

## **STABLE HUMAN-POWERED GROUND EFFECT MACHINE WHICH SATISFIES THE REQUIREMENTS FOR HUMAN-POWERED HELICOPTER FLIGHT.**

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### **ABSTRACT**

The search for human-powered flight has been around for hundreds of years, with proposed designs being sketched by Leonardo da Vinci in the late 1400's. The concept of human-powered flight has revealed itself to be a challenging problem. From the time of da Vinci's dream, over 500 years passed without success. Finally, in 1977, the *Gossamer Condor* became the first human-powered airplane. The next challenge in the quest for human-powered flight was the human-powered helicopter. However a successful helicopter design that meets the requirements as set forth by the American Helicopter Society, based on the power generated by its pilot, has not yet been achieved. The problems associated with this challenge are twofold. First, the rotor area of previous designs has been many times greater than the exhaust area available in hover. Therefore, the center part of the rotor stalls. Second, the distance between the rotor center of lift and the assembly center of gravity is too short for natural stability, thus the pilot must have controls to maneuver the rotor level. In this project, a design using a shrouding concept was proposed. By shrouding the propeller, the size required of the propeller could be greatly reduced and no part of the rotor<sup>1</sup>

would stall. Pressure would build and cause an upward force on the shroud because of ground effect. This would make the moment arm between the center of gravity and this point of pressure long, generating stability. Once this concept was formed, data was reduced to calculate specific parameters manifested in the theory. Finally, to test the accuracy of the theory, a scaled 1:55 test model was constructed using a 2-foot base diameter and the same techniques used to theoretically design the full-sized machine.

### **INTRODUCTION**

#### **History of Human-Powered Aviation**

Even before Leonardo da Vinci's time, humans have dreamed of flight on their own power. The first known helicopter was a small toy built by the Chinese in the 1100's. Later, in the late 1400's, the famous Leonardo da Vinci designed his own helicopters. The first was da Vinci's *Helix*, named for the corkscrew-like propeller at the top. Secondly was his *Ornithopter*, a machine that gave humans a pair of wings.

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