ACCIDENT

Aircraft Type and Registration:	Velos Single Rotor, (UAS, registration n/a)
No & Type of Engines:	2 Xnova 4035-400KV 3Y
Year of Manufacture:	2018 (s/n VUAV10417006)
Date & Time (UTC):	18 September 2019 at 1435 hrs
Location:	Hangingstone Hill, Dartmoor, Devon
Type of Flight:	Aerial Work
Persons on Board:	Crew - N/A Passengers - N/A
Injuries:	Crew - N/A Passengers - N/A
Nature of Damage:	Damaged beyond economical repair
Commander's Licence:	Other
Commander's Age:	48 years
Commander's Flying Experience:	533 hours (of which 21 were on type) Last 90 days - 18 hours Last 28 days - 11 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The single rotor UAS was being flown back to its landing site when it pitched up, uncommanded, and lost control. Assessment of the UAS flight data identified that an ESC fault caused one of the UAS's motors to run down. The increased load required to maintain the aircraft in flight depleted the battery power rapidly, resulting in the loss of control. The telemetry screen, that would have alerted the pilot of the ESC failure, was not in the pilot's field of view.

History of the flight

The single rotor UAS had completed a 13-14 minute automated survey flight in an area of the Dartmoor national park. Once the survey had been completed the pilot took control of the UAS and flew it back towards the Take Off and Landing Site (TOLS). During the return flight the pilot noticed that the aircraft was slowly descending, so he increased the collective input in an attempt to climb back to the original height. This did not have an effect, so he gently reduced the collective input and pulled back on the cyclic control to reduce forward speed. As he did so the UAS pitched up violently and then fell to the ground from approximately 30 ft agl.

Aircraft information

The Velos single rotor UAS helicopter (Figure 1) is capable of carrying varied deployable and fixed payloads such as survey equipment and cameras.

Figure 1

Example of Velos single rotor UAS with underslung camera as payload (image reproduced with permission)

Two individual Electronic Speed Controller (ESC) controlled motors combine to provide power to a 1,950 mm diameter main rotor. In the event of a single ESC or motor failure, the UAS can fly using the remaining functional ESC and motor. The controls are the same as a conventional helicopter with a collective control which changes the pitch of all the main rotor blades simultaneously to control vertical movement, and a cyclic control which controls the pitch of individual blades to provide pitch and roll control, a yaw control provides directional control through a variable pitch tail rotor. The total mass of the UAS involved in this accident was 19.8 kg.

The pilot was operating the UAS by visual line of sight, supplemented by two First Person View (FPV) cameras on the aircraft which transmitted forward and rearward video streams to two monitors positioned in front of the pilot. Another monitor, which displayed the aircraft telemetry, was positioned behind the pilot and was not directly in his line of sight.

Recorded data

Recorded data from the accident flight was downloaded and interpreted by the UAS manufacturer. The manufacturer determined that the UAS was returning to the TOLS after completing its desired activity when the accident occurred. It was toward the end of the flight and the batteries were in a low energy state.

The data showed that three minutes prior to the end of the flight the left ECS malfunctioned. This resulted in it and the left motor shutting down, for the remainder of the flight. As the malfunction occurred, a short circuit was recorded across the batteries. This lasted for approximately one second and reduced the battery voltage to below their minimum operational level.

After the loss of the left motor, the right motor was commanded to increase its output. This increased the right motor current load, which in turn reduced the battery voltage further[1]. To maintain the main rotor speed the governor started to compensate for the lowering voltage by increasing the current demand.

Approximately one minute before the loss of control, the right governor was demanding 100% power to maintain the required rotor speed, however the available voltage diminished to a level where the batteries no longer had sufficient charge to maintain it. The rotor speed then dropped below that able to sustain flight, resulting in the aircraft pitching up.

It was not possible to determine the cause of the ESC failure; however, it should have been possible for the UAS to land away from the TOLS in the event of a single ESC failure. The pilot flying the UAS was operating alone in visual line of sight, supplemented by using FPV and was not monitoring the telemetry which was shown on a separate screen positioned behind him as he flew the aircraft. Had he been monitoring the telemetry screen he may have noticed cautions regarding the ESC failure and the rapidly diminishing battery charge which should have prompted the pilot to land the UAS immediately. The position of the screens had been optimised for the planned mission but did not allow easy viewing of vital information which could have prevented the accident.

Footnote

[1] During normal operation the load is shared between the two motors, but when operating on a single motor, the load on that motor is more than double the normal load.