ACCIDENT

Aircraft Type and Registration:	UAVE Prion Mk 3 (UAS, registration n/a)	
No & Type of Engines:	1 Valach piston engine	
Year of Manufacture:	2019 (Serial no: 3-007)	
Date & Time (UTC):	3 February 2021 at 1138 hrs	
Location:	MoD Area 7, Salisbury Plain, Chitterne, Wiltshire	
Type of Flight:	Training	
Persons on Board:	Crew - None	Passengers - None
Injuries:	Crew - N/A	Passengers - N/A
Nature of Damage:	Substantial damage to forward fuselage, front skids, both wings, propeller and rear boom	
Commander's Licence:	Other	
Commander's Age:	61 years	
Commander's Flying Experience:	351 hours (of which 3 were on type) Last 90 days - 3 hours Last 28 days - 3 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

Synopsis

During a training flight at a height of 400 ft agl the engine lost some power and the aircraft started to descend. The operator sent a command to limit the throttle but this did not resolve the issue. The autopilot was in a mode whereby the throttle was used to control airspeed and elevator used to control altitude. The loss of altitude caused the autopilot to pitch the unmanned aircraft nose-up until it stalled, entered a spin, and then hit the ground.

Following this accident the engine has been modified and the operator has changed their training and operational procedures to help mitigate the risk of recurrence.

History of the flight

The UAVE Prion Mk3 is a fixed-wing unmanned aircraft with a 3.8 m wingspan and a 45 kg maximum takeoff mass (Figure 1). It was being operated by the aircraft manufacturer on a training flight in a protected area of Salisbury Plain. The flight crew consisted of a Remote Pilot Station Operator (RPSO), a Safety Pilot and a Flight Operation Manager. The flight was conducted within Visual Line of Sight rules and the Safety Pilot was the PIC. The RPSO was sat inside a van equipped with a control station, while the Safety Pilot stood outside the van with a remote controller, in a position to be able to monitor both the aircraft and the displays inside the van. The Safety Pilot is able to take manual control within five seconds or less.

The takeoff was an automatic takeoff initiated by the RPSO. The UA climbed on a pre-programmed profile to a holding pattern height of 400 ft agl. After two minutes of normal flight the engine lost some power and the aircraft started to descend. The RPSO, after discussion with the Safety Pilot, decided to send an instruction to the aircraft to limit the throttle to 80% to see if that would resolve the problem. It did not and the aircraft continued to descend and slowed. The autopilot was set to Longitudinal Mode '0' which meant that it was controlling airspeed with throttle and altitude with elevator. As the aircraft started descending, due to the loss of power, the autopilot commanded nose-up elevator to regain the pre-programmed height. However, due to the loss of power this resulted in the aircraft decelerating and continuing its descent. Eventually, at a height of about 100 ft agl and about 480 m from its takeoff point the aircraft stalled, entered a spin, and then hit the ground.

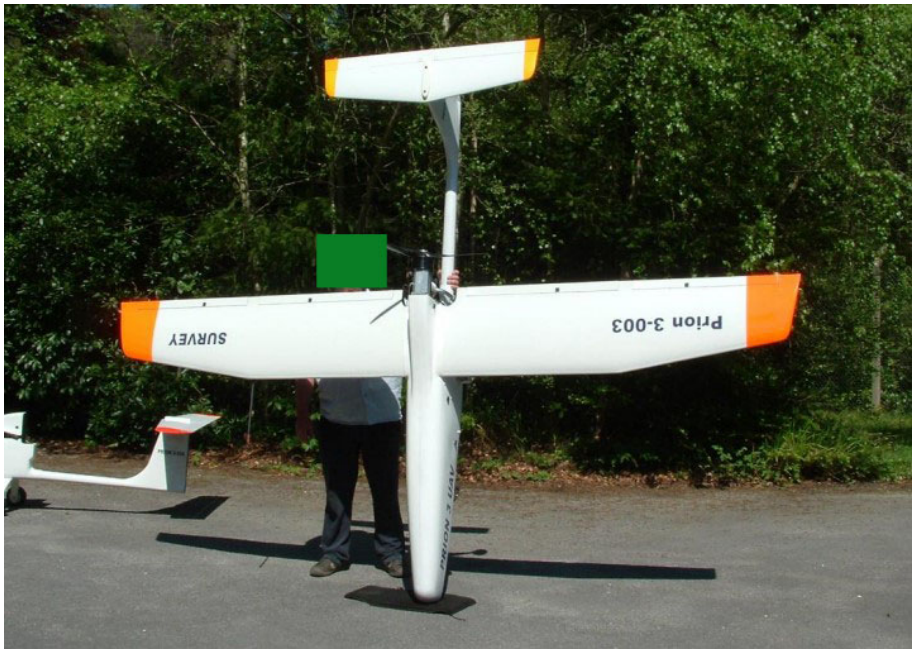

Figure 1
UAVE Prion Mk 3

Autopilot information

The autopilot has four longitudinal modes and these cannot be changed in-flight. Mode 0 is the default mode which uses throttle to control airspeed and elevator to control altitude. Modes 1 to 3 are airspeed modes which use elevator to control airspeed and throttle to control altitude. Mode 1 is the standard airspeed mode, whereas modes 2 and 3 allow the throttle to be fixed at 100% or 5% respectively while allowing the elevator to manage airspeed in a under-speed or over-speed situation. The autopilot will automatically switch from Mode 0 or 1 to 2 or 3 in the following situations:

- If the airspeed is lower than the minimum allowable value and the commanded throttle has reached 90% of full throttle, mode 0 or 1 will switch to mode 2. The throttle will increase to 100% and the autopilot will try to increase speed using nose-down elevator.

- If the airspeed has exceeded the commanded speed by a defined threshold and the throttle is at less than 5%, then mode 0 or 1 will switch to mode 3. The throttle will be set to 5% and the autopilot will try to reduce speed using nose-up elevator.

During the accident flight the RPSO restricted the commanded throttle to 80% to try and resolve the power issue, but this had the unintended consequence of preventing the autopilot from automatically switching from longitudinal mode 0 to mode 2. Therefore, the autopilot caused the aircraft to stall by increasingly demanding more nose-up elevator to regain the commanded height.

Powerplant examination

The loss of power was determined to have been caused by a loose spark plug cap. After the accident the engine was modified with a safety feature which provides additional security to ensure the plug cap is fitted correctly. This modification has been embodied fleet wide.

Additional information

The Safety Pilot reported that airspeed is constantly monitored and called out by the RPSO so that the Safety Pilot and Flight Operation Manager are aware. He explained that by the time they realised that their throttle instruction had not had the desired effect the aircraft was at 100 ft agl and there was no longer sufficient time for the Safety Pilot to take manual control and prevent the stall.

The default longitudinal autopilot mode is user definable, but once the aircraft is in flight the mode cannot be manually changed. The UAS manufacturer was of the opinion that in 99.9% of cases there was no need to manually change the mode in-flight. In the event of a stuck throttle the autopilot would still change to longitudinal mode 2 and prevent a stall, because the logic is based on the demanded throttle position rather than actual throttle position.

The UAS manufacturer is not planning to make any system changes but training exercises now reference this accident and their operational procedures have been amended to avoid limiting the autopilot's ability to command full throttle.

Conclusion

The UAS accident was the result of a combination of factors:

- The engine suffered a loss of power due to a loose spark plug cap.
- The attempt to resolve the power issue by limiting the throttle did not work.
- Limiting the throttle caused the autopilot to remain in a mode that would result in the autopilot stalling the UA.
- The system design did not permit the operator to change autopilot modes in-flight.
- There was insufficient time to take manual control when the airspeed started reducing towards the stall speed.

Safety actions

The UAS manufacturer has modified the engine on the fleet of Prion Mk3 aircraft with a safety feature which provides additional security that the spark plug cap is fitted correctly. As an operator they have also changed their training and operational procedures to help mitigate the risk of recurrence.