**The Life Saving Delta Wing**

Nick Skowronek

NickSkowronek@gmail.com (404) 426-3465

Stephen Phillips

StevePhillips@mac.com (408) 316-6779

Randy Hamilton

pgcinc@windstream.net (706) 265-3565

**Abstract**

Upon pitching the idea of the UAS challenge it became clear that in order to be effective, our solution must be unique. To achieve the maximum flight time possible with currently available energy storage technology, we will be integrating the Bernoulli's Principle based wing with a propeller based vertical lift system. Our solution will have a number of capabilities that will allow the user to effectively support and relay radio communications, autonomously search extremely large areas, and deliver a payload long distances while remaining in flight for hours.

This approach is unique, because instead of simply starting with a drone design that can already take off vertically and fly autonomously, we began our design process centered around the real problem with current technology, flight time. Starting with an aircraft that can already fly for 3-5 hoursgives us the most effective approach possible in achieving the goals of the challenge. Building a UAS that can autonomously take off and land vertically, and transition to horizontal flight while carrying a payload is not a difficult feat given the current technology available to the consumer. However as described above, the limitation of flight time as a result of energy storage technology is in actuality, the bigger problem.

Our approach will result in a solution that has the required capabilities while still achieving the maximum flight time possible. In that interest, a large focus of this project is our power source. We will be using our own high capacity and lightweight Lithium Ion batteries that we custom build under our LLC, BlueChip Labs. These cells are set apart by their high capacity, their ability to support a very high current draw, and their short charge time. Although it is of less relevance to the challenge, our batteries are also extremely cost effective to produce.

The skills possessed by each individual member of our group come together to compose a team capable of developing a solution to this problem that is very effective for three main reasons. The computerized side of the project will be handled by Stephen Phillips, with 30years of programming experience, and a passion for cutting edge technology and its application to problem solving. Our chassis and the majority of our parts are built by Randy Hamiltonfrom an extremely effective, and secret carbon fiber blend that is the product of his own 30+ years in the industry developing the best process possible. Production of our batteries as well as the aircraft itself is handled by myself, Nick Skowronek with a lifelong passion for radio controlled aircraft and almost twenty years of experience building and flying them. Every member of our team shares a fun-loving passion for cutting edge technology and for solving interesting problems that require the creation of something superior to existing solutions.

**Project Description**

It is not possible to brainstorm a solution to the problem in this challenge without being limited by the small arsenal of energy storage technology in existence. Focusing on this limitation, an effective solution must have the highest efficiency possible given the constraints, in order to get every bit of flight time out of the energy that can be carried on board. The combination of this approach, with the capabilities of our team sets up apart from the rest of the field.

The outline of our solution begins with the way in which we approach the previously described energy storage problem. Lithium ion battery technology provides the most power for the least weight, while remaining cost effective. However, to simply pack our UAS full of off the shelf Li-Po’s would give our solution no advantage over the rest of the field. In the pursuit of more power for projects just like this one, our team produces our own custom built high capacity and lightweight Lithium Ion batteries under our LLC, BlueChip Labs. We have the capacity to build these batteries in a number of sizes, voltages, and current draw capabilities to better suit the specific application. These custom built batteries are extremely important to the effectiveness of our solution. Once in horizontal flight, our aircraft is easily kept aloft by the Bernoulli's Principle acting on our 1,000 sq/in+ wing area, and thus requires a small amount of energy to maintain flight. However when lifting a payload vertically, the entirety of the aircrafts mass is being supported by the lift motors. During this stage of flight, having high current supply capabilities from the power source is extremely important, and our custom built batteries will allow us to lift a heavier payload as a result.

Our prototype is currently outfitted with four of our custom 3 cell packs, providing a total of 60,000 mAh of battery capacity onboard the aircraft. In its current state, we are in the neighborhood of 3 to 5 hours of horizontal flight time without a payload and depending on wind conditions. There remains however, space to fit another 30,000 mAh of battery power (two of our 3s packs) into the fuselage. Combined, the four packs currently outfitted clock in at around 48oz. Because of the high surface area of each cell, our 3 cell battery packs can each handle 300 amps of constant discharge (rated at 20c). In its current setup, the prototype carries onboard the capability to support a constant current draw of 1,200 amps at 3.7v per cell. These cells can also be recharged at a rate of up to 2c, giving the added advantage of faster charge times compared to most commercially available packs. Each pack consists of three Li-Po cells wired in series, and four of these packs are then wired in parallel inside the aircraft maintaining an 11.1v supply to the electronics. Should the need arise, this configuration can be very quickly and easily changed to support a variety of different motors and speed controllers. We have the capability to reconfigure our existing onboard power system to supply the aircraft with any voltage from 3.7v all the way to 44.4v in order to adapt to different propulsion system combinations. We fully anticipate experimenting with adding even more Li-Po power to our aircraft during the process if need be.

Our solution will be produced as a delta wing type aircraft that has the ability to take off vertically, hover in place, and then transition to a very efficient horizontal flight.The design is based on a wing constructed entirely from carbon fiber, with a six foot wingspan and two control surfaces, one on on the rear of each wing acting as a compound of elevator and aileron input. This “elevon” setup is very effective in horizontal flight, and requires only two servos to operate. The aircraft is propelled in horizontal flight by a single propeller motor at the rear of the fuselage. Onto this very efficient platform, we will integrate our vertical lift system consisting of four large quadcopter motors and propellers, each with their own electronic speed controller. These lift motors will be held out away from the aircraft by very strong but lightweight carbon fiber arms, two front and two rear. Placed equidistant from the center of gravity and 12 inches out toward the wingtips (measured from the centerline of the fuselage), we should have little trouble achieving predictable flight with the a quadcopter stability control system.

Given the capabilities of our existing power supply, we also anticipate having little issues producing the thrust necessary to vertically lift a payload. Initially, we will build our prototype using four Tiger Motor U11 drone motors to handle vertical lift. According to the Tiger Motor data sheet, using their 29\*9.5 CF propeller at full throttle one U11 motor will output almost 28 lbs of thrust. As the vertical lift process will be handled by four U11s, our prototype will be outputting over 100 lbs of thrust vertically. Weighing in at under 10 lbs we will expect to be able to comfortably lift a payload in the range of 75 lbs with capacity to spare. Under the full throttle condition, the four vertical lift motors will be drawing a total of slightly less than 250A of current, only 21% of our power supply capability. Four Tiger Motor Flame 80A ESCs will power the vertical lift system, providing more than enough current to allow the motors to achieve these thrust numbers. Currently, on our existing prototype horizontal thrust is handled by a large brushless outrunner motor spinning a four blade propeller and a 50A ESC. However this will likely be changed after preliminary testing to produce more thrust while using less current.

In the event that the wing cannot generate substantial lift during horizontal flight to effectively keep the payload aloft, the vertical lift system can be used to assist the aircraft with additional thrust while in horizontal flight conditions.

The issue of heat must be addressed as well, primarily with regard to the total of five ESC’s onboard. During horizontal flight cool air is funneled through the length of the aircraft's fuselage by way of carefully placed vents, providing cooling for the ESC that will be in use. However, under vertical lift or hover conditions there will be no such airflow. We fully anticipate the necessity for an aluminum heat sink on each of the four vertical lift ESC’s along with vent holes in the top and bottom of the fuselage at each of their positions respectively. We do not anticipate seeing substantial heat generation from our batteries, because they will not be drawn near their current supply capacity in this application. Likewise, Each of the five motors onboard will recieve cool airflow when running in each mode of flight.

Transitioning from vertical to horizontal flight is an operation that will be given special attention in the form of programming by Stephen Phillips. The two stages of flight, vertical and horizontal will be handled by two separate controller systems in our initial prototype. These will be programmed to communicate with each other in order to carry out the transition procedure between vertical and horizontal flight. They will both take input from the autonomous flight computer or from the remote control. All of the technology necessary to accomplish this is both affordable and readily available, thus requiring only a solution to the issue of communication between modules. The aircraft will take off vertically and hover using the quadcopter controller, whether by human or computer command. Then, the sequence to transition to horizontal flight will consist of powering up the regular airplane controller and the horizontal flight motor. The quadcopter stability controller will be commanded to expect a certain amount of forward motion during the transition before fully handing off control of the aircraft to the horizontal flight system and powering down. A reverse of this procedure will bring the UAS back to the ground.

In addition, we plan to outfit our aircraft with the ability to autonomously search large areas such as a section of ocean or desert, looking for irregularities by capturing and then scanning photo images. The technology to do so already exists, allowing us to put together a system that will be able to very quickly locate a lifeboat or a man overboard in the ocean, or an individual, group, or vehicle stranded in the desert. Programing a fleet of these aircraft to efficiently divide and conquer a large area in a grid pattern will provide an incredible advantage to first responders. It will allow them to not only locate someone, but also to quickly deliver life saving supplies such as a flotation device, food, water, handheld radio or GPS, critical medical supplies, mylar blankets, or tools such as knives and fire starting materials. In its currently tested configuration, the range of the aircraft is calculated to be between 50 and 100 miles depending on payload and wind conditions. With more efficient horizontal flight propulsion and more batteries onboard this range is expected to increase.

As mentioned above, another very important asset to our team is Randy Hamilton, our carbon fiber expert. Production of our UAS chassis, control surfaces, and propellers will be expertly handled by Randy, giving us the unparalleled advantage of an extremely rigid, durable, and lightweight aircraft with an exceptionally small number of limitations to its design in comparison to other materials.

Our solution will go into production in the next month, as we have been testing and building our power system along with carrying out preliminary chassis production since December of 2017. Production can be easily verified electronically by photo and video, or by other means upon request at any time throughout the process.

**Team Member Resume Information**

**Stephen Phillips**

Stephen’s father was a drafting engineer, educator, woodworker, tree-house builder, HAM radio operator and all around early-stage hacker with a basement full of great tools. He encouraged Stephen to ask questions; A choice he learned to regret. Stephen took that upbringing and undiagnosed ADD and built a number of creations, including a 3-story tree-house, gravity powered drift-cars built from plywood and 2x4s, go-carts out of riding mowers. Much to the chagrin of his parents, he disassembled and re-assembled every appliance and electronic device in the house. In high school, he snuck into the computer lab and started to learn to write software. When college rolled around, as a UGA freshman he took all of the senior-level computer classes and developed a commercial software application for the UGA reading department. His product was eventually purchased by Scholastic and was sold as an education tool for many years to come. Bored with college, he took a job with a computer store in Greenville, SC and later became the technician for Apple, Wang, televideo and other equipment. After a short stint at Computerland, and in effort to seek the big bucks, he left the computer industry and partnered in a car stereo business, installing high-end stereo systems, alarm systems, and remote start systems. Gamechanger – In 1995, he took a job at the EPA, keeping all of their systems running and managing the data center and the network. This (and a proper ADD diagnosis) led to a job at Apple in California, initially as a Data Analyst, then Systems/Business Analyst, then Systems Architect. This was a job spun out of combining everything he had ever learned with a company that needed that exact combination. He designed and launched a number of highly visible systems while at Apple, including launching the world’s largest web-streaming content site at the time. Settling into Cali, he bought a house, made investments, discovered BMWs, Sailboats and international travel. In 2007, he left Apple for Motorola and created MOTODEV, a platform to bring Android Developers to Motorola’s mobile phones. After completing that project, he started freelancing. His projects included a web-based volunteer site for a non-profit, creating a municipality tax and licensing system and then an energy management cloud solution with a compatible industrial controller for collecting and controlling the consumption of energy. The EMS system is now the default standard for all new construction McDonald's stores, controlling the lights, signs, temperatures, building pressures and maintenance notifications. In 2014, he resumes part-time work on a military communications device. Built the prototype in less than 1 year and successfully tested it in the field with the US Army at PACMAN-I, via an event sponsored by the US Army’s TARDEC group.

**Randy Hamilton**

Randy began working with fiberglass in 1980 and within 18 months, was responsible for production and creating all of the tooling for manufacturing fiberglass removable Jeep tops, ambulance tops and other components. He then started a company with a friend, manufacturing first generation satellite dishes, creating 5 models in 8 and 10 foot diameters and later moved to designing and manufacturing skateboards. In 1985, Randy entered the racing industry and was challenged with rebuilding a crashed Camel GT LIght car from “before” photos where nothing remained of the front half of the car after a major crash. In 5 weeks, the car was back on the track and competitively racing again. He remained with this team, keeping the bodywork intact until the team disbanded at the end of the season. He continued with another team after that season until 1998, when he moved to Cumming, GA to partner in a racing business, maintaining their cars and working on a Salt Flat Streamliner in 1989 and 1990. This was the first ground-effect tunnelled streamliner and it broke the land speed record by 30 mph. In 1991, Randy went into business for himself, refinishing marble molds for an Atlanta company, but still working with race cars in his spare time. In 1985, he began working with Carbon Fiber and Kevlar, developing proprietary methods and formulas for delivering specific properties. In 1995, he became involved with BMW Works, the BMW factory race team, building carbon fiber body panels for their M3 race cars. In 1997, he was involved in a fuel reduction project, working with the production of hydrogen, alcohol, water and gasoline. He built all of the prototypes and did all of the practical applications. The theory and prototypes worked, but the people and the money didn’t, so in 2005, he took on a project to put everything he had learned into rebuilding a 1969 Camaro, resulting in an unreal vehicle with a tube frame from scratch and a fully carbon fiber, race-car based design. The Camaro sits unfinished, due to being abandoned by the original client, but when eventually finished, will deliver 1000 hp in a car weighing 2000 lbs and is almost 100% carbon fiber construction. He recently designed and built the carbon-fiber core and protective shield used in the PACMAN-I event sponsored by the US Army TARDEC Group in Hawaii. Until we start the next phase, Randy is producing body parts for BMW, Porsche, Volvo and Ferrari.

**Nick Skowronek**

Nick began life with an unexplainable interest for everything mechanical. Starting with a fascination with power tools, it was not long before he was building tree-houses, remote control airplanes, and drawing up crazy monster trucks with the intention of one day building them. Influenced by his grandfather's engineering background and lifelong passion for model airplanes and northern railroads, he spent countless hours of his youth in his grandfather's basement machine shop learning basic skills on his milling machine and lathe. In the seventh grade an interest in fishing prompted him to design and build two prototypes of a fiberglass and plywood jon boat in order to get out on the water with his dad. Back on dry land his upbringing contributed to a driving interest in go karts, beginning the day he saw his neighbor tearing up and down the street in a go kart of his own. After two engine swaps on his first go kart because “it was not fast enough”, he set out to build a bigger go kart outgrowing the first one. After being introduced to welding in the eighth grade, it became his biggest interest because of the doors it opened for potential projects. A birthday present of a MIG welder allowed him to take his next big thing. In tenth grade, an open ended school project allowed him to justify to his parents another go kart project, this one scratch built from steel square tube and a 16hp industrial pressure washer engine. Although the frame may not have been perfectly square, three weeks of measuring, cutting, and welding produced his fastest go kart yet. When the go kart phase lost its novelty and excitement, he took a cut-off wheel to the scratch built machine with the intention of giving it another lease on life. Using the square tube lengths, wheels, bearings, and chain drive cut from the go kart he set to work on a two wheeled mini bike. This time, only a week passed before the mini bike had taken its first ride. Moving to full size vehicles at sixteen, he performed major modifications to his jeep wrangler in his parents driveway, and later even more serious and in-depth motor work on his powerstroke turbo diesel pickup truck in his college apartment driveway. Through other phases, his passion for radio controlled airplanes was never lost, and upon being introduced to Stephen Phillips and Randy Hamilton, he knew that sooner or later a project like this one would provide the perfect challenge for each of the three members of the team to work together, fully displaying their skills.