Personal Blimp

Thermal Airship Development
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Project Summary

Skyacht Aircraft, Inc. has developed a new type of airship. Previous airship designs have had severely limited control in at least one dimension. Our airship is the first to have full control in all three dimensions. Airships with this unprecedented capability will be able to do, at vastly reduced cost, what current airships do. Further, they will be able to fulfill the requirements of numerous applications that are out of the reach of current airships. Control is the key.

Helium airships have full control in only two dimensions. They have adequate forward motion and steering but suffer from limited control in the vertical direction (a.k.a. “lift”.) Despite significant research effort, no effective means has ever been developed to control the buoyancy of helium nor adequately compensate for this lack of lift control.

Contrary to popular belief, helium airships do not change altitude via buoyancy control. Rather, altitude is controlled by pitching the aircraft upward (or downward), powering forward, and using the body of the aircraft as a (very inefficient) airfoil to create some dynamic lift. This approach has been somewhat effective, but changes in temperature, payload, etc. frequently make airships that use helium excessively "light" or "heavy", greatly hindering their operational value.

Some modern helium airships obtain a limited amount of lift control through the use of vectored thrust. (Typically they have propeller assemblies that can be swiveled upward or downward.) However, the amount of force provided by these vectored thrust systems has been, at best, only a small fraction of total aircraft weight. As such, vectored thrust has made helium airships somewhat easier to manage but has never provided sufficient force to compensate for large changes in weight such as the loading or unloading of cargo.

Other airship designs have used a flattened body shape (rather than the conventional “cigar” shape) and/or added wings to the sides of the body to create marginally more effective lifting airfoils. These so-called “hybrid” designs have been uniformly unsuccessful. They can (like the vectored thrust designs) provide only a limited amount of control over lift while creating other significant operational problems such as the need for substantial take-off and landing runs.

In contrast to helium based airships, the Skyacht design has complete control of lift because it uses hot air rather than helium as its lifting gas. The technology for creating and managing hot air for lift has been under active development for over 40 years, primarily for recreational ballooning. As a result, there are over 7,000 hot air balloons in the US today. In contrast, there are only a few dozen helium-based aircraft, both balloons and airships.

With the sole exception of Skyacht, all thermal (hot air) airships experience exactly the opposite control problem of helium airships. They have good control of the forces in the vertical direction. However steering, especially at the low airspeeds required for approach to a mooring mast, has been problematic. The steering problems are caused by the limited stiffness of their structural elements. In particular, all other thermal airships rely exclusively on the super-pressurization of fabric shapes. Rigid structural members are not used in the body of the aircraft. Most importantly, the fins and control surfaces of these designs are inflated "air mattress" style structures with very limited effectiveness.

The Skyacht design avoids these structural pitfalls by using a rigid, but folding, ribbed envelope (body) that retains shape without requiring increased internal air pressure. (A patent, USPTO #6,793,180, for this unique structural design was issued on September of 2004.) This foldable structure also provides “hardpoints” at two strategically important locations -- the nose and tail of the airship. Of particular importance is the hardpoint at the tail which supports the engine/propeller assembly. With the propulsion assembly mounted on the tail of the ship, steering can be accomplished by swiveling the propeller from side to side (as is done on small outboard motor boats). The Skyacht design has no pitch control because none is needed. Altitude is changed through control of buoyancy.

The combination of thermal (hot air) lift and a tail-mounted swiveling propeller creates, for the first time, an airship with full control of lift and effective steering.

The use of hot air, rather than helium, provides other important operational benefits. In particular, our aircraft is routinely deflated between flights, and, once deflated, the ship can be readily disassembled. This ease of deflation and disassembly, combined with full control authority provides numerous practical advantages:

No Hanger Required
-- the aircraft is deflated and covered with a tarp between flights
Little or No Ground Crew or Field Support Equipment Required
-- with full 3-D control authority, the aircraft can fly directly to a mooring mast
Minimal Cost Between Flights
-- no helium leakage
Ease of Transport to Distant Flight Locations
-- once deflated the ship is readily packed for transport via surface or air cargo
Efficient Operation at a Wide Range of Altitudes
-- no ballonets or "pressure height" such as those that limit helium ships
Continued Safe Flight after Accidental Fabric Damage
-- lifting gas lost during flight can be rapidly replenished
Ease of Fabric Repair in the Field
-- no heat sealing or other complicated assembly procedures required
Reduced Construction Cost
-- retention of helium requires expensive materials and design features

The use of hot air as a lifting gas for airships raises two important design issues: 1) the need to burn fuel to maintain buoyancy and 2) the larger volume of gas required to provide the same amount of lift.

For certain applications, such as extremely long duration flights, fuel consumption is a crucial factor. For those cases, helium is clearly the better choice of lifting gas. However, for most applications, flight duration is several hours or less. In these cases, fuel consumption represents only a small fraction of aircraft weight and overall program cost. The advantages (listed above) provided by hot air lift greatly outweigh the disadvantage of higher fuel consumption. Future design advances, such as capturing the waste heat from the propulsion system (i.e. “co-generation” of lift) and adding thermal insulation to the envelope fabric, promise to greatly reduce or possibly eliminate the fuel consumption difference between helium and hot air airships for many applications.

The point that a larger gas volume is required, while true, has only minor practical consequences. In particular, for the same horsepower, the larger volume required for a hot air airship means that it will fly about 20% slower than a helium airship with the same gross lift. Few applications will be seriously compromised by such a difference in airspeed.

First flight of a human-carrying technology demonstrator, the Airship *Alberto*, was made on October 27, 2006. Ten hours of initial (FAA "Phase I") flight testing were completed on November 29, 2006. Secondary flight testing and refinement of the aircraft's systems continue at present.

The Personal Blimp Team

Core Members

Dan Nachbar

Principal Designer -- After earning Computer Science degrees at the University of California at Berkeley and Columbia University, Dan spent 25 years in Computer Science research and development, primarily at Bell Labs and Bell Communications Research. In 2001 he decided to change the focus of his creative work to aviation. Dan has been a pilot for more than 20 years with most of his flight time in gliders and power planes. Since starting work on hot air airships, Dan has earned his commercial pilot's rating for hot air balloons. When not thinking about flying, talking about flying, or actually flying, he has been involved in the founding of several computer start-up companies and non-profit organizations. Over the same period, he has managed two investment funds.

Mike Kuehlmuss

Mechanical Design and Fabrication -- After studying Aeronautical Engineering at FH Munich Germany, Mike moved to the US in 1990 and became an A&P/AI Mechanic as well as a commercial pilot. Overall, he has built, maintained, and flown both type certified and experimental aircraft for over 12 years. Mike is the owner and operator of Flightworks of Northampton, Inc.

Wayne Crouch

Crew Chief -- Wayne's academic and professional life, all prior to any connection with airships, started with a B.S. in Physics and Mathematics and an M.S. in Journalism, both from The University of Illinois, followed by a Ph.D. in Communication from Michigan State University. Career activities have ranged from underwater acoustic research for the Navy to faculty member at Syracuse University and Babson College (interpersonal communication topics). After academia, he established and ran his own management consulting firm for 11 years. He is relatively new to aviation and has started the work to get his pilot's certificate.

Technical Advisors

John Fabel

Structural Design Concepts -- John is a noted designer, inventor, and entrepreneur. John's work is held in the permanent collection of the Smithsonian where he was also recently featured in the "Inventors at Play" exhibit at the Museum of American History. His licensed product designs are currently sold in more than 20 countries.

Don Piccard

All Things Ballooning -- One of the "fathers" of the sport of modern hot air ballooning and co-founder of the Balloon Federation of America, Don Piccard's interest in ballooning began in 1933 when he flew in a gas balloon with his mother, Jeannette Ridlon Piccard. For more than 50 years he has concentrated his enthusiasm and energy in ballooning. In 1988, Don was honored with the Elder Statesman of Aviation Award from the National Aeronautic Association and in 2002 he was inducted into the FAI Ballooning Commission Hall of Fame.

Chuck Richey

Structural and Design Engineering -- Chuck started his life in advanced aerospace engineering at the White Sands Missile range. He spent much of his career working with Burt Rutan as the Vice President of Engineering and the Technical Director for Scaled Composites, Inc., the world's premier experimental aircraft engineering and development company. Chuck now heads his own engineering consulting firm, Mechanical and Composite Engineering.

Blair Perot

Computational Fluid Dynamics -- Blair is an assistant professor in the University of Massachusetts Department of Mechanical and Industrial Engineering. Blair's work currently focuses on Turbulence Modeling and Numerical Methods. Since joining UMass, he has assembled one of the largest clusters in the world of computing power devoted solely to Computational Fluid Dynamics.

Specifications for
The Airship *Alberto*
Personal Blimp
Technology Demonstrator

Length	102 feet
Diameter	70 feet
Envelope Volume	205,000 cubic feet
Seats	2
Max Lift	4,100 lbs.
Horsepower	24
Cruise Speed	12 MPH (projected)
Propulsion Type	Reciprocating Gasoline Engine
Lifting Gas	Propane Fueled Hot Air
Envelope Construction	Nylon Fabric over Aluminum Ribs
Car, Nose, and Tail Cones	Welded Steel Framework
First Flight	October 27, 2006