GROEN BROTHERS AVIATION, INC.

SolidWorks software helps build innovative gyroplane designs

The ability of gyroplanes to fly faster than helicopters and slower than airplanes of comparable power makes them something of a hybrid, having the good qualities of the other two types of aircraft.

Until recently, helicopters were usually considered the only viable aircraft to use when runways were not available or if slow flight was required. However, the gyroplane is a low-cost alternative rapidly gaining popularity in a number of industries. From commuting, package delivery, air taxi, traffic monitoring, land management, and aerial photography, to surveillance and police work, many companies are realizing how useful low-cost, efficient, vertical flight can be when using the economic gyroplane.

Gyroplanes have been around for decades. The word "gyroplane" is an official term used by the Federal Aviation Administration describing an aircraft that gets lift from a freely turning rotary wing (rotor blades), and which derives its thrust from an engine-driven propeller. Gyroplanes were the first rotary wing aircraft to fly successfully with sufficient control. The design is inherently safe. It has better low-speed flight characteristics than airplanes, and the capability to take off and land vertically.

The gyroplane combines design elements of both airplanes and helicopters. It has an engine and a propeller like an airplane to provide propulsion, but a rotor similar to that of a helicopter to provide lift. The rotor in a gyroplane is not powered; instead, it is made to spin by aerodynamic forces. Gyroplanes derive lift from freely turning rotor blades tilted back to catch the air. The rushing air spins the rotor as the engine-driven propeller thrusts the aircraft forward. Early gyroplanes were powered by engines in a tractor (pulling) configuration. Groen Brothers Hawk Gyroplanes use a pusher propeller configuration, providing better forward visibility from the cockpit.

Juan de la Cierva, a Spanish civil engineer, invented the modern day gyroplane in the 1920s. The gyroplane proved its usefulness in the 1930s and 1940s when the Post Office Department used these craft for mail delivery from the roofs of post offices. For nearly 10 years, hundreds of flights, carrying thousands of pieces of mail, were performed by gyroplanes flying in cities in the Northeast.

Today, innovators such as Groen Brothers are using new materials and design technology to build gyroplanes that have the quality, durability, and longevity of the Douglas DC3, creating aircraft that truly qualify to be called "the DC3 of gyroplanes."

Results:

- Reduced testing costs
- Introduced greater innovation
- Shortened development time
- Performed a variety of analyses at all stages of the design cycle

SOLIDWORKS

Comparing gyroplanes to traditional aircraft

The ability of gyroplanes to fly faster than helicopters and slower than airplanes of comparable power makes them something of a hybrid, having the good qualities of the other two types of aircraft. Gyroplanes have two distinct advantages over airplanes: First, the area it needs to take off and land, second is its low-speed flight characteristics. Gyroplanes do not require as much area to take off and land as airplanes. While airplanes require hundreds of feet, gyroplanes, like helicopters, are capable of vertical take-off and landings. This allows gyroplanes to be flown from practically anywhere, needing almost no runway. Another advantage gyroplanes have over airplanes is their ability to fly slowly without stalling.

Using analysis in the design process

In order to build a gyroplane that will hold up under all expected loads, the engineer must understand how each component in the aircraft is loaded and how much load it can withstand. The high degree of complexity of airframes makes design analysis extremely challenging. Groen Brothers engineers turned to SolidWorks® Simulation to meet the challenge. In testing their designs, they use SolidWorks software before prototypes are constructed, which reduces testing costs, introduces greater innovation, and shortens development time.

With SolidWorks software, a model can account for the geometry of the design, load and boundary conditions, and the material properties, allowing a part to be "tested" before building a prototype. If an analysis shows a problem area in a component, the area can be redesigned. Thus, SolidWorks software enables engineers to modify designs to achieve a minimum weight while providing adequate strength. This stresses the need for modern aerodynamics, as well as modern design and manufacturing techniques.

Engineers at Groen Brothers used SolidWorks Simulation to perform a variety of structural and thermal analyses on many components of the aircraft at all stages of the design cycle. SolidWorks software was used to size material thicknesses in the preliminary design phase, and to refine the design of components at the detail design phase. Other applications include analyzing complex sheetmetal assemblies, designing complex tube weldments, and predicting heat transfer through gasses and materials.

"SolidWorks Simulation is useful in helping the design engineer understand the behavior of a component under load, as the visualization of deflection reveals a great deal about how well a part is working," says Mark Woolsey, chief engineer at Groen Brothers Aviation. Using SolidWorks software, engineers can not only test their current design but study ways to build better, smarter designs.

Summing up

"SolidWorks Simulation has, in general, been an excellent FEA program for us. It is by far the easiest one I have encountered," Woolsey points out. "The broad array of elements available is of great help in optimizing a model. The fast solvers it has are simply amazing. I remember when a 20,000-element model would require several hours of run time on a mainframe. Now, a model 10 times that size runs in only a few minutes."

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Mark Woolsey
Chief Engineer

A gyroplane was used by the Utah Olympic Public Safety Command during the 2002 Winter Olympics.

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