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Vantage™ Unmanned Air Vehicle

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Introduction: The Vehicle Research Section (VRS) at the Naval Research Laboratory (NRL) in Washington, DC, has been developing airborne unmanned air platforms to support electronic warfare (EW) and intelligence, surveillance, and reconnaissance (ISR) missions for over 30 years. The Vantage™ unmanned air vehicle (UAV) is one such platform. Here at NRL the goal is to push technology and develop concept vehicles that can be transitioned into industry to better meet the needs of the Armed Forces. NRL conceives and develops designs for the technologically advanced warfare needs of the future.

Vantage™ Evolution: The VRS often receives requests from a branch of the Armed Forces to develop vehicles with specific requirements to complete a specified mission. The Vantage™ vehicle (Fig. 1) evolved directly from the Dragon Warrior vehicle, originally developed at NRL for the Marine Corps Warfighting Laboratory (MCWL) specifically for reconnaissance and communications relay missions. During the Dragon Warrior program, the vehicle under development evolved into a three-bladed main rotor, ducted electric tail rotor helicopter vehicle with a Wankel rotary heavy-fuel engine. When the Dragon Warrior program ended, the vehicle continued development under the name of Vantage™.

The Dragon Warrior program had involved three research groups at NRL: the Vehicle Research Section, for the vehicle design and development; the Optical Sciences Division, for development of the HMMWV (Humvee)-based Ground Control Station (GCS), along with the integration of the MCWL-selected electro-optic/infrared/laser range finding (EO/IR/LRF) camera gimbal, RF links, and all non–flight control system (FCS) avionics; and the Transmission Technology Branch, for integration of a communications relay as the secondary payload.

Vantage™ Vehicle Features: One of the key groundbreaking products developed during the Dragon Warrior program was a 44-hp heavy-fuel engine. No engine of this size was available before the development in this program. UEL Engines Ltd. from the UK modified their existing AR-801 water-cooled rotary engine to accept heavy fuel. In just under six months, UEL was able to deliver their heavy-fuel engine. NRL took on the task of further modifying the propulsion system and operation sequence to allow integration and use of the AR-801.

Another unique development was the ducted electronic tail rotor. An electric motor offers several advantages. First, it is an efficient and reliable system. It also allows for a much simpler transmission. The VRS estimates that use of the electronic tail rotor eliminated nearly 140 parts as compared to a standard tail rotor and linkage. There is also a weight savings in trading the complexity of a mechanically driven system with an electric motor. The directional stability is controlled by rpm, instead of a direct-drive pitch-controlled system.

The vehicle's three-bladed rigid main rotor is highly responsive. It would be impossible for a human to fly the vehicle without computer assistance, so even when the vehicle is under pilot control, it is augmented by a highly sophisticated control system. A linear

FIGURE 1
The Vantage™ vehicle in storage configuration.

Proportional Integral Derivative (PID) autopilot was developed for the Vantage™ by the VRS for slow-speed autonomous flight.

One of the original requirements of the Dragon Warrior program was that the entire system fit into the back of a HMMWV (Fig. 2). This was one of the reasons that the VRS decided to locate the payload bay in the nose of the UAV and to make the nose removable. This allows the payload to be changed with only four simple latches. It also shortened the body of the UAV to enable it to fit inside the HMMWV.

The Vantage™ program was considered complete on November 14, 2005, when an autonomous flight demonstration was performed for NRL's Commanding Officer, CAPT Daniel Gahagan, and Director of Research, Dr. John Montgomery (Fig. 3).

FIGURE 2
The original Dragon Warrior vehicle as it would be transported in a HMMWV along with the onboard Ground Control Station.

FIGURE 3
The Vantage™ vehicle during the November 14, 2005, flight demonstration.

Formation of the CRADA: The VRS participates in various shows every year to demonstrate its capabilities and to offer the technologies developed at the NRL to other entities. The Dragon Warrior/Vantage™ program has been exhibited at these various events since July 2002. At the Association for Unmanned Vehicle Systems International (AUVSI) Symposium in August 2006, the president of CybAero LLC, Peter Muhlrad, stopped at the NRL display booth and pressed for more information on the Vantage™ vehicle. The vehicle and its capabilities nearly mirrored the capabilities that CybAero was seeking.

One month later, Mr. Muhlrad contacted the VRS and requested an on-site visit to discuss any developing opportunities with the Vantage™ vehicle. On November 14, 2006, the VRS hosted CybAero LLC, and a discussion of developing a Cooperative Research and Development Agreement (CRADA) commenced.

On July 12, 2007, a CRADA between NRL and CybAero LLC was fully executed. This CRADA is intended to demonstrate the overall design capabilities of the Vantage™ vehicle. CybAero LLC will fund NRL to perform modifications to the vehicle to allow for autonomous takeoff and landing and to perform high-speed flight tests of up to 100 knots. With guidance from the VRS, CybAero LLC will choose, or develop, an autopilot that will interface with the vehicle to perform fully autonomous high-speed flight.

If this research is successful, CybAero LLC intends to put this vehicle concept into production. Once in production, industry and the military can benefit from the use of this vehicle for activities such as pipeline monitoring, power line monitoring, border patrol, remote sensing, forest inspection, communication relay, reconnaissance, surveillance, and target acquisition.

This CRADA is one example of the capability of NRL to interface with industry to develop programs that take advantage of the Laboratory's multifaceted and multidisciplinary research.

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