoticed if you do everything perfectly, but they will override an incorrect manual landing plan. 'It's like an instructor-pilot backup,' Hahn says. 'Even if you have a heart attack, the computerized backup will complete the flight for you'…"
The New York Times Magazine, **September 26th 2004**

625

Policing the Sky

626

"…Boeing is also considering how to police the airways - and prevent total pandemonium - if thousands of flying cars enter the skies. 'The neat, gee-whiz part is thinking about what would the vehicle itself look like,' said Dick Paul, a vice president with Phantom Works, Boeing's research and development arm. 'But we're trying to think through all the ramifications of what would it take to deploy a fleet of these.' Past proposals to solve this problem have included artificial intelligence systems to prevent collisions between air traffic…"
BBC News, **September 22nd 2004**

627

"…Collision-deterring navigation systems are key to transforming highways into skyways. Regular people just can't be trusted to avoid pasting themselves against office buildings. Instead, personal air vehicles will use GPS and cell phone technology to automatically broadcast information about location and speed to ground-based towers. From the ground, an automated computer system will update the flight path of every sky vehicle and provide instant directions – automatically avoiding collisions and minimizing flight time. Meanwhile, on-board sensors will detect nearby trees, buildings and power lines and avoid collisions. And the jackpot bonus item for the sky-car consumer: For most of the flight, the human 'driver' can take care of anything besides flying, like eating a whole bag of potato chips…"
Popular Mechanics, **September 2009**

628

EQuiPT

629

"…One beneficiary of computerized navigation is national security: thanks to G.P.S. and cellphone technology, flying cars could be tracked more easily than any road vehicle. NASA is already at work on a device that will function as an on-board air-traffic controller, and the agency expects to have it ready in time for the debut of its first flying car, the EQuiPT, or Easy Quiet Personal Transport. The vehicle will automatically broadcast information on its location, so ground monitors and every other aircraft in the sky will know exactly who and where you are (any rogue vehicle ought to be easily spotted; another driver who sees a car that is in the air but not on his monitor can be expected to sound the alarm). Automated navigation will also keep airborne drivers from smashing into one another. If the computerized navigation system senses a tree, or another plane, or the White House, it won't let you steer in that direction…"
The New York Times Magazine, **September 26th 2004**

630

"…'The technology already exists in the military, and we're adapting it so it can come standard on any personal air vehicle and still be affordable,' Sally Johnson, the technical leader of NASA's Small Aircraft Transportation System (SATS) project, says. 'It's not a big jump to put these on flying cars,' adds Johnson, who is in regular communication with Hahn and his EQuiPT team. 'We talk to them and make sure that what we're doing dovetails with what they're doing, and we've found the two are very complimentary and synergistic'…"

***The New York Times Magazine*, September 26th 2004**

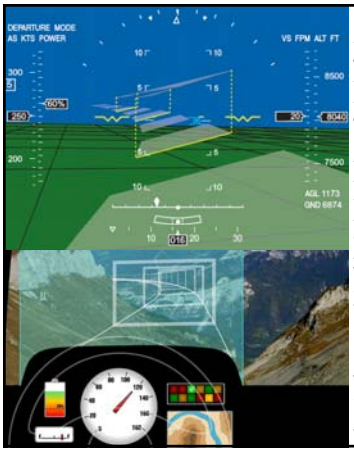
631

HITS

632

Above L&R: *Highway in the Sky* (HITS) technology adds an easy-to-interpret flight path depiction to an *Electronic Flight Instrument System* (EFIS) type of cockpit display, which may be located on the instrument panel or projected on a HUD (*Heads Up Display*). The intended flight path is shown as a series of virtual rectangles that appear to stand like a series of window frames in front of the aircraft. The pilot maneuvers the aircraft so that it flies through each rectangle, essentially following a visible path through the sky. When installed as part of a general aviation "glass cockpit," this simple graphic computer display replaces many of the conventional cockpit instruments, including the attitude indicator, horizontal situation indicator, turn coordinator, airspeed indicator, altimeter, vertical speed indicator and navigation indicators. Engine and aircraft systems information may also be incorporated.

633



"…This renewed interest has been spurred by changes in aviation, including the widespread use of lightweight carbon-composite materials, the advent of smarter flight control computers and new FAA regulations that reduce training requirements for pilots of small aircraft. It seems like a hopeful time for the flying car…"

***Popular Mechanics*, Jan. 2011**

Top: caption: "Highway in the Sky. The HITS display conveys flight path and attitude information using an intuitive graphic interface."

Bottom: caption: "Flying cars will need computerized control systems, such as this 'Highway in the Sky' view, to make them safe and easy to fly"

634

Can Do

635

"The appeal is obvious. There's always a market - if you can do it well."

***R. John Hansman*, Director of the MIT-based *International Center for Air Transportation* (2011)**

636

Part 10

Next Generation

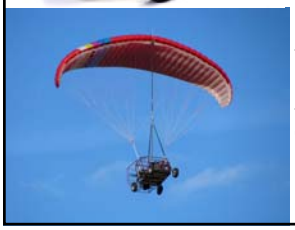
637

Keeping the Dream Alive

638

"…the dream is very much still alive. Over the past 10 years, scores of startup companies have proposed a new generation of dual-purpose vehicles. In 2010, the I-TEC Maverick, which is a dune-buggy-style vehicle with a pusher prop and parachute, was cleared for flight by the FAA and for the road by the state of Florida…"
***Popular Mechanics*, January 2011**

639



Left T&B: to switch from drive-mode to fly-mode, the operator deploys a mast and parachute - the largest powered parachute certified by the FAA (the deployable chute is tucked away on the roof and the mast is underneath the chassis when the car is in drive mode). The mast locks into place, the parachute is attached and it's raised to 27-feet. Then, all the operator has to do is switch the motor from drive to fly, travel about 100-meters and take-off. With its four-cylinder Subaru engine, the Maverick's top speed in flight is 40 mph and 100 mph on the ground. Its flight ceiling is 10K-feet. It can be driven on or off-road. The fact that both road and/or flight propulsion use the same rear engine makes the Maverick extremely light (it's half the weight of a *Smart Car*).

640

"The Maverick is not only a practical flying car but it's also a beefy car. They put a Subaru engine in this thing with 250 horsepower. It goes 0 to 60 in 3.9 seconds. We were really impressed they gave it that sort of on-road performance. This thing is poised to hit the market. They have plans to sell it, to manufacture it. They have a price tag. This is becoming a reality where so many flying cars have just been pie in the sky toys for billionaires."
Logan Ward* – writer for *Popular Mechanics
RE: PM gave the *Maverick* one of its "Breakthrough Awards" in 2009 after Ward wrote an article about the prototype. The I-TEC team had two goals for the vehicle in addition to flying: It had to be rugged enough to drive in the jungle and fly into remote areas and cheap enough that non-profits like his could afford one. Result: it rides like a car on the road and bounces like a dune buggy off road. Its structure is chromoly-steel tubing and the black skin of the vehicle is made of canvas.

641

"What we're doing here at I-TEC is we're reinventing the technology so it fits the people…We've been working on this particular project for six years…"
***Steve Saint*, I-TEC CEO**
Above L&R: caption: "Out for a ride in a sand pit"
Top Left: caption: "The Maverick was the first flying car to win FAA Certification"
Bottom Left: caption: "The Maverick can do 0 to 60 mph in 3.9 seconds"

642

"…the bigger thing that we do is developing health care technology and tools and training systems so that we can train people that live out in the jungle areas, that don't have any formal education, and don't have access to doctors or nurses or midwives, or optometrists, or dentists, teaching them how to take care of these needs for their own people. That's really what we're doing."

***Steve Saint,* I-TEC CEO**

RE: Saint - one part Christian missionary, one part pilot, one part inventor, grew up in Ecuador. His family moved there after the *Waodani Indians* speared his father to death. His dad, *Nate Saint* - a pilot, was part of a group of Christian missionaries trying to make contact with the tribe. Later, Saint's Aunt Rachel made contact with the tribe. Saint returned to the U.S. but when his Aunt died in 1994, the tribe asked him to return. Saint and his family agreed and went back to living in the Ecuadorian jungle. The tribe asked Saint to teach them to fend for themselves rather than have to depend on outside aid to survive. Out of that grew the small Florida-based non-profit that today is known as I-TEC (*Indigenous People's Technology and Education Center*)

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"A flying car crashed on Friday morning near an elementary school in Vernon, British Columbia, reports CBC News on May 10. The air-car clipped a fence, hit a tree and came crashing down. No one was seriously injured in the crash. Pilot Ray Siebring and a co-pilot suffered minor injuries in the crash of the flying car, called the 'Maverick'…The crashed flying car's pilot and passenger had to be pulled from the tree. They suffered minor injuries and were taken to a hospital and released…"

***Examiner.com,* May 11th 2013**

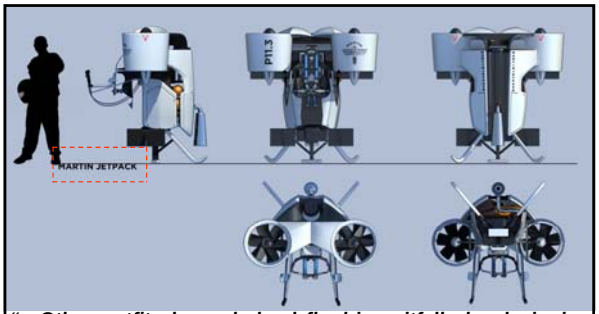
646

"…Later on, pilot Ray Siebring explained the flying car's crash. 'It seemed there was an anomaly on our approach to landing. It was just a sharp left turn that turned into a spiral, so the spiral took at least three rotations…This is an aircraft that has been demonstrated and is airworthy so we passed all our aircraft certifications. The vehicle uses a parasail for take-off and flight. It requires a 100-meter runway to take off and land.' Or just a schoolyard to crash in." 647

***Examiner.com,* May 11th 2013**

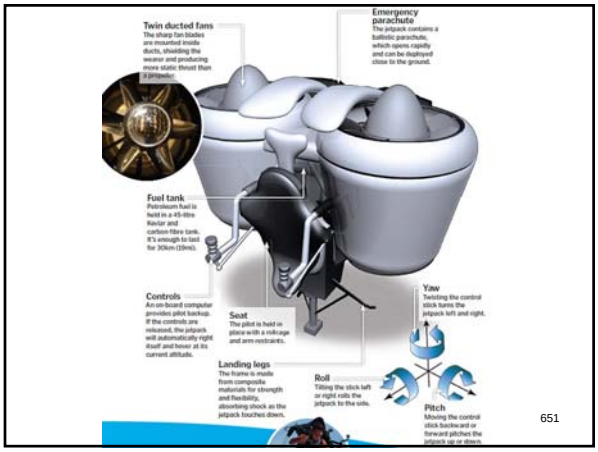
It's the Only Way to Fly

648



"…Other outfits have dodged fly-drive pitfalls by designing personal air vehicles that require neither roads nor runways. Martin Jetpack has lined up funding to build a factory that will produce a backpack mounted with shrouded propellers…"
***Popular Mechanics*, January 2011** 649
Above: caption: "Martin Jetpack"

Left: unveiled in July 2008, the *Martin Jetpack* can fly for a duration of 30 minutes to a height above 5K-feet or a maximum speed of about 60 mph and a maximum range of 31.5 miles. However, the "Jet" in this jet-pack refers to the two jets of air produced by its duc-ted fans (powered by a 200-hp V-4 piston engine). Thus, the Martin Jetpack is more of a 280 pound helicopter back-pack that's too noisy for the urban com-mute and much too bulky to store in the hallway closet. The Martin Jetpack's price range is +$100K. 650



651

652

Battle-Ready

653

"…In addition to these private sector players, the Pentagon is funding a flying Humvee program…"
***Popular Mechanics*, January 2011**

654

The Transformer

655

"It looks too far-fetched to be anything but a child's toy. But for front-line troops in Afghanistan, this revolutionary vehicle could soon be a reality. The road-going army truck turns into a helicopter at the touch of a button, allowing it to fly above hazards such as roadside bombs. And military chiefs believe the American-made vehicle, complete with rotor blades and wings, could transform the fortunes of soldiers fighting the Taliban. It would be similar to a Humvee vehicle for patrolling on the ground but could turn into a helicopter at the touch of a button in an emergency…"
***Daily Mail*, December 2nd 2010**

656

"…Troops could maneuver past lethal roadside bombs, improve resupply operations to remote patrol bases and insert elite Special Forces into Taliban strongholds. The vehicle would also enable soldiers to escape quickly by air if they were caught in a Taliban ambush. It would also reduce the time required to evacuate wounded soldiers from the battlefield because they would not need to wait for a medical helicopter - increasing the chances of survival…"
***Daily Mail*, December 2nd 2010**
Left: caption: "Take-off: A concept design for the Transformer vehicle which will be able to fly troops safely over areas littered with roadside bombs"
Right: caption: "Convertible: The vehicle's wings fold away so it can operate like any other armored car"

657

"…The Pentagon's Defense Advanced Research Projects Agency (DARPA) has launched a £41 million program to develop a flying armored vehicle that can carry four servicemen or women. The vehicle - which uses composite armor to protect crew from gunfire, IED blasts and missiles - would be able to travel 280 miles by land or in the air. It could take-off and land vertically - like the Royal Navy's Harrier jump jets - to increase access to rugged terrain. Fitted with automatic flight controls, it could be flown by someone who was not a qualified pilot - increasing its flexibility. And it would be fitted with machineguns and cannons to kill and maim attacking insurgents…"
***Daily Mail*, December 2nd 2010**

658

- **Speed**: Around 65 mph on ground and more than 150 mph in air;
- **Range**: 280 miles in air or on land;
- **Length**: Around 20-feet;
- **Wheels**: Four-wheel drive for ground operations including silent 'creep' mode;
- **Protection**: Lightweight composite anti-blast armor, ballistic-proof windows, machineguns and cannons for defense;
- **Engine**: JP-8 Turboshaft for airborne cruising;
- **Wing Span**: About 27-feet;
- **Rotors**: Powerful blades for smooth vertical take-off and safe landing if engine fails;
- **Price**: £132,000 – similar to that of a Ferrari.

"…The 20 ft. car could reach speeds of around 65 mph on the ground and more than 150 mph in the air. A prototype of the vehicle, dubbed the Transformer, or TX, could be ready by 2015 when British and U.S. troops are still in Afghanistan. A DARPA spokesman said: 'We are seeking to combine the advantages of ground vehicles and helicopters into a single vehicle equipped with flexibility of movement. The concept is to provide options to avoid traditional and asymmetrical threats while avoiding road obstructions. With this type technology, transportation will no longer be restricted to trafficable terrain that tends to make movement predictable'…"
***Daily Mail*, December 2nd 2010**

659

"…Terrafugia, a company which has already pioneered a flying car for commercial use, has been drafted in to help produce a prototype armored truck. The commercial vehicle, which costs about £132,000 - a similar price to a Ferrari - has wings rather than rotor blades with a 27 ft. span when lowered. This means it needs 1,700 of clear road to take-off. A military source said: 'We take an interest in the development of all new technology that may have the potential to help our Armed Forces, no matter how ambitious they may appear to be.'"
***Daily Mail*, December 2nd 2010**

660

661

"Last month, Maryland-based AAI Corp. landed a $3.05 million DARPA grant to develop its hybrid wing/rotor Transformer vehicle. Then Lockheed Martin scored a similar study contract to develop its own alternative Transformer design (left), employing a huge ducted fan on each wing to provide lift and thrust. Shortly thereafter, jet engine maker Pratt & Whitney Rocketdyne received $1 million to develop a lightweight diesel engine to power the vehicle. The three companies have already put their heads together on the project…"
***Popular Science,* October 2010**

662

"…But if one report is to be believed, the flying car is almost here - it's just not for the public. Scientific American reports that two 'transformer-type' vehicles in development, for government use. Lockheed Martin and the much smaller Advanced Tactics are each working on potential designs, both with government DARPA backing. Lockheed Martin's take on the flying vehicle is called Aerial Reconfigurable Embedded System (ARES), and is not necessarily the 'flying car' part. Rather it is an unmanned vertical take-off and landing (VTOL) platform that can pick up various types of payload. That includes the option for a dune buggy, which could carry ARES while traveling on the ground…"
***Yahoo.com*, March 26th 2014**

663

"…With economic incentives and a strategic imperative in mind, it appears the flying car is finally getting off the ground. The progress of the Transformer program points optimistically toward an increasingly aerial future for the common driver, as defense technology tends to roll downhill. If DARPA succeeds in providing the military with a flight-capable automobile, it's difficult to imagine a scenario where that technology isn't commercialized at some point. It certainly won't happen overnight (or in the next decade for that matter), but with the technology sitting right in front of us we would be foolish to keep our rubber restricted to the road…"
***Popular Science,* October 2010**

664

What Next, Flying Trucks?

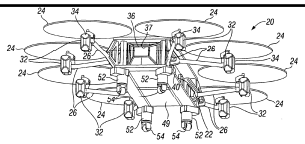
665

"Though they were once a staple of sci-fi, a symbol of a future many had become skeptical they'd ever get to see, the flying car is finally on its way. Technically their creators prefer them to be called 'roadable aircraft' now, though it's a minor distinction. They come in various flavors, from civilian plane-cars like the Transition to military troop transports like the Transformer, but they all combine the mobility of air travel with the ease and safety of 'roading' (known to regular humans as 'driving'). Now, a new contender called the Black Knight has appeared to vie for the honor of being the U.S. military's first roadable aircraft, debuting with a fully successful flight test…"
***Geek.com*, April 12th 2014**
RE: the operational concept design of the *Black Knight Transformer* is a streamlined aircraft optimized for payload carrying and multi-mission capabilities. It will use turbo-diesel engines and aerodynamic enhancements to provide a payload capacity of over 1K-lbs. or five passengers with a 250 nautical mile range. Configured without the ground drivetrain, the aircraft can carry up to 1,600 lbs. of payload or eight passengers. The aircraft will cruise at a speed of 130 knots and drive at up to 70 mph. It is intended to provide a safe, low-cost option for casualty evacuation, medical, cargo resupply and other military and/or civil missions.

666

"…The Black Knight uses a vertical take-off vertical landing (VTVL) design via helicopter-like rotors. This increases its mobility and versatility, but limits its range and top speed. The idea is essentially to make a driving, flying platform for a wide variety of compatible, modular attachments. For instance, upon delivery cargo a team might quickly reconfigure the whole thing for troop transport, removing two rotors now unnecessary with a lighter load, before climbing inside for a quick trip back to base. The modules can be armored or lightweight, and even comes with a boat-hull design for fully amphibious missions. It's so customizable that the entire drive train can be removed for extra cargo space…" 667

Geek.com, April 12th 2014



"Advanced Tactics' TRANSFORMER technology is the basis for a family of vehicles that transform between a vertical takeoff and landing aircraft and a cargo truck, allowing new mission profiles and capabilities. The TRANSFORMER technology is not limited to these two modes of operation – it is designed as a modular 'payload truck' that can carry a ground drive system, a cargo container, a boat hull, or a passenger compartment. The vehicles' distributed propulsion design is not a new one – it dates back to the earliest helicopter designs. Recent technology has enabled simple and reliable control of such aircraft which have become prevalent in small UAVs such as quadcopters, hexacopters, and octocopters. Distributed vertical lift aircraft, i.e. multicopters, are simpler, more reliable, lower cost, and more controllable than conventional helicopters. AT's vehicles use off-the-shelf aircraft engines and propellers without the complexity and cost of helicopter rotor systems. Additionally, they have configuration advantages in that they are compact for their payload capacity compared to conventional rotorcraft. Advanced Tactics' patented technology allows this design to be used on a much larger scale while retaining these advantages." 668

Advanced Tactics, Inc.

"…As mentioned, the rotors can be folded down by two people to reduce driving width and protect rotors from fire; one of the primary uses for readable aircraft is to enter hostile cities on the ground, after rapid insertion via the air. It's not an assault vehicle by any means, but it is being designed with rough missions in mind. Unlike DARPA's similarly named Transformer TX, the Black Knight Transformer requires a pilot, either remote or in the cockpit. Cutting out a pilot's weight can free up precious cargo capacity, and lets all passengers remain in the most heavily armored portions of the vehicle…" 669

Geek.com, April 12th 2014

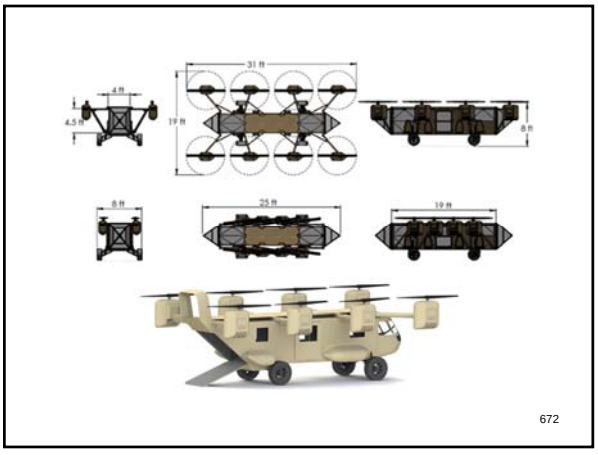
"…In a test flight performed this week, the Black Knight completed multiple low-altitude flights. Though it is designed to fly thousands of feet in the air, this demonstration kept to less than 10 feet for safety. With just simple 'up/down' instructions from a remote pilot, the system automatically kept balance through simple, quadcopter-like adjustment of rotor speed…" 670

Geek.com, April 12th 2014

Top Left: caption: "AT Black Knight Transformer technology demonstrator during driving tests. The engines are stowed along the side of the vehicle to reach a street-legal width."

Top Right: caption: "Four-engine technology evaluation aircraft flown in 2012. It is gas powered and weighs over 2,000 lbs."

Left: caption: "Black Knight Transformer operational concept design with streamlined aerodynamics and more powerful and efficient turbo diesel engines." 671



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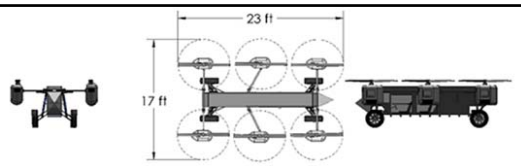
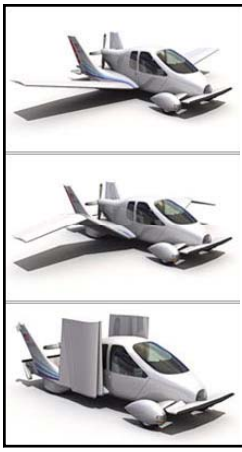


"…The Black Knight is one of two major models incoming from Advanced Tactics, the other being the Panther Transformer, which is designed for quicker, lighter missions."
***Geek.com,* April 12th 2014**
Above: caption: "Panther TRANSFORMER concept vehicle. Advanced Tactics Inc. was awarded a contract for the Air Force Research Laboratory (AFRL) Special Ops Transport Challenge in June 2012. The program aims to leverage Advanced Tactics' unique roadable vertical takeoff and landing vehicle technology to solve the challenge put forth for the Special Ops Transport Challenge, announced in mid-2011. The primary goals of the challenge are as follows:
• Transport at least two people and their equipment (700 lbs. total) without being detected;
• Provide transport and safe return over a distance of at least 30 kilometers over rugged, mountainous terrain;
• Permit packaging for delivery or shipping in the CV-22 cargo hold;
• Be able to transition from storage to operation in under four hours;
• Operate autonomously in day/night and inclement weather conditions;
• Consider OSHA and Air Force safety standards for manned vehicles."
673


674

Escape the Earth
675


"The Transition, the most advanced flying car in the United States, rolls down a runway, gathering speed at the start of its test flight. The pusher propeller at the back of the car buzzes loudly as the nose lifts and the car lurches into the gray skies over Plattsburgh, N.Y. Once airborne, the Transition prototype looks like a bulky light-sport plane, with a bulbous fuselage, a 26-foot 6-inch wingspan, a slender twin tail and a wide front bumper that doubles as a canard. The flight is brief, about a minute. The Transition does not rise higher than 300 feet and never veers from the safety of the 2-mile runway, which was designed to accommodate massive B-52 bombers. The test pilot uses every bit of the long stretch of asphalt to set down. Terrafugia quietly conducted this milestone flight in March 2009, away from the eyes of the public and press…"
676
***Popular Mechanics,* January 2011**


"…Last month, the Terrafugia Transition took to the skies for a brief but successful test flight in Plattsburgh, N.Y. Designed with folding wings that can transform it from a two-seat car to a plane in 15 seconds, the Terrafugia could be available as early as the end of next year. 'This flight is a symbol of a new freedom in aviation,' declared Terrafugia's chief executive, Carl Dietrich, who led the group of MIT-trained aeronautical engineers that designed it…"
***Popular Mechanics,* April 2009**
Left: caption: "Terrafugia Transition – 'The first practical street-legal airplane in the world.'" The carbon-fiber wings stow and deploy electrically. On the road, the *Transition* is able to reach 62 mph, with its rear wheels driven by a four-cylinder *Rotax* 100-hp engine. The price is expected to be about $230K. "Terrafugia" is latin for "Escape the Earth." One hundred customers placed $10K deposits for production versions.
Right: caption: "The Terrafugia Transition 'street legal' plane completes its first test flight in upstate New York."
677


"…Formed by five MIT graduate students in 2006, the company is built on solid engineering and tech-business roots. Carl Dietrich, who spearheaded Terrafugia's creation while he was still working on his Ph.D. in aeronautics and astronautics, wants to build a product for pilots who don't want to pay for hangar space. It's a practical business model applied to an infamously impractical idea. 'People tend to have popular-culture visions of flying cars,' Dietrich says. 'The reality does not match that set of expectations. However, the reality is Transition offers a freedom that does not exist in the aviation market'…"
***Popular Mechanics,* January 2011**
Above L&R: caption: "The Transition Terrafugia, a real flying car with folding wings, is now on sale for $279,000. The first models will be delivered in late 2012."
678

"…The Transition is perhaps best described as a road plane, rather than a flying car. It is essentially a small, $279,000 plane that has been designed to be legally roadworthy. Push a button and the wings fold up, allowing the pilot to start driving it like a car. It even runs on petrol, with a range of 600 miles (1,000 kilometers) on the ground or 400 miles in the air. Around 100 aircraft have been reserved, and the first is due to be delivered later this year…"
The Economist, March 2012

679

"…The Transition is a car that has been adapted for flight, and that simple fact brings some serious limitations to its performance as an aircraft. During takeoff, for example, an airplane's wings must be at a certain angle, at a certain speed, to generate enough lift for flight. When a pilot reaches takeoff speed, he pivots the airplane's nose over its center of gravity, a maneuver called rotation. Most engineers position the main landing gear close to the airplane's center of gravity for easier rotation, which allows for takeoffs and landings at relatively slow speeds on short runways. But Transition's wheels - like those on most flying cars - are at the perimeter of the chassis. And for good reason: If a car's wheels were at its center of gravity, a pothole or speed bump could flip the vehicle. But, Dietrich admits, 'it makes for some different takeoff dynamics.' In other words, Transition owners will need to find long runways…"
Popular Mechanics, January 2011

680

"…'Look at the video,' says aeronautical engineer Austin Meyer of the Transition's test flights. 'The pilot has the elevator fully deflected and he can still barely raise the nose.' Meyer is the creator of X-Plane, the leading flight simulator for personal computers. Other simulators use data from test flights to plug into simulations; X-Plane can predict how an aircraft will handle in flight while it's still being designed. The simulation models the aerodynamic forces on aircraft parts: A wing is not judged as a single component; it is split into dozens of sections, each of which is evaluated separately. When Meyer flew the Transition in his simulation, he found that its twin-vertical stabilizers, canards and external wheels created enough drag to degrade the flight performance…"
Popular Mechanics, January 2011

681

"…Technically, the Transition has been made possible by the availability of modern engines, composite materials and computerized avionics systems. But it has also taken advantage of the 'Lite-Sport' aircraft category introduced by America's Federal Aviation Administration (FAA) in 2004…"
The Economist, March 2012

682

"…This category was partly intended to plug gaps created by unregulated small aircraft, but there was another reason to introduce it, says Carl Dietrich, Terrafugia's co-founder and chief executive: to spur innovation and make it easier to get a pilot's license. Part of the FAA's remit is to promote flight, yet getting a license is difficult and time-consuming. Safety is paramount, of course, but in theory this could be made simpler for people who want to fly a simpler class of plane…"
The Economist, March 2012

683

"…The complexity of the certification process deterred anyone from designing small, easy-to-use planes, however. As a result, says Mr Dietrich, 'you had an average age of aircraft of over 40 years.' The Lite-Sport category was introduced to encourage the development of such aircraft. Certification is simpler, and since the category's introduction there has been a flowering of innovation. More than 120 new models of small aircraft have entered the market. An aircraft that is simpler to certify and easier to fly need not be any less safe. Whereas once a pilot needed to know how to triangulate his position using ground-based radio beacons, portable GPS units and altimeters can now do the job. 'There are now off-the-shelf systems that can give you the same kind of instrumentation capabilities as an airliner,' says Mr. Dietrich. As a result, although there are restrictions on flying at night or through bad weather, it is possible for someone to get a Lite-Sport license with just 20 hours' flying experience - less time than many people spend learning to drive…"
The Economist, March 2012

684

"…Even supporters acknowledge the vehicle's limitations. 'The Terrafugia guys have done a good job,' says MIT's Hansman, who advised the company. But no matter what, 'it's a compromised car and a compromised airplane.'"
***Popular Mechanics*, January 2011**

685

"…The Transition is being aimed at pilots who want to be able to drive to the airport and take off without changing vehicles, or land at a distant airport and not be stranded. As its name implies, it is intended to be a transitional product, a step on the way to true sky cars capable of taking off and landing almost anywhere…"
***The Economist*, March 2012**

686

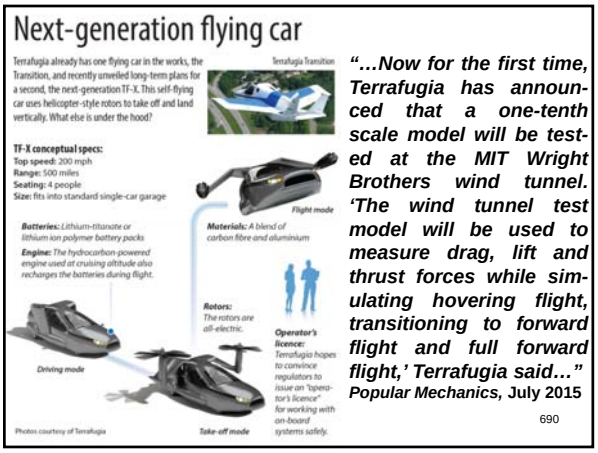
687

NextGen

688

"While the likes of Google focus on driverless cars, Terrafugia continues to look much further into the future with flying cars. The company has been talking about its heli-car hybrid the TF-X since 2013 and has just released a video showing its new exterior design in action…"
***Popular Mechanics*, July 2015**

689



"…Now for the first time, Terrafugia has announced that a one-tenth scale model will be tested at the MIT Wright Brothers wind tunnel. 'The wind tunnel test model will be used to measure drag, lift and thrust forces while simulating hovering flight, transitioning to forward flight and full forward flight,' Terrafugia said…"
***Popular Mechanics*, July 2015**

690

"…The video shows the TF-X leaving a garage and taking off from a landing pad. It's equipped with twin electric motor pods, two wings and two helicopter-style propellers. Four passengers can be carried a maximum of 500 miles, while the TF-X is capable of flying up to 200 mph. Unfortunately, Terrafugia predicts that development of the heli-car hybrid will take 8-12 years."
***Popular Mechanics,* July 2015**

691

"…the company looks at the TF-X as the kind of vehicle that could - big could - usher flying cars into the mainstream. It would be capable of taking off and landing vertically, outside of an airport. (Heliports or empty lots are fair game, as long as you have permission). It would have 'fly-by-wire' controls that would let you set your destination, and have the vehicle navigate to it with minimal pilot involvement. It'd be a plug-in hybrid outfitted with both batteries and an internal combustion engine, which would presumably make it more fuel efficient than most of today's 'general aviation' (a/k/a private) aircraft..."
***Boston.com,* May 6th 2013**

692

"...The TF-X would have a 500 mile range. And as with the Transition, if you encountered bad weather, rather than trying to fly through it, you would simply land at the nearest safe spot and drive the rest of the way to your destination, at highway speeds. And if Terrafugia can somehow attain large enough production volumes, the TF-X might actually be a flying car that the middle class (OK, upper middle class) could afford (the base price of Terrafugia's Transition will be $279,000, and hopes that the TF-X would sell for less than that). Dietrich acknowledges that getting the TF-X to the market will probably be at least an 8 to 10 year process, and require his company to do some major fundraising."
***Boston.com,* May 6th 2013**

693

Jet Pack With a Cockpit

694

"…NASA is designing a one-person electric helicopter/small-aircraft hybrid for commuters…Mark Moore, an aerospace engineer at NASA Langley who designed the Puffin, is not interested in trying to meld airplanes and automobiles. Instead, he envisions a radical personal aircraft with only one mission - to deliver a commuter to his office. On a budget of less than $1 million, Moore designed the Puffin to avoid gridlock…"
***Popular Mechanics*, January 2011**

695

"…NASA is designing a one-person electric helicopter/small-aircraft hybrid for commuters…Known as a loner, the puffin is an awkward-looking bird with wings that seem too small for its rotund body. It's appropriate, then, that engineers at NASA adopted the moniker for their bizarre one-person aircraft that takes off from an upright position…"
***Popular Mechanics,* January 2011**
Above L&R: caption: "The Puffin is a conceptual design developed by NASA Langley. Designed to take-off and land vertically like a helicopter and fly like a plane, the craft has carbon composite construction and weighs less than 400 pounds, including the lithium phosphate batteries. The craft is shown in an artist's rendering parked in its vertical position (left) and in flight showing the pilot in the prone position (right)."

696

"A super-quiet, hover capable aircraft design, NASA's experimental one-man Puffin could show just how much electric propulsion can transform our ideas of flight. It looks like nothing less than a flying suit or a jet pack with a cockpit"
Scientific American

697

"…Here's how the Puffin could redefine a typical commute: A rider walks to his backyard, steps into the cockpit, enters his destination into the flight-control computer and takes off. Two electric engines, powered by 100 pounds of lithium-phosphate batteries, are so quiet that the rest of his family doesn't know he's leaving for work. The commuter steers the Puffin with a two-axis joystick to indicate direction and speed, and the flight-control computer translates the input into movement of the Puffin's control surfaces. Always on some level of autopilot, the craft would not obey dangerous commands. At a pre-designated altitude, automatic controls take over. Instead of rotating its engine nacelles, like a traditional tilt-rotor aircraft, the Puffin tips its entire body (and its passenger) over onto its belly for forward motion through a flight corridor - a sort of bicycle lane in the sky…"
Popular Mechanics, January 2011

698

"…In Moore's world, the nation's airspace is open to unmanned aerial vehicles. In reality, the FAA has been reluctant to allow UAVs to share the sky with airliners, sport aircraft and helicopters. The Pentagon is leading the effort to draft the rules and define the technical standards that will open the nation's airspace. Pressure is mounting to do so as federal and local agencies develop plans for using drones to monitor weather, provide tactical reconnaissance for police or conduct environmental studies. So commuting in a Puffin would be like hitching a ride on a UAV studded with collision-avoidance sensors and wired for direct communication with other aircraft and sensors on ground infrastructure…"
Popular Mechanics, January 2011

699

"...Flying in a prone position might be unacceptable to most commuters. But there's one thing Moore does not have to worry about that consumes flying-car companies: marketability. The government's role, Moore believes, is to come up with the innovations and regulations needed to finally build a flexible point-to-point transportation system. What companies sell, and what products customers will actually buy, is another matter. 'Let the private market figure it out,' says Moore. 'It always does.'"
Popular Mechanics, January 2011

700

The Intersection of Technology & Art

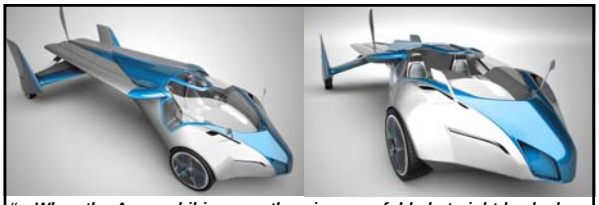
701

"There's a saying in flying: 'If it looks good, it will fly well.' Stefan Klein, a designer from the Slovak Republic, has announced the first flight of his Aeromobil Version 2.5, a flying car prototype he has been developing over the last 20 years. This vehicle is a strikingly beautiful design with folding wings and a propeller in the tail. But will its flight capabilities match its looks?..."
Gizmag.com, October 2013
Left: caption: "This earlier prototype of the Aeromobil flying car had just one tail fin"
Right: caption: "A rear view of the flying car showing the propeller arrangement. The prop does not move in car mode, just in the air"

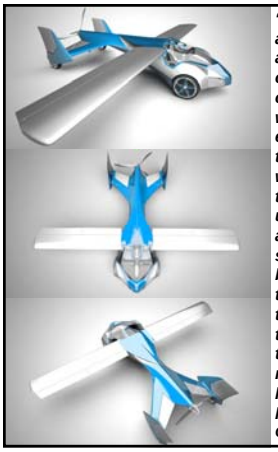
702

"…The Aeromobil V2.5 is a propeller-driven aircraft that also functions as an automobile - or you can think of it as a car with lofty aspirations. The aviation aspects seem to be prominent in the design, with a streamlined cockpit, super light weight, and sleek tail fins in the back. Propulsion is provided by a 100 hp Rotax 912 water cooled engine mounted behind the seats, with drive shafts leading both aft to the propeller and forward to the two front wheels for driving…"
***Gizmag.com*, October 2013**
Left: caption: "The Aeromobil cockpit is very snug, and has two steering wheels, one for the ground and the smaller wheel for flying"
Right: caption: "Stefan Klein poses in the skeletal frame of the flying car. You can see the driveshafts from the mid-mounted engine run forward to drive the front wheel in car mode." 703

"…Klein has a very interesting background, with degrees both in mechanical engineering, and in fine arts. He originally wanted to be a sculptor, but received his engineering degree first. He later studied design at the Academy of Fine Arts in Bratislava, the Slovak Republic and became the head of the Department of Transport Design at that school. As a professional, he worked on car designs for Audi, BMW, and Volkswagen, and won a national design award for a three-wheeled electric scooter, which he still drives to work each day…"
***Gizmag.com*, October 2013**
Left: caption: "Designer Stefan Klein in his award winning three wheeled electric scooter" 704

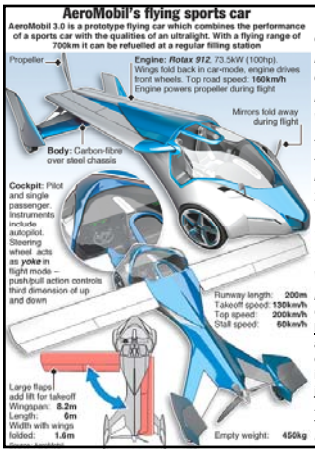


"…When the Aeromobil is a car, the wings are folded straight back along the fuselage and the engine drives the front wheels, while the small back wheels support the tail. There seems to be very little structure, and the entire vehicle weighs just 980 lb (450 kg) empty of fuel and passengers. There is room for two people in the very snug cockpit, and there are two steering wheels, mounted one inside the other in front of the driver/pilot. The larger wheel is for driving on the ground, and the smaller wheel is used for flying…"
***Gizmag.com*, October 2013**
Left: caption: "The wings fold back to make the flying car fit on the roadways. It also runs on automotive gas."
Right: caption: "Front view of the sleek Aeromobil flying car in ground mode" 705



"…when the Aeromobil gets to the airport, the driver/pilot pushes a button and the wings fold out for a wingspan of 8.2 m (27 ft), which is comparable to other light sport aircraft of similar weight and power. The large flaps (moveable surfaces on the trailing edge of the wing) in this prototype flip over the wing and hang down to add lift for takeoff with the entire wing also tilting up a few degrees to assume the proper angle to the wind for takeoff. The driver switches the gearbox to send power back to the propeller that is mounted at the very end of the vehicle between the two vertical tails. The Aeromobil then takes to the runway and accelerates for takeoff…The airplane mode of the Aeromobil would have a top speed of 200 kph (124 mph) and a range of over 700 km (430 miles)…" 706
***Gizmag.com*, October 2013**

"…Klein says that in car mode the Aeromobil fits into a standard parking space and can be refueled at the same gas station as all the other cars - in other words, it does not require special aviation fuel like most aircraft. The flying car is extremely lightweight, coming in at less than half the weight of a compact car like the Ford Fiesta, which weighs 1,041 kg (2295 lbs). The structure is a steel tube frame with a carbon fiber composite shell, a configuration familiar to fans of racing cars. The Aeromobil is a prototype intended to demonstrate to investors that the concept is viable. Klein is now shopping this striking flying vehicle to potential manufacturers and investors in order to make it a reality. Once such a deal is struck, he estimates that it would take two additional years to get certification for the Aeromobil to go into production, presumably under the existing Light Sport Aircraft rules…"
***Gizmag.com*, October 2013**
Above: caption: "The Aeromobil flying car designed by Stefan Klein takes to the skies for the first time" 707



"…Over the twenty year gestation of this flying car concept, Klein has created four different versions of his dream. The first version did not have folding wings at all, but was a boxy canard (tail first) design with tall wheels. The next versions featured the signature folding wings, but different tail configurations. Version 2.0 had an inverted V-shaped tail and this last version 2.5 was the first with two vertical tail fins enclosing the wheels. His web site shows drawings for Version 3.0…"
***Gizmag.com*, October 2013**
Left: the *AeroMobil V3.0* fits into a standard-size parking space, uses regular gasoline and is capable of taking-off and landing using any grass strip or paved surface just a few hundred feet long. In 2010, the AeroMobil received certification from the *Slovak Federation of Ultra-Light Flying*. 708

709

"…Flying is in the Klein family, however, and his grandfather, father and brother are all pilots. He started flying as a teenager with his brother, and today flies both powered aircraft and gliders. For the Aeromobil, he is also the chief test pilot, which in unusual in these days of large aerospace companies. Klein calls his Aeromobil flying car 'the intersection of technology and art.'"

***Gizmag.com*, October 2013**

710

Transformer-Like

711

"The Krossblade SkyCruiser is a flying car unlike any other. While folding wings are pretty common among these car/plane prototypes, the SkyCruiser has a Transformer-like power to reconfigure itself in mid-air. From its road-going configuration, the vehicle becomes a helicopter with eight sets of rotor blades for vertical take-off. Once aloft, it transforms again into a fixed-wing aircraft…"

712

***Popular Mechanics*, October 2014**

"…The SkyCruiser was built by Krossblade Aerospace Systems, a start-up originating from the makerspace HeatSync Labs in Arizona. The group is dedicated to developing swift and easy air transport for everyone; their 'switchblade' transformer mechanism could be incorporated into a range of aircraft…"

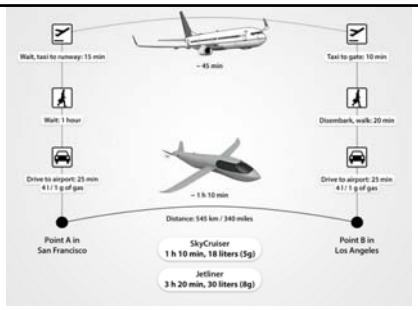
713

***Popular Mechanics*, October 2014**

714

"…Krossblade CEO Dan Lubrich argues that the SkyCruiser is not just another flying car. It's a roadable aircraft that's optimized for flight, rather than a hybrid vehicle that's not really great at either. While AeroMobil Roadster cruises at 124 mph and Terrafugia's makes 100 mph, the SkyCruiser zips along at more than 300 mph. Its range of 1,000 miles can take you from New York to Washington, San Francisco to L.A., or London to Paris with ease. The SkyCruiser's vertical take-off ability means you don't need an airport or a runway - it could take off from any reasonably open space. You probably live within a mile of a suitable take-off point, Lubrich says…"
***Popular Mechanics*, October 2014**

715



"…'I personally do not see a huge advantage to driving to an airport seventeen miles away (the average distance a U.S. person lives form the nearest airport), then flying relatively slowly, and then driving again after landing,' Lubrich says. 'One saves the time by not having to change vehicles, and the flexibility is great. But SkyCruiser on top of that cuts out two airports, which saves about an hour right there'…"
***Popular Mechanics*, October 2014**

716

"…Krossblade's construction secret is using new lightweight, powerful electric motors to drive both the hover rotors and the separate forward flight system. This means SkyCruiser can lift around eleven pounds per horsepower in helicopter mode, then cruise with the speed of a fixed-wing aircraft. The engine is hybrid, but it can land and take-off on electric power alone, so it shouldn't wake the neighbors up…"
***Popular Mechanics*, October 2014**

717

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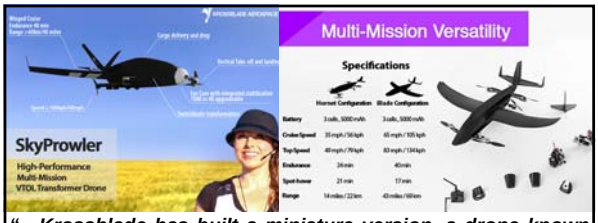

"…Krossblade has built a miniature version, a drone known as SkyProwler…In addition to demonstrating the concept, the little drone will provide some serious competition in the small delivery market. Amazon's Prime Air and Google's Project Wing are looking at small drones for parcel delivery, and they're not the only ones. SkyProwler, with its combination of speed, range, payload, and vertical landing could be ideal for bringing shoppers anything from medical supplies to pizza…"
***Popular Mechanics*, October 2014**

719

"…The full-size five-seater SkyCruiser won't be around for a while. But if Krossblade can bring it to market, it could be the flying car for people who don't have a pilot's license. While SkyProwler may be a more immediate proposition, the five-seater SkyCruiser is rather more eye-catching. Even if you don't have a pilot's license, this could be the flying car for you. 'We envision SkyCruiser as fully autonomous - just tell it where to go and it will go there,' Lubrich says. The vehicle will have manual controls for those who want to fly themselves, Lubrich says. But the autonomous technology does more than open up the SkyCruiser to a much larger market - it also could help Krossblade to skirt some of the air traffic control and legal issues that have previously kept flying cars firmly on the ground. The price tag? Assuming the SkyCruiser goes into mass production, expect to pick one up in 2018 for around $350,000."
***Popular Mechanics*, October 2014**

720

In the Land of the Autobahn

721

"In the land of the autobahn, drivability is a passion - even if the car is designed to fly. And the need for good road performance has driven the design of Germany's Carplane flying car, the near-complete prototype of which was unveiled at the Aero Friedrichshafen general-aviation show on April 15-18…"
***Aviation Week,* April 27th 2015**
Left: caption: "Germany's Carplane project unveiled the near-complete prototype of its twin-hull flying car at the Aero Friedrichshafen general aviation show on April 15-18. The vehicle is planned to fly later this year."
Right: caption: "Based in Braunschweig, Germany, Carplane is developing its prototype flying car with funding support from the European Union and the German state of Lower Saxony (Niedersachsen)"

722

"…Braunschweig-based Carplane is developing the prototype with funding from the EU and the German state of Lower Saxony. The prototype is expected to be complete by the time funding support ends in July, after which Carplane plans to fly the vehicle and continue working toward certification on private investment, says program manager John Brown…"
***Aviation Week,* April 27th 2015**

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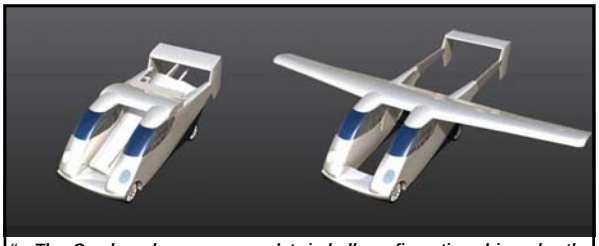

"…The Carplane has an unusual twin-hull configuration driven by the need for good road handling. Stowing the removable wings between the hulls prevents them from producing lift at higher road speeds, or the forces that could be produced by sidewinds if the wings were folded along the sides of the fuselage, he says…"
***Aviation Week,* April 27th 2015**
Above: caption: "Carplane has a twin-hull configuration to make it more drivable as a car. Stowing the sailplane-style wings between the hulls prevents them generating lift, and sideforce in winds, at autobahn speeds. To convert from automobile to aircraft, the Carplane's wings are unstowed and its empennage extended."

725

"…Dual hulls also enable use of full-size car wheels to improve roadholding. While other flying-car designs use smaller aircraft-size wheels to reduce drag in flight, Brown says the twin hulls allow the vehicle to accommodate 15-in. road wheels (from the Smart Car) while minimizing parasitic drag in flight…"
***Aviation Week,* April 27th 2015**
Above: caption: "Where other flying-car designs have smaller, aircraft-style wheels to reduce drag in flight, Carplane's twin hulls allow use of full-size car wheels for better roadholding, while minimizing drag"

726

"…The Carplane is powered by a 151-hp piston engine burning unleaded gasoline. This drives a gearbox with seven positions: four forward and one reverse driving the road wheels in car mode; one that drives the pusher propeller in flight; and one that drives both wheels and prop for a shorter takeoff. Driving both wheels and prop increases acceleration. 'We can get off the ground in 80 meters (260 ft), at 45-50 kt,' says Brown. 'And we can land and stop within 80 meters.' Licensed by LSA Engines from Weber Motor and originally designed as a snowmobile powerplant, the 850-cc two-cylinder, four-stroke engine is turbocharged for use in flight and is already certified by the European Aviation Safety Agency (EASA), he says, and meets the Euro 6 emissions standard in Europe…"
***Aviation Week,* April 27th 2015**

727

Left: caption: "Carplane has a 151-hp piston engine and a gearbox that allows power to be directed to the drive wheels in road mode, to the pusher propeller in flight mode, and to both wheels and prop for a short takeoff."

728

"…In the prototype, the sailplane-style wings are removed, stowed and reattached manually, but Carplane has designed a mechanism that enables the wings to stow and unstow, and empennage to extend and retract, automatically. This has been demonstrated with a quarter-scale model, and the prototype's structure is designed to accommodate the mechanism…"
***Aviation Week,* April 27th 2015**
RE: production Carplane's highly automated wing extension/retraction process will take about fifteen seconds. *Carplane* was designed to fit in a single car garage.

729

Left: caption: "In the prototype, the wings will be removed, stowed and re-installed manually, but Carplane has designed a mechanism to enable automatic folding and unfolding of the wings in a production vehicle." A driver/pilot can stay in the same seat during Carplane's mode transition since *Carplane* is driven/flown from one side.

730

"…Carplane plans to certify its flying car as a very light aircraft (VLA) under EASA airworthiness regulations. This limits maximum gross weight to 750 kg (1,650 lb.). With the automatic deployment mechanism, the vehicle weighs 795 kg. 'We either go manual or apply for an exemption,' says Brown, adding that EASA has indicated it would consider approving a heavier weight. The company is pursuing EASA approval, rather than self-certification under industry standards for light sport aircraft (LSA), because the VLA category is recognized worldwide, he says. VLA certification does require a private pilot's license, whereas an LSA can be flown with a sport pilot's certificate requiring as little as 20 hr. flight time. The Carplane is too heavy for the LSA category, but if the FAA approves flying-car developer Terrafugia's request for an exemption to raise the gross-weight limit to 1,800 lb. for its Transition, then the vehicle could be ready more quickly. As a VLA, 'we will not be on the market before 2018,' Brown says. 'But if Terrafugia gets a weight exemption, that sets a precedent. We could self-certify as an LSA and go to market sooner'…"
***Aviation Week,* April 27th 2015**

731

"…For now, Carplane has focused efforts on getting the prototype flying later this year. 'The measure of progress for our funding is based on whether it can fly, not drive. As we are getting close to the end of that funding, we have stopped engineering involved with ground certification to concentrate on flying,' says Brown…"
***Aviation Week,* April 27th 2015**
Left: caption: "Carplane plans to certify its flying car as a very light aircraft under European Aviation Safety Agency airworthiness rules. This will require the driver to have a private pilots' license."
Right: caption: "When European and state funding winds up midyear, Carplane plans to continue on private investment, completing and flying the prototype and proceeding into certification of the production vehicle"

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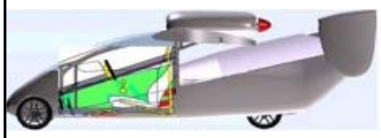


"…For road certification, the vehicle will have to pass a 5-mph/8-kmph crash test. The next level of testing is a 27-mph/40-kmph crash 'in which 98 of the vehicles are destroyed,' says Brown. But the higher level of safety testing is not required until vehicle sales exceed 1,000 per year in Europe or 1,500 per year in the U.S., he says, so Carplane will start with the 5-mph safety test."

Aviation Week, **April 27th 2015**

RE: a complex, sophisticated design such as *Carplane* required a lengthy development process starting in late 2007. A patent application filed on July 28th 2008. Like Terrafugia's *Transition,* Carplane is intended for a high-end market.

733

Catamaran-Like

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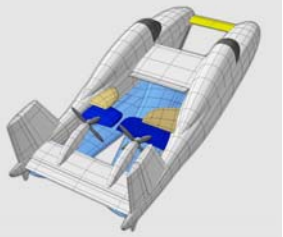
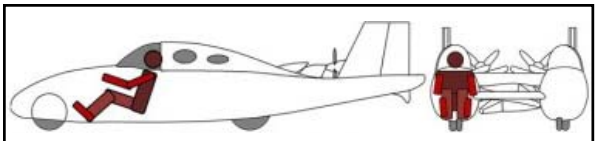



"…It compares to 1930s modular concepts where actually the BiPod's wings are screw-on/screw-off 'modular' and use that older concept…"

John Brown, **Carplane's Project Manager**

RE: Brown pointing out the differences between the *Carplane* and Burt Rutan's design for a competing catamaran-style roadable aircraft known as "BiPod" (left T&B), built by *Scaled Composites* (a *Northrup-Grumman* subsidiary)

735



Differences between *Carplane* and *Bipod* Brown points out include:

- **Manual assembly/disassembly of the wings which takes about ten minutes of labor;**
- **Pilot and passenger have to swap places following a mode change;**
- **BiPod has a sailplane-like cockpit (BiPod is registered as a "Glider" with the FAA);**
- **Brown claims superior airflow over the Carplane in driving configuration, anticipating problems with the BiPod's forward-facing wing roots in their stowed position and a possible lack of downforce as compared to Carplane;**
- **Brown notes that longitudinal weight distribution, lack of flaps on BiPod and placement of wheels on the two vehicles would lead to better take-off and landing characteristics for Carplane, although BiPod has flown with wheel-powered runway hops (a/k/a "wheelies") with one person on board;**
- **According to Brown, elevator size and area for necessary rotational force (to allow take-off) and propeller placement on BiPod's stabilizer might be restrictive;**
- **BiPod does not fit in a one-car garage;**
- **Configuration issues give the Carplane an apparent edge in crosswind landings;**
- **With battery packs in front of them and motorcycle engines behind them in both cockpits, BiPod's passengers may feel a bit cramped, and;**
- **Carplane has a liquid-cooled ground power system and liquid/air cooling for its high-mounted aerial engine.**

736

During initial conceptual design studies for their BiPod program, *Scaled Composites* found that many of their propulsion system characteristics were well aligned with the drivetrain needs of a roadable vehicle thus they expanded the research program to include a "flying car" airframe. *Burt Rutan* and his design team placed their emphasis on developing a configuration that was safe for ground operations yet efficient at high flight speeds. Accordingly, BiPod's twin fuselage catamaran-like configuration provided a low-drag enclosure for a four-wheeled chassis with two cockpits, while providing a protected storage location for the wings and tail surfaces during ground operations. Two internal combustion engines (one per fuselage) provide power to the rear wheels and to propellers located on the horizontal stabilizer. Lithium batteries in the nose provide additional energy for take-off and in case of an engine emergency. The vehicle's *Center-of-Gravity* is positioned for ground operation stability, while aircraft rotation is enabled by direct blowing of the horizontal stabilizer and by applying power to the rear wheels. The use of electric power transmission decouples engine location from propeller location without the need for mechanical shafts and gearboxes, enabling BiPod's unique geometry. The design operates as a high-performance airplane with STOL capabilities, 200 mph maximum speed with 700 mile range or as a road commuter vehicle capable of freeway speeds and/or urban driving.

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Prius Meets the Red Baron

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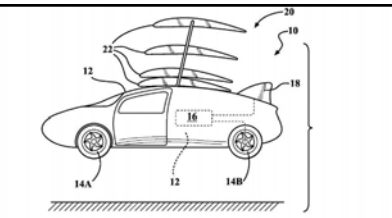
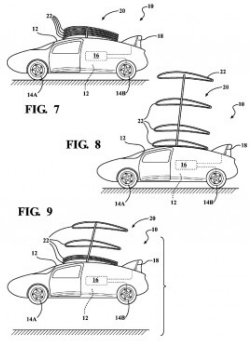


"No, the children's doodle of a flying car pictured here isn't a joke. This is an actual Toyota patent filing for a 'stackable wing for an aerocar' that was just recently published by the U.S. Patent Office and reported by Automotive News. That horizontal line with the diagonal squiggles underneath it? That's the ground. The wheels attached to that baleen Prius-shaped thing with a dorsal fin? Yeah, those are <u>not touching the ground</u>. Now may we direct your attention to the series of wings that look to be fitted to a tall pole protruding from the vehicle's roof; this stackable wing apparatus forms the actual meat of Toyota's patent filing…"
***Popular Mechanics,* September 2015**

741



"…To read the patent filing, which was jointly submitted by Toyota and two inventors, is to be fed the assumption that 'aerocars' are a mature technology in search of improvements. Trivial matters like propulsion sources are brushed off, Toyota offering that thrust could be sourced from things 'such as a pusher propeller, open rotor, turbofan, or other thrust generation system in flight mode.' You know, plane stuff. It appears that Toyota is merely hedging against future use of a similar stacked-wing design with various power sources, both for in-flight and on the road…"
***Popular Mechanics,* September 2015**

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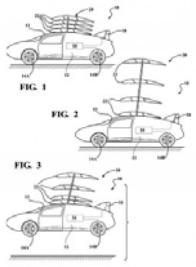

"…Addressing aerocar concerns both practical and vain, Toyota claims its novel 'closely stowable' wing design, which can collapse into a vaguely car-top carrier–sized volume, 'does not interfere with the side and aft view for the driver' when in its 'roadable mode.' As for the overall package's compactness, that 'facilitates, for example, a low profile and stylish body design potential.' Driving down the street in your flying car is so much easier when your wings aren't creating blind spots and cramping your style…"
***Popular Mechanics,* September 2015**

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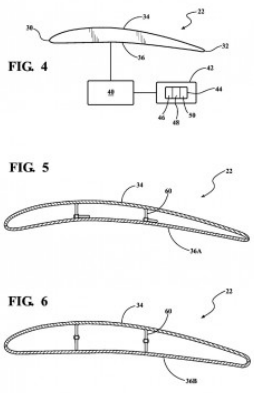

"…Intriguingly, Toyota's patent lacks much clarity surrounding the width of the aerocar's stackable wing sections - and herein lies the patent's true focus. Assuming the sections are relatively narrow, perhaps as narrow as the car itself (remember, roadable mode visibility is a priority), there is thus a need for multiple airfoils piled atop one another. If you can't get the necessary wing area (and by the same token, the necessary lift) by stretching out, stretch up! Besides deploying from its stowed 'roadable mode,' the wings can assume various positions for takeoff, landing, and cruising. While the highest wing features a fixed section, the lower wings incorporate internal actuators to vary their section (see Fig. 5 and Fig. 6, at left); this not only alters the wing's production of lift, but also enables the wing to shrink in thickness for stowage - a critical capability when multiple wings must be stacked…"
***Popular Mechanics,* September 2015**

744

Leveraging the Future (?)

745

"…We highly doubt Toyota is actively working on a flying car, and most likely this patent is something the company filed, again, to hedge against future, um, innovation in this area. More worryingly, at least from our perspective, is that Toyota was investing time on this baloney while we continue to wait for the fruits of more enticing efforts..."
***Popular Mechanics,* September 2015**
RE: at Bloomberg's *Next Big Thing Summit* in San Francisco, Toyota Motor Corporation's *Hiroyoshi Yoshiki* was quoted as saying that the company has seriously considered looking into the idea of developing flying cars. However, he added that the cars will not fly like a plane or a helicopter. Instead, they will hover over the road surface. Although Yoshiki gave no assurances as to whether or not such a vehicle would ever make it to the market, many consider the company's willingness to at least consider developing a flying car (of one sort or another) to be a significant move by a major automobile manufacturer.

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"…Toyota is currently working on some new tech that will raise some of its cars a bit over the ground to increase efficiency…Toyota's technical administration group managing officer Hiroyoshi Yoshiki said the automaker had been studying the idea of flying cars in one of its 'most advanced' research facilities…the company wants to lift the weight of the car a bit more from the wheels. This will minimize the hysteresis effect along with the rolling resistance of the tires, thus reducing energy consumption. So it's kinda like a hovercraft but with wheels attached…"
***autoevolution.com,* June 10th 2014**

747

Round Pegs and Square Holes

748

"Here's to the crazy ones. The misfits. The rebels. The troublemakers. The round pegs in the square holes. The ones who see things differently. They're not fond of rules. And they have no respect for the status quo. You can quote them, disagree with them, glorify or vilify them. About the only thing you can't do is ignore them. Because they change things. They push the human race forward. While some may see them as the crazy ones, we see genius. Because the people who are crazy enough to think they can change the world, are the ones who do."
RE: excerpt from an *Apple Computer Company* advertisement

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