Freewing Aircraft

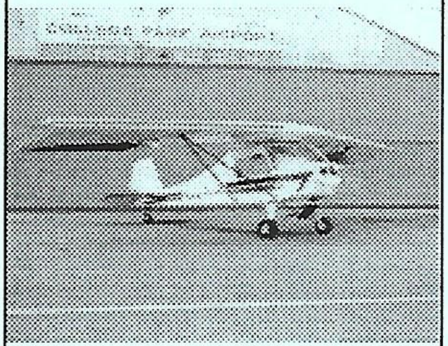
President & CEO:	Hugh Schmittle
Exec. Vice President:	Odile Legeay
UAV Program Manager:	Henry Lavery
Senior Project Engineer:	Damien Erceau
UAV Project Engineer:	William Cronin

Freewing Aircraft Corporation has developed and flown a variety of unmanned and manned aircraft, all of which utilize patented freewing technology. Freewing Aircraft has developed a series of UAVs called the Tilt-Body, which: provide an inherently more stable camera/sensor platform; can launch/recover and perform mission in gustier conditions than fixed wings; are designed to give both S/VTOL and high dash speeds at a fraction of the cost and complexity of tilt-rotors.

Freewing Aircraft is collaborating with Burt Rutan and Scaled Composites on a 50-pound payload vehicle to compete in the close range UAV program, and plans to establish additional teaming arrangements to compete in various UAV programs. The company also plans to enter production in 1994 on its 2-place manned Freebird. Freewing Aircraft has won major awards for technological innovation for its manned and unmanned vehicles.

Tilt-Body UAVs will be available for sale in payloads from 10 lbs to 50 lbs, beginning later in 1993. Discuss your mission needs with us.

Whether you're a man . . .



Or an unman . . .

. . . We have something revolutionary for you.

Airplanes that automatically neutralize turbulence; or that can be flown both at high dash speeds and at 80% slower than stall speed — *without stalling*; or that can approach small target areas on a *slow* final — not a high speed dive — at angles in excess of 45°.

Freewing Aircraft Corporation
Technology Advancement Program
Bldg. 340-1300, University of Maryland
College Park MD 20742 USA
Telephone (301) 314-7794 / Telefax (301) 314-9592

EDITORIAL

TOM ATWOOD

SOMETHING NEW UNDER THE SUN

The photo shows a new UAV model that may be of interest to those who are particularly fascinated by design. It was developed by Burt Rutan and Freewing Aircraft Corp. The Scorpion is a 40-percent-scale, proof-of-concept model of a remotely piloted vehicle to be entered in the Defense Department's "Close-Range Unmanned Vehicle Competition" in July this year. The UAV to be entered—itself a *super* R/C model—must meet astonishing requirements. It will weigh 200 pounds (gross), which includes a 50-pound payload. The "radius of action" (range) will be 50 kilometers. It must be able to achieve 150 knots in a dash, cruise at 100 knots, stay aloft for three hours and have a service ceiling of 10,000 feet. It must also be able to achieve a rolling launch and recovery within a 30x75-meter clearing that is surrounded by a 10-meter wall.

The Scorpion—a proof-of-concept model developed by Burt Rutan and Freewing Aircraft—climbs out. The photo shows the main wing and the tail booms angled in the same plane, both pointing into the relative wind.

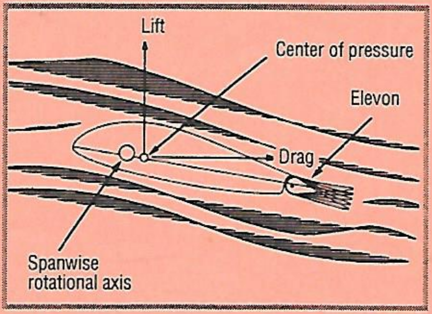
One of the design's secrets is thrust vectoring—the body's nose can be pivoted upward relative to the tail boom (to a limit of 90 degrees above the horizon). This allows the prop wash to be directed downward, and this, in turn, permits the plane to fly at 20 percent of stall speed. Thrust vectoring allows takeoff and recovery in tight confines that would otherwise require a catapault-and-net system.

THE FREEWING

Perhaps even more remarkable than the rotating body is the "freewing." The main wing is mounted on pivots that are oriented spanwise along the wing's CG. This permits the wing to swing or pivot in the pitch axis, independent of the tail booms and fuselage body. The wing's reflexed airfoil keeps it aerodynamically in trim; the wing constantly adjusts to point directly into the relative wind. When flying through turbulence, the wing's leading edge reacts by momentarily rocking upward or downward, i.e., with the trailing edge moving in the opposite direction. Any turbulence-induced wing rocking is almost immediately damped.

The freewing's action reduces by as much as 90 percent the airplane's vertical displacement when it's hit by sudden gusts, e.g., the airframe would bounce up 5 inches instead of 50 inches. This is possible because when a gust hits the wing, the wing rocks and absorbs most of the energy instead of sending it to the airframe. The result is a steadier, shorter, more efficient flight path.

This design is another example of high technology springing from the modeler's workbench. The 6-foot-span, 11-pound Scorpion is powered by a Super Tigre .90 spinning a 13x6 APC prop. Byron 15 percent fuel has been used on test flights. The wing loading is a hefty 50 ounces per square foot. The heavy wing loading underscores the payload-carrying capacity of the design and raises the top-end speed. In a conventional airplane, a heavy wing loading would also bring up the landing speed, but the Scorpion's thrust vectoring minimizes both approach speed and takeoff speed. Wind-tunnel tests with a similarly configured model have demonstrated a minimal level flight speed of around 20mph. Contrast this with the Scorpion's top speed of around 100mph.



The model's construction is familiar. It has fiberglass-covered (vacu-bagged) foam-core wings that have a few ply ribs at critical points. The body is of fiberglass, monocoque construction (the body was laid up over foam, which was later dissolved out). The tail feathers are MonoKote-covered balsa. An ACE Micropro 8,000 radio controls the plane. Five standard servos and one full-scale, linear-output aircraft trim servo are used; this servo controls the angle between the tail boom and the body and exerts 40 pounds of thrust over one inch.

Freewing technology is currently being applied to manned aircraft such as Freewing Aircraft's two-place Freebird MK-5. But I have to wonder, also, what this design advance can mean for modelers. Many a modeler has been temporarily grounded by gusty conditions! How new is the freewing concept? George Spratt, a pioneer of similar pivoting wing technology, has pointed out that it is, in fact, quite old. His father—a contemporary of the Wright brothers—suggested that they try the concept. George further points out that birds have been applying their own version of this design for tens of millions of years. Modelers who would like to know more should contact Freewing Aircraft Corp., Bldg. 340, University of Maryland, College Park, MD 20742. ■

The New York Times
Business
Sunday, May 2, 1993
Section 3

INSIDE

Technology

The Sky's the Limit

Hugh Schmittle and his Freewing Aircraft start-up company are operating on a wing and a prayer. The wing is an eye-opener: it can pivot up or down, enabling a plane to climb, descend and adjust to changes in air speed and wind conditions while the cabin remains relatively level. And there is nothing modest about the prayer: Freewing hopes to revive the market for private, propeller-driven recreational planes.
By Roy Furchgott

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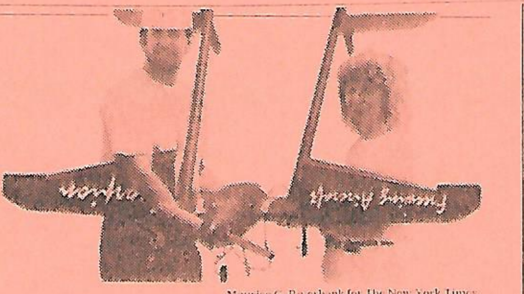


Maurice G. Riverbank for The New York Times
Freewing's Hugh Schmittle and Odile Legeay.

Technology

Reviving Mr. Spratt's Flight of Fancy

By ROY FURCHGOTT

ON the wall of Hugh Schmittle's office in College Park, Md., hangs a copy of an 1899 letter from the editor of Scientific American, discouraging an inventor named George Spratt from pursuing his latest idea. "We do not know of anyone," the editor wrote, "who would be likely to take an interest in flying machines."

For Mr. Schmittle, 43, the document provides prove-'em-wrong inspiration as he drums up grants and investors for his start-up company, Freewing Aircraft. But Mr. Schmittle owes an even greater debt to the inventor: Freewing's planes are based on Mr. Spratt's unusual rocking-wing design, which predates the fixed-wing approach that has been the aviation standard since the Wright brothers flew at Kitty Hawk in 1903.

"The technology benefits are real," Mr. Schmittle said. The 37-year-old former military airplane salesman works from an office at the University of Maryland where he has been supported by the state-financed "business incubator" program since 1989. "If you can sit someone down long enough to explain it," he says of his plane, "they will be convinced."

So far, Mr. Schmittle has persuaded the State of Maryland to give him $500,000 in grants and private investors to put up about $1.3 million.

Freewing's design, which has attracted little interest since Mr. Spratt's initial drawings, uses a single wing from which the plane's fuselage hangs parallel to the ground. Like a ruler balanced lengthwise along the edge of a table, the entire wing can pivot up or down.

The wing design enables the plane to climb, descend and adjust to changes in air speed and wind conditions while the cabin remains relatively level. Through wind-tunnel tests, models and experimental manned aircraft, Freewing says it has shown that the Spratt-style wing dampens the effect of air turbulence, offering a safer, more comfortable ride than a fixed-wing design.

Freewing hopes to revive the market for private, propeller-driven recreational planes. In the next year or so, it plans to begin selling a two-passenger plane in kit form for $25,000 or an assembled version for $40,000.

The small plane market has been chilled in recent years by costly government-certification requirements and multimillion-dollar product-liability suits. The Cessna Aircraft Company, which once made half the world's small aircraft, stopped making two- and four-seaters in 1986, citing the continual threat of liability problems, even from planes that were made decades earlier.

As a result, the current market in small private planes — about 50,000 sales a year — is mostly in used aircraft. The average plane is 25 years old and sells for $40,000, according to industry estimates. The scarcity of good used planes has driven up prices, and their age has contributed to rising maintenance costs.

Freewing, which believes its design is safer than traditional designs, hopes that selling owner-built kits would avert many potential liability problems. Still, the company plans to set aside 6 percent of the revenue from each sale as legal reserves.

But even if Mr. Schmittle's two-seater, the Freebird MK-5, were to improve safety in light aircraft, that would not assure market prowess. "Will it reduce gust response?" asked Bruce Holmes, assistant director for aeronautics at the National Aeronautics and Space Administration's Langley Research Center. "Sure. The question is, will an industry member take the financial risk in bringing it to market?"

EVEN Mr. Schmittle concedes that without the backing of a larger company, his dream is unlikely to become reality. But Freewing appears to have benefited from a shifting regulatory environment. Last December the Federal Aviation Administration streamlined its certification procedures for small aircraft, under which a new plane must prove its safety and airworthiness and its maker must demonstrate adequate quality-control standards.

"The intent is to resurrect the small airplane industry," said Sandra Campbell, an F.A.A. spokeswoman. Under the simpler rules, certifying a new small aircraft will now cost less than $500,000, by Mr. Schmittle's estimate, compared with $5 million to $10 million in the past.

The F.A.A. has cleared a prototype of the Freebird MK-5 for flight testing, a crucial step in the certification process. And the design is credible enough that the aviation innovator Burt Rutan — who designed the Voyager, the airplane that his brother Dick Rutan and Jeana Yeager flew nonstop around the world in 1986 — is working with Freewing to develop an unmanned craft for military uses like aerial reconnaissance photography.

Though the Freebird MK-5 will undoubtedly compete with some popular existing kit planes now seeking certification, it would apparently be the only one that has a hinged wing.

On any type of airplane, the wing is designed to produce a specific amount of lift, and left to its own physics will point into the wind at an angle that most efficiently produces the intended lift. In a fixed-wing airplane, when the wing moves, so does the plane's fuselage. In turbulent updrafts and downdrafts that cause the plane to tilt up and down, the pilot must make constant adjustments to keep the plane level — as passengers try to quell air sickness.

In Freewing's design, the wing is attached to the fuselage by a hinge that allows the leading edge of the wing to rise or drop as much as 37 degrees in response to wind gusts. Whether the gusts come from above or below does not matter; the wing can aim into the teeth of the wind, somewhat like a weathervane. And the plane does notlose or gain much altitude because the wing, though tilted, still supplies constant lift. The plane's fuselage should remain steadier than a fixed-wing aircraft of comparable weight.

CRUCIAL to the Freewing design is its control surfaces, which are primarily on the wing. On conventional aircraft elevator flaps on the tail direct a plane to climb and dive, and aileron flaps on the wings direct it to roll left and right. In contrast, the Freewing has a combined-function "elevon" flap on the trailing edge of the wing.

The wing configuration helps the Freebird avoid stalls, one of the leading causes of crashes. Stalls can occur if the wing's angle to the wind is so oblique that it interrupts normal airflow, causing the wing to lose lift and the plane to lose control.

"It's very safe," said Roc Miles, who has test piloted an earlier prototype of the company's plane. "Full back stick" — throwing the plane into a steep climb — "won't stall the plane. It just slows the plane down."

Mr. Schmittle's sales background has given him a feel for what customers want and has had a major influence on the Freebird's design. With the wing-mounted elevon, the plane theoretically requires no tail section. But Mr. Schmittle has given it a tail anyway, explaining, "You do something that doesn't look like a regular plane, and it becomes hard to sell."

Even with a tail, the plane "has to get out there and prove itself," said Jack Cox, the publications editor of the Experimental Aircraft Association, a group of enthusiasts that builds or restores small planes. The association has given Freewing an award for technical innovation.

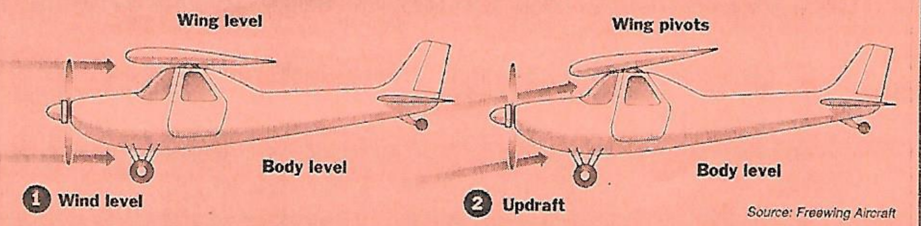
"Aviation people are a little bit conservative, and they want to see it up and working," Mr. Cox said. "When it comes time to write the check, we'll see."

Among those pulling for Mr. Schmittle's dream is a 90-year-old aeronautical engineer who serves as an unpaid consultant to the company: George Spratt Jr. Hoping finally to see an appreciative audience for his father's concept, he asks, "When was the last time you saw a fixed-wing bird?"

Roy Furchgott is Mid-Atlantic correspondent for Adweek magazine.

A Steadier Flight With a Pivoting Wing

Freewing Aircraft has developed a pivoting-wing prototype aircraft based on the ideas of a little-known, late 19th-century inventor named George Spratt. The technology, which dampens the effects of air turbulence, is intended to offer a safer and more comfortable ride than the conventional fixed wing.



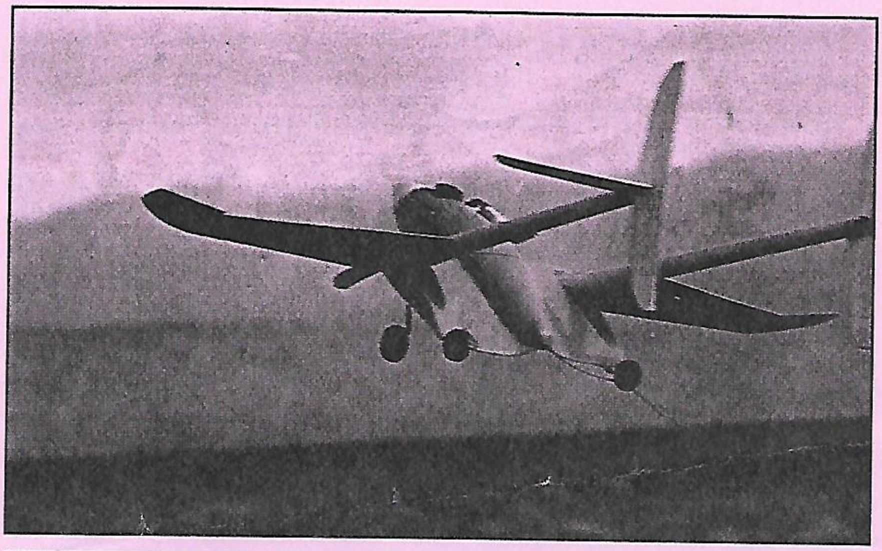
Source: Freewing Aircraft

The New Y

Sport Aviation®

EAA'S MONTHLY MEMBERSHIP MAGAZINE

April 1993 VOL 42, NO. 4



Courtesy of Freewing Aircraft

Freewing Aircraft's freewing concepts have been nominated by the editors of Discover Magazine for their annual Award for Technological Innovation in the Aviation and Aerospace category . . . and here are a couple of Freewing's latest projects. The Freebird MK-5, which we pictured in an earlier issue as an artist's conception, has been completed and is currently undergoing flight testing at Lake Wales, FL. It will be on display at Sun 'n Fun '93. A tri-gear version will be developed for the sportplane market. A unique new feature of the MK-5 is the ability to lock the freewing for takeoff and landing, then release it to serve its gust alleviation function in flight. The blue RC model you see pictured in flight is a joint project of Freewing Aircraft and Burt Rutan's Scaled Composites. Called the Tilt Body, it is a concept for an unmanned aerial vehicle (UAV) in which the central fuselage tilts to vector thrust and make possible nearly vertical slow flight. A patent pending on this system is held jointly in the name of Burt Rutan and Hugh Schmittle, president of Freewing Aircraft.

AVIATION WEEK
& SPACE TECHNOLOGY

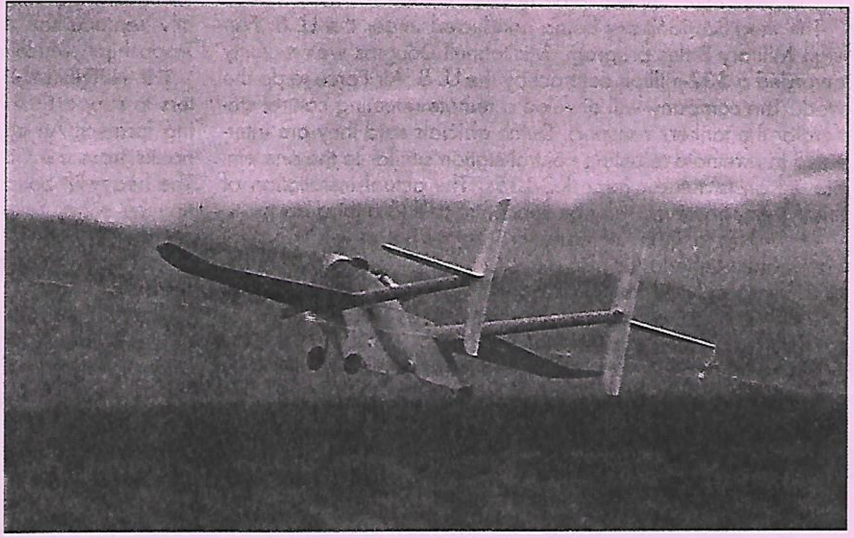
RUTAN REVEALS UAV DESIGN

DAVID A. FULGHUM/WASHINGTON

A radical aircraft design jointly developed by Burt Rutan and the Freewing Aircraft Corp. at the University of Maryland is flying in preparation for the Defense Dept.'s close-range unmanned aerial vehicle competition.

The UAV's outer wing panels, called freewings, swing independently of the fuselage and center wing section. The fuselage remains stable as the outer wings rotate in the pitch axis to absorb a great deal of destructive air turbulence. In a fixed-wing design, the pounding would be transmitted to the fuselage, causing a shortened lifespan for the airframe.

New Burt Rutan design has outer wings and tail booms that pivot vertically to dampen up to 75% of the wind gust load.



By contrast, the flexible, hinged design allows the aircraft to ignore "three-fourths of the gust load" for smoother flight, according to Hugh Schmittle, president of Freewing.

A 40% scale model of the UAV was test flown in December and January at Mojave, Calif., and will be followed by a full-size, 200-lb. aircraft with a 50-lb. payload, which is to be completed by mid-1993, he said.

The Freewing UAV is designed to be carried by two men from its transport to the takeoff site and assembled in as little as 4 min. Once airborne it can stay aloft up to 5 hr., fly at 130kt. and operate within a 50-km. (31 mi.) radius.

THE FREE WINGS also constantly adjust themselves to point directly into any relative wind, which reduces the distance the UAV's flight path is altered by successive gusts, Schmittle said. The dampening effect is so pronounced that a gust that displaces a fixed-wing aircraft 50-in. from its flight path would shift a Freewing of equal size only 5 in., he contended.

Such stability is critical for shipboard operations, during which the landing deck can pitch and roll, or when clearing tall obstacles to slip into small landing spaces. Currently the Defense Dept.'s close-range UAV design requirements are to land in a 30- by 60-meter field over a 15-meter obstacle in a 20-kt. crosswind.

In fact, Freewing officials believe the design has potential for vertical takeoff and landing. In its current configuration, the UAV's nose can be trimmed up to 90 deg. above the horizon.

With the addition of stability augmentation devices, the UAV could be adopted to the Defense Dept.'s cruise missile and UAV Joint Program Office's shipboard vertical launch and recovery requirements, they said.

Because the UAV's flight path is determined by elevons on the outboard freewings, the horizontal tail can independently set the pitch of the fuselage. By rotating the aircraft's nose, sensors in the UAV's body can be pointed ahead or behind, independently of the actual flight path. Such versatility in maneuvering the aircraft means the sensor is never masked or hidden by the aircraft's body. Moreover, as the nose goes up, the propeller can be used for lift, allowing the UAV to remain a stable platform at very low speeds.

Stability is a key requirement for the operations of airborne sensors. The Pentagon is particularly interested in increasing the numbers of laser spot designators available on future battlefields. The laser spot designators are focused on targets to correct the flight of precision guided munitions to within a few feet.

THE AUTOMATIC stability of the freewing design and the ability to maintain a constant angle of attack would help hold the laser spot accurately on a target. Laser spot trackers on UAVs would complement those planned for use by helicopters, forward air control parties, A-10s and F-16s modified for close air support.

Looking at the future of UAVs, Schmittle envisions using VSTOL freewings to deliver mail and cargo to isolated and uneconomical locations since no airport is required. Company officials also anticipate roles for longer-endurance versions of the freewing as communications relay and electronic warfare platforms.

Because the gust loads on freewing aircraft are less, designers anticipate the freewing's life span will be much greater than conventional aircraft designs. It also could mean lighter-weight freewing designs could carry greater payloads over longer distances, they said. ■

photographed at Scaled Composites, Inc., Mojave CA

Manned and Unmanned Aerial Vehicles

Since 1987 Freewing has developed and tested a number of vehicles, both manned and unmanned. The company has received international television and print-media attention with its award-winning, breakthrough-technology designs.

Aerospace Partnerships

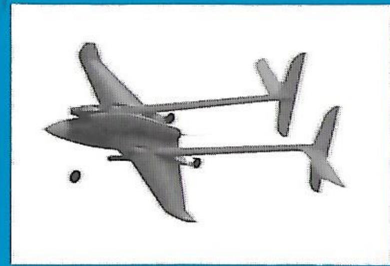
Freewing is forging alliances with other companies involved in the design and manufacture of aircraft. One such arrangement was initiated in 1992 with Burt Rutan and Scaled Composites, Inc. to work with Freewing in designing and testing new-technology UAVs (unmanned aerial vehicles) for military and civilian remote reconnaissance missions. Possible future Rutan collaborations include high-performance manned freewings. Other partnerships are in various stages of negotiation for avionics and systems integration.

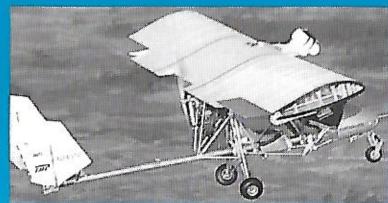
Conclusion

Freewing Aircraft is taking the freewing concept into production, with innovative airframes for manned and unmanned missions, for military and civilian uses. Contact us for further information on how our innovative technology can meet your needs.

Freewing Aircraft Corporation
Technology Advancement Program
Bldg. 340, University of Maryland
College Park, Maryland 20742
Tel: (301) 314-7794 Fax: (301) 314-9590 or 92

Freewing Aircraft

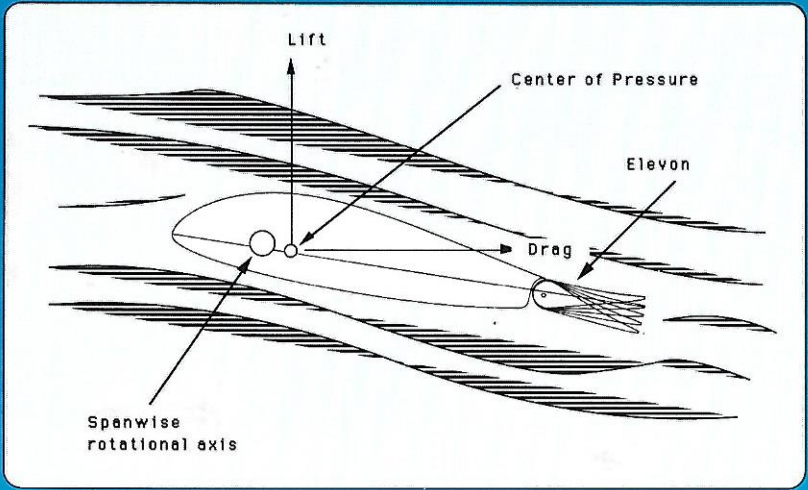




Taking a revolutionary concept into production . . .

. . . with innovative light planes and UAVs

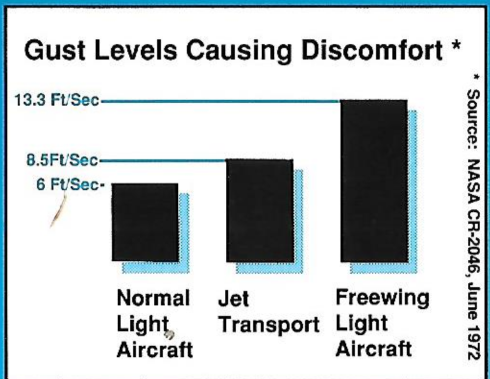
The Concept



The freewing is an entirely different approach to the concept of flight. It promises aircraft that look like conventional fixed-wings, but with some remarkable properties:

- **Stall-resistant**
- **Automatically smooths turbulence**
- **Performance impossible with conventional technology**

The wing of a freewing aircraft rides on a cushion of air, attached to the fuselage by spanwise hinges and held at the correct angle solely by aerodynamics!



The Company

Background

Freewing Aircraft Corporation was incorporated in Maryland in 1987 to develop and manufacture new types of aircraft based on proprietary technology involving the freewing concept.

In 1989 Freewing won admission into the Technology Advancement Program, a high-tech business incubator at the University of Maryland. Significantly, the first several years of company research and growth were funded via competitive high-tech grants, including more than $500K from Maryland's Office of Technology Development and Maryland Industrial Partnerships.

Through TAP Freewing established joint research with the University, including extensive work with the Glenn L. Martin Wind Tunnel, the UMD Computer Aided Design Lab, precision machine shops, specialized engineering libraries, the Aerospace Department, and a number of other entities whose cost would be prohibitive even if they were all available commercially. The results of this research are being published through the AIAA and elsewhere.

The 2-place Freebird MK-5, above, and the Tilt-Body™ UAV, right, are just two of the exciting applications of the freewing principle being pursued by Freewing Aircraft. Tilt-Bodies can fly in hover, near hover, or at high dash speeds – yet are much simpler than, e.g., tilt-rotors.

Manned Ai(raft

The secret of the freewing lies in reduced inertia. That is, all stable aircraft tend to maintain a constant angle of attack, but the problem is that the conventional fixed-wing, being coupled rigidly to its fuselage, has the mass of the entire airplane to contend with.

By contrast the freewing, being freely *hinged* to the fuselage, is able to respond to airborne gusts very rapidly. Building on the seminal work of aviation pioneer George G. Spratt, with his series of flying boats and roadables, Freewing has devised its own freewing technology that has some ten separate patents granted or in various stages of pendency or preparation.

Opposing Theory : Conventional Wing vs. Freewing

Angle of Incidence = angle of wing with regard to the fuselage
Angle of Attack = angle of wing with regard to the relative wind

Conventional Design:	*Freewing Design:*
Angle of attack is a **variable**.	Angle of attack is a **constant**.
Angle of incidence is a **constant**.	Angle of incidence is a **variable**.

Unn(nned Aerial Vehicles

Freewing is developing a variety of reconnaissance UAVs, some in concert with Burt Rutan and Scaled Composites. All these vehicles incorporate proprietary freewing technology.

In recent years UAVs have become an important market force in aviation. In a world of declining defense budgets, they will become even more so, since they are simultaneously low-budget and force-multipliers, as shown dramatically in the Persian Gulf War. Their expanding civilian missions in "aerial robotics" make a strong "dual use" case.

Summary of Advantages for Manned Vehicles

- **Stall-resistant;**
- **Autostable in pitch;**
- **Automatically smooths turbulence;**
- **Reduced incidence of airsickness;**
- **Inherently stable camera/ sensor platform;**
- **Center of gravity of fuselage very flexible, without affecting basic longitudinal stability, since torque cannot be passed through a hinge. (Lockable freewing as in MK-5 negates some of this advantage.);**
- **Can operate *comfortably* in far gustier conditions than fixed wings, which also makes possible fast penetration speeds in turbulent air, and longer airframe life;**
- **G-loading in turbulence reduced significantly;**
- **Amphibian : Because a freewing's wing operates independently of any pitching movements of the cabin, a freewing equipped with floats should permit utilization in rougher waters than conventional light planes, and allow shorter take offs;**
- **Lighter structure possible because airframe stress is lower due to much reduced aerodynamic loads;**
- **Can apply to many sizes and types of airplane, since the freewing really constitutes a class of aircraft unto itself.**

Summary of Advantages for Unmanned Vehicles

- **S/VTOL at a fraction of the cost and complexity of tilt-rotors;**
- **Inherently stable camera/ sensor platform;**
- **Center of gravity of fuselage very flexible, without affecting basic longitudinal stability, since torque cannot be passed through a hinge. Thus payload is more flexible (i) from mission to mission and (ii) over life of system to accommodate changing requirements;**
- **Reduced need for sensor stabilization = lower cost;**
- **Can pitch fuselage independently of flight path;**
- **Wing and fuselage inherently modular; can mix & match according to mission needs;**
- **Can launch, recover, do mission in gustier conditions than fixed wings;**
- **G-loading in turbulence reduced significantly;**
- **Extended sensor and avionics life due to reduced aerodynamic shocks to airframe;**
- **Reduced maintenance costs due to inherently simple structure; and**
- **Reduced weight because (i) lower airframe stress due to much reduced aerodynamic loads, (ii) no need for transmissions through wings, and (iii) sensor stabilizing system can be simpler, perhaps eliminated.**