Aviation Investigation Final Report

Location:	Cashiers, North Carolina	**Accident Number:**	ERA19FA130
Date & Time:	March 14, 2019, 18:15 Local	**Registration:**	N6075Q
Aircraft:	Mooney M20C	**Aircraft Damage:**	Destroyed
Defining Event:	Loss of control in flight	**Injuries:**	1 Fatal
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The pilot obtained a weather briefing and filed his instrument flight rules flight plan the night before the cross-country flight. About 30 minutes after departure, an air traffic controller advised the pilot that he had overcorrected a turn. Shortly after, the pilot advised the controller that his attitude indicator was not functioning. The controller asked the pilot if he was in the clouds, and the pilot responded that he was in instrument meteorological conditions. The controller attempted to help the pilot get to clearer air, but the pilot continued to have difficulty controlling the airplane and maintaining an assigned course. Radar contact and radio contact were lost shortly thereafter.

The wreckage was located in mountainous terrain, and all major components and control surfaces were accounted for at the accident site. Various parts of the airplane were scattered through the treetops and the wreckage debris field. While the airplane's attitude indicator was not recovered, the directional gyroscope and vacuum pump were, and they were each examined in detail.

Examination of the vacuum pump revealed that the shear coupling that connected the driveshaft between the engine accessory drive gear and the vacuum pump driveshaft assembly likely fractured before impact. The condition of the fractured shear coupling was consistent with the drive side rotating after fracture while in contact with the separated (and hence, stationary) driven side. A transverse fracture as observed through the shear coupling would have disengaged the two-piece driveshaft, which would not have allowed the pump to rotate. Additionally, all six of the vacuum pump's vanes were intact but the rotor was fragmented into four relatively large pieces, and a relatively small area had fragmentated into smaller pieces. Given this information, the vacuum pump was likely not rotating at impact, as a greater degree of fragmentation would be expected if the pump were rotating. The interior surface vacuum pump housing displayed wear consistent with vane impact, dragging, and debris contamination within the housing at some point during the pump's operational lifetime. One of

the vanes exhibited heat tinting, and portions of the rotor's exterior circumference also exhibited wear scarring. These observations were all consistent with the presence of forces resisting the pump's normal rotation. It is likely that these resistive forces ultimately resulted in the failure of the rotor or the shear coupling. Additionally, examination of the directional gyroscope revealed that the rotor and its housing displayed signatures consistent with ingestion of dirt particles or foreign debris during operation, though none of the signatures conclusively supported its operational status at the time of the accident.

Given these observations, it is likely that the vacuum pump ceased operating during the flight, which would have rendered the airplane's vacuum-driven attitude indicator and directional gyroscope inoperative. A definitive cause for this failure could not be determined, though it is possible that the system had been contaminated with debris, which may have contributed to the failure. Because the operational status of the directional gyroscope was inconclusive, it could not be determined whether the pilot attempted to use the airplane's standby vacuum system or whether that system was functional at the time of the accident.

Because the pilot was operating the airplane under instrument flight rules and in instrument meteorological conditions, he would have primarily relied on the airplane's instruments to maintain control and orientation of the airplane. It is likely that following the inflight failure of the vacuum pump, the pilot's ability to control the airplane continually degraded, based on his communications with air traffic control and the airplane's flight track as observed by the air traffic controller. While the pilot might have used the airplane's standby vacuum system or attempted to maintain control of the airplane using partial instrument techniques, this would have been difficult given his lack of recent instrument flight experience. Ultimately, it is likely that the pilot succumbed to spatial disorientation and lost control of the airplane.

While toxicological testing of specimens collected from the pilot's remains following the accident were positive for the presence of ethanol, there was no evidence available to suggest that it was the result of ingestion rather than post-mortem production.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be:

The pilot's loss of airplane control due to spatial disorientation while flying in instrument meteorological conditions. Contributing to the accident was the failure of the vacuum pump and its associated instruments.

Findings

Personnel issues	Spatial disorientation - Pilot
Personnel issues	Aircraft control - Pilot
Aircraft	(general) - Failure
Aircraft	(general) - Not attained/maintained
Environmental issues	Obscuration - Effect on personnel

Factual Information

History of Flight

Enroute-cruise	Flight instrument malf/fail
Enroute-cruise	Loss of control in flight (Defining event)
Uncontrolled descent	Collision with terr/obj (non-CFIT)

On March 14, 2019, about 1815 eastern daylight time, a Mooney M20C, N6075Q, was destroyed when it was involved in an accident near Cashiers, North Carolina. The pilot was fatally injured. The airplane was operated as a Title 14 Code of Federal Regulations (CFR) Part 91 personal flight.

According to information from the Federal Aviation Administration (FAA) and a commercial vendor, the pilot obtained a weather briefing the night before the flight and filed an instrument flight rules (IFR) flight plan. The flight departed Knoxville Downtown Island Airport (DKX), Knoxville, Tennessee, about 1724 and was destined for Aiken Regional Airport (AIK), Aiken, South Carolina. After departure, the airplane was observed on radar climbing on course to AIK.

About 1743, the pilot contacted air traffic control (ATC) and reported level at 9,000 ft. The controller issued the Knoxville altimeter setting. About 1758, the controller contacted the pilot and asked, “are you alright up there it looks like you took a pretty good turn.” The pilot responded, “I’m correcting now.”

About 1800, the controller cleared the pilot direct to AIK, and the pilot read back the clearance. About 1802, the controller told the pilot that it appeared he was “over correcting to the left” and asked the pilot if he had lost his altimeter; the pilot responded he had lost his attitude indicator and then clarified, “artificial horizon.”

About 1805, the controller asked the pilot, “are you in the clouds there” and “is that attitude being out ah gonna be an issue for you?” The pilot responded that he was in instrument meteorological conditions (IMC). The controller asked the pilot if he wanted to climb or remain at 9,000 ft. The pilot asked if there was a lower altitude. The controller assigned the pilot 7,200 ft and informed the pilot he could have a lower altitude “in a minute.”

About 1807, the controller asked the pilot if he was trying to find “clear skies,” and the pilot responded with an unintelligible transmission; the controller then contacted the pilot twice with no response. About 1808, the controller asked the pilot, “how do you hear?” The pilot responded with a transmission that was partially unintelligible and finished the transmission with “I’m trying to get my speed down here.” The controller responded that he wanted to ensure that the pilot was “doing alright” and that the lowest altitude he could offer was 7,200 ft. The pilot responded that he was still in IMC.

Another sector controller then took over the frequency and established communications with the pilot. About 1810, the controller issued the Asheville altimeter, instructed the pilot to "focus on keeping your wings level and flying south," and asked the pilot if he saw any visual conditions. The pilot responded he was in IMC. About 1811, the controller advised the pilot that he was working on finding visual conditions and instructed the pilot to "fly south as best as you can and maintain wings level." There was no reply from the pilot. The controller asked the pilot if he was "wings level," and the pilot responded that he was in IMC. The controller transmitted that he understood the pilot's attitude indicator had failed and asked if the pilot still had his heading indicator. The pilot responded, "I don't believe, I don't believe." The controller transmitted that it appeared that the pilot had been in a slight, shallow turn for the last several minutes and asked if the pilot's magnetic compass worked. The pilot responded that the compass worked.

About 1812, the controller asked the pilot if he had an electrically powered turn indicator that he could use to keep the wings level. The pilot responded negative. The controller responded, "I am hoping that your electric turn indicator will help you with wings level if you can use that to keep your wings level and your magnetic compass to give you a heading, we can get you turned south." There was no reply from the pilot.

About 1813, the controller advised the pilot that it appeared that he was in a shallow left turn for the last several minutes and asked him to stop his turn and keep the wings level; the pilot's response was unintelligible. The controller then asked the pilot if the airplane was under control, to which the pilot responded "somewhat under control"; the remainder of the transmission was unintelligible. The controller advised the pilot it appeared the airplane was on about a 310° heading currently heading northwest and the altitude was 6,500 ft, which was below the minimum IFR altitude. The pilot's response was difficult to understand.

About 1815, the controller advised the pilot that radar contact was lost. There were no further communications with the pilot.

Pilot Information

Certificate:	Commercial	**Age:**	59,Male
Airplane Rating(s):	Single-engine land	**Seat Occupied:**	Unknown
Other Aircraft Rating(s):	None	**Restraint Used:**	3-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	Yes
Medical Certification:	Class 2 Without waivers/limitations	**Last FAA Medical Exam:**	July 24, 2018
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	June 9, 2017
Flight Time:	(Estimated) 1957 hours (Total, all aircraft), 1662 hours (Total, this make and model), 0 hours (Last 90 days, all aircraft), 0 hours (Last 30 days, all aircraft), 0 hours (Last 24 hours, all aircraft)		

A logbook that detailed flights between August 2013 and December 2018 was recovered and examined. In the logbook the pilot recorded 1,957 total hours of flight experience, of which 1,662 hours were in the accident airplane make and model. Between July and December 2018 the pilot had accumulated 1.2 hours of actual instrument as well as 1.9 hours of simulated instrument flight time spread over the course of 4 flights. Two of the logged flights, completed in July and December, noted a total duration of flight of 1.0 and 1.2 hours each, respectively. The logbook entries for those flights also noted the completion of 6 instrument approaches during each of the flights (1 VOR, 4 GPS, 1 ILS for the July flight; 1 VOR, 1 GPS, and 2 ILS for the December flight). There were no flights logged between December 2018 and the accident flight.

Aircraft and Owner/Operator Information

Aircraft Make:	Mooney	**Registration:**	N6075Q
Model/Series:	M20C No Series	**Aircraft Category:**	Airplane
Year of Manufacture:	1965	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	3254
Landing Gear Type:	Retractable - Tricycle	**Seats:**	4
Date/Type of Last Inspection:	April 2, 2018 Annual	**Certified Max Gross Wt.:**	2575 lbs
Time Since Last Inspection:		**Engines:**	1 Reciprocating
Airframe Total Time:	3836.8 Hrs as of last inspection	**Engine Manufacturer:**	Lycoming
ELT:	C91A installed, not activated	**Engine Model/Series:**	O360-A1D
Registered Owner:		**Rated Power:**	180 Horsepower
Operator:	On file	**Operating Certificate(s) Held:**	None

The airplane was equipped with an attitude indicator and directional gyroscope that were powered by an engine-driven vacuum pump. Review of FAA airworthiness records revealed that a standby vacuum system was installed onto the airplane in 1992. The system utilized vacuum generated through the engine's intake manifold and was controlled with a valve that was actuated via a handle mounted on the instrument panel.

Maintenance records spanning 5 years preceding the accident were reviewed. Those records did not contain any entries noting inspection of, or maintenance to any components of the airplane's vacuum system, or the vacuum-driven flight instruments. According to the maintenance logbooks, the airplane's altimeter system and altitude reporting equipment tests and inspections, in addition to the ATC transponder tests and inspections, were performed on

July 24, 2018.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Unknown	**Condition of Light:**	Day
Observation Facility, Elevation:	K1A5,2035 ft msl	**Distance from Accident Site:**	16 Nautical Miles
Observation Time:	18:20 Local	**Direction from Accident Site:**	305°
Lowest Cloud Condition:	Scattered / 2300 ft AGL	**Visibility**	10 miles
Lowest Ceiling:	Broken / 2900 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	/	**Turbulence Type Forecast/Actual:**	None / None
Wind Direction:		**Turbulence Severity Forecast/Actual:**	N/A / N/A
Altimeter Setting:	30.11 inches Hg	**Temperature/Dew Point:**	15°C / 14°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Knoxville, TN (DKX)	**Type of Flight Plan Filed:**	IFR
Destination:	Aiken, SC (AIK)	**Type of Clearance:**	IFR
Departure Time:	17:24 Local	**Type of Airspace:**	Class G

ForeFlight data revealed that the pilot filed a flight plan and requested a weather briefing at 2040 the day before the accident flight. The weather briefing was requested about 21 hours before departure; thus, the aviation weather advisories and warnings did not cover the proposed departure time. It is unknown if the pilot checked or received any additional weather information before or during the accident flight.

AIRMET advisories Sierra and Tango were valid for the accident site at the accident time for below FL200. AIRMET Sierra warned of mountain obscuration conditions due to clouds, precipitation, and mist, while AIRMET Tango warned of moderate turbulence below 12,000 ft mean sea level and low-level wind shear conditions.

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Destroyed
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:		**Aircraft Explosion:**	None
Total Injuries:	1 Fatal	**Latitude, Longitude:**	35.0625,-83.153892

The wreckage was located in mountainous, forested terrain in a debris field about 50 ft in circumference. The tops of the trees immediately surrounding the ground impact site were damaged. The fuselage came to rest inverted with the nose of the airplane pointing down vertically on a 60° magnetic heading at an elevation of 3,892 ft. All major components and control surfaces were accounted for at the accident site. Various parts of the airplane were scattered through the treetops and the wreckage debris field. Flight control continuity could not be confirmed due to multiple push/pull tube breaks and fractures. All breaks and fractures exhibited signatures consistent with overload failure.

All of the cockpit instruments were crushed or destroyed and the dial readings were unreliable. No components of the airplane's standby vacuum system were identified or recovered. The attitude indicator was also destroyed, but the vacuum pump and directional gyroscope were recovered and examined in detail. The pump driveshaft, which connected the pump rotor to the engine's accessory drive, consisted of a two-piece splined shaft coupled via a translucent, light amber-colored urethane shear coupling with a flanged cylindrical shape. The flange of the drive side exhibited an approximate 90° section of edge damage consistent with impact and abrasive wear. The reduced section of the urethane shear coupling was fractured transversely into two pieces and exhibited postfracture mechanical and thermal damage. The fracture surface features were heavily obscured by a swirled circumferential pattern of stringy and flowing opaque whitish-gold material consistent with melted and resolidified shear coupler material.

All six of the vacuum pump's vanes were intact, but the rotor was fragmented into four relatively large pieces, and a relatively small area that fragmented into smaller pieces. The interior surface of the vacuum pump housing displayed circumferential wear scarring. One of the vanes exhibited heat tinting, and portions of the rotor's exterior circumference also exhibited wear scarring.

Examination of the directional gyroscope revealed that a portion of the gyroscope housing was crushed around the gimbal set, which was separated from the deformed and fractured frame. The rotor rotated freely about the spin axis within the rotor housing. The gyroscope housing was disassembled to examine the rotor and interior of the housing. A scar was observed on the corner of an end cap, consistent with mechanical impact damage. The inner race of one of the bearings about which the housing rotated was fractured, and the fracture surface exhibited a dull, rough appearance, consistent with overstress separation. The rotor exhibited faint circumferential scarring around the outer diameter surface.

Medical and Pathological Information

The Wake Forest Baptist Medical Center Department of Pathology, Winston-Salem, North Carolina, performed an autopsy on the pilot. His cause of death was multiple blunt force injuries.

Toxicology testing performed by the FAA Forensic Sciences Laboratory detected ethanol at 0.047 grams per deciliter (g/dL) in the pilot's liver, and 0.030 g/dL in his muscle.

Administrative Information

Investigator In Charge (IIC):	Alleyne, Eric		
Additional Participating Persons:	Greg Small; FAA FSDO; Charlotte, NC		
Original Publish Date:	June 10, 2021	**Investigation Class:**	3
Note:	The NTSB traveled to the scene of this accident.		
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=99117		