Aviation Investigation Final Report

Location:	Madeira Beach, Florida	**Accident Number:**	ERA09LA502
Date & Time:	September 5, 2009, 09:40 Local	**Registration:**	N185SQ
Aircraft:	M-SQUARED SPRINT 1000	**Aircraft Damage:**	Substantial
Defining Event:	Powerplant sys/comp malf/fail	**Injuries:**	2 Fatal
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The float-equipped, pusher-configured experimental light sport airplane overflew an intercoastal waterway, landed and water-taxied for several minutes, then took off again. At an altitude estimated to be between 200 to 300 feet, witnesses heard a "pop," saw parts come off the airplane, and then saw it nosedive into the water. An installed ballistic recovery parachute partially deployed just before water impact. No witnesses reported any bird activity in the area at the time of the accident. The airplane was recovered from the water, except for the propeller and propeller gearbox, which were never located. After a Federal Aviation Administration (FAA) examination, and unknown to the pilot's wife, who thought it was in storage, the airplane was disposed of. The pilot's wife subsequently recovered the engine with the three-pronged engine-side gearbox coupling flange still attached, but after moving out of state disposed of that as well.

Photographs provided by the FAA and sheriff's department indicated that once the gearbox and propeller separated from the engine, they severed the airplane's tail support structure, which resulted in a loss of pitch control. Additional photographs indicated that the propeller gearbox adapter that joined the gearbox to the engine was fractured and mostly missing and that three bolts, one of which would have normally been in each of the three prongs that connected the engine-side gearbox coupling flange to a rubber damper inside the adapter, were missing. Threadlocking material, which would have helped maintain torque, was not observed in the photographs.

The pilot had purchased the airplane about 2 1/2 weeks before the accident as non-flyable parts. The former owner had previously removed the engine, had work performed on it by the

engine distributor, and reinstalled it on the airplane prior to selling it to the accident pilot. No maintenance entries were recorded in the airplane logbook. According to the engine distributor, after repair the engine would have been shipped with the gearbox attached loosely, in an "up" position, to fit into the shipping box. Upon installation, the gearbox would have needed to be rotated 180 degrees to the "hanging" position to maintain the thrust line below the engine.

After the sale of the airplane, the accident pilot was seen performing maintenance on the airplane, which was legal since it was experimental. However, the airplane had no annual condition inspection, which was required by its operating limitations, and could have only been performed by an FAA-certified mechanic or repairman.

Sometime after the pilot had begun flying the airplane, the previous owner observed that the gearbox retaining bolts were loose, and advised the pilot that they had to be tightened. The previous owner subsequently saw the pilot tightening the bolts without using a torque wrench, and advised him that he needed to use one. The pilot then acquired a torque wrench, but the torque values he used could not be determined. The pilot was the last known person to work on the airplane, and several days before the accident had advised the kit manufacturer that he had cleaned and retorqued all the bolts. Whether he meant only the gearbox-to-adapter bolts or whether he included the flange bolts among those torqued is not known; there were no maintenance entries in the airplane's logbook.

Because of the missing gearbox and propeller, and the disposal of the engine, it was not possible to definitively determine the sequence of events leading to the separation of the gearbox. However, if the gearbox adapter had failed first, there would likely still have been some remnants of the flange bolts remaining in the flange, and possibly bent flange prongs along with torn threads in the bolt holes. Because the majority of the bolt hole faces were pristine, it is likely that there was a loss of torque on the flange bolts and that they backed out of their holes. It is unknown if the loss of torque resulted from inadequate torque during bolt installation or whether a different part of the gearbox became loose first, which then overcame the proper torque. Because of a lack of record-keeping, the person who last torqued the bolts could not be determined.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: A loss of torque to the gearbox engine-side coupling flange bolts, which resulted in separation

of the gearbox and propeller from the engine and the subsequent severing of the airplane's tail structure.

Findings

Aircraft	(general) - Attain/maintain not possible
Aircraft	(general) - Not specified
Aircraft	(general) - Damaged/degraded

Factual Information

History of Flight

Enroute-climb to cruise	Powerplant sys/comp malf/fail (Defining event)
Enroute-climb to cruise	Aircraft structural failure
Enroute-climb to cruise	Loss of control in flight
Uncontrolled descent	Collision with terr/obj (non-CFIT)

HISTORY OF FLIGHT

On September 5, 2009, about 0940 eastern daylight time, an experimental light sport M-Squared Sprint 1000, N185SQ, was destroyed when it impacted water in Madeira Beach, Florida. The certificated private pilot and the pilot-rated passenger were fatally injured. Visual meteorological conditions prevailed, and no flight plan had been filed for the local flight that originated at Lake Seminole, Seminole, Florida. The personal flight was conducted under the provisions of 14 Code of Federal Regulations Part 91.

According to the county sheriff's incident report, one witness, a kayaker in the area, observed the airplane flying in his vicinity before landing on the water. It then water-taxied for several minutes before taking off again. The witness subsequently saw the airplane climb to about 200 to 300 feet before hearing a "pop" and seeing the airplane head straight down and impact the water.

Another witness also heard a "pop," then looked up to see the airplane "plunging toward the water" from an altitude of 300 feet. A third witness also heard the pop, and saw the airplane "nose dive" into the water. Two other witnesses observed the airplane and saw "something" happen to the airplane's propeller, then observed that parts "came off" the engine area. They then saw a parachute start to deploy before the airplane impacted the water.

In their statements, none of the witnesses indicated the presence of birds in the vicinity of the accident site.

The owner of the company that recovered the airplane from the water stated that a number of people had told him that they heard the engine "rev" before the crash.

Following the accident, the airplane was moved to a facility where a Federal Aviation Administration inspector examined it. The inspector did not provide written results of his examination; however, he did provide some photographs and noted that the airplane's ballistic parachute system had deployed, but at a low altitude, and that the propeller and gearbox were never recovered.

The inspector also provided excerpts from the pilot and aircraft logbooks, and sales receipts for the airplane, as well as engine and gearbox parts.

AIRCRAFT INFORMATION

- Airplane History -

According to FAA records, the airplane was manufactured in 2001, but not initially registered. The president of M-Squared reported that the airplane was delivered to the original owner powered by a Rotax 582 engine, driving a three-bladed pusher propeller.

FAA records indicated that the owner registered the airplane in the experimental light-sport category on January 14, 2008. The application listed 515 total airframe hours at that time and indicated that the airplane was then powered by a Hirth 3701 engine, driving a four-bladed Warp Drive composite pusher propeller.

According to the aircraft logbook, on January 14, 2008, the airplane underwent a condition inspection by a certificated airframe and powerplant mechanic with inspector authorization, "for the purpose of LSA [light sport aircraft] Conversion from 'Ultra-Light'" and was found "in airworthy and serviceable condition acceptable for issuance of an LSA airworthiness certificate." Another logbook entry on that date indicated that the next inspection was due no later than February 1, 2009; however, there were no additional entries noted in the logbook.

A receipt revealed that on February 11, 2008, the owner purchased from the engine distributor, among other items, an engine assembly kit, a gearbox assembly kit, and a used coupler flange (gearbox side).

An FAA Aircraft Bill of Sale revealed that on March 13, 2008, the airplane was sold to a second individual.

Another sales receipt indicated that the second owner sold the airplane to a third individual on November 22, 2008. There was no FAA Aircraft Bill of Sale, nor was there a change of registration noted in the FAA aircraft data base. The third owner stated that he had bought the airplane as parts from the widow of the second owner.

According to an associate of the third owner, the associate contacted the Hirth engine distributer at Sun 'n Fun in April 2009, because the engine had a compression problem with one or two of the cylinders. The engine distributor then took the engine to his facility for warranty repair.

A receipt, dated July 7, 2009, indicated that the third owner and the associate purchased from the engine distributor, among other items, a used 3.33 ratio gear set with installation kit, a large prop shaft seal, a prop shaft bearing, and a top end gasket set.

The third owner and the associate recalled that the engine was returned to the owner's place of work in a shipping container, and was subsequently installed on the airplane by a group of individuals.

According to the engine distributor, the engine would have been shipped with the gearbox in the up position, as otherwise it would not fit in a shipping container. The gearbox and adapter plate would have needed to be rotated 180 degrees, to the "hanging" position, to put the thrust line below the engine.

A sales receipt, dated August 17, 2009, indicated that the third owner sold the airplane to the accident pilot. The third owner noted on the sales receipt, in part, "I sell this aircraft in parts, not flyable at present time," and, "I am selling these aircraft parts to [the accident pilot]." The FAA Aircraft Bill of Sale listed the second owner as the seller.

According to the pilot's wife, the airplane was flyable prior to the sale, having seen it fly the previous weekend. However, the third owner, who was also a certificated flight instructor (CFI), stated that it was not flying when sold, and that he gave the accident pilot flight training in another airplane because the accident airplane was not airworthy at the time.

According to the county sheriff's report, the third owner also stated that the accident pilot had kept the airplane at his facility, that it was not flyable and needed repairs, and that the pilot was recently asked to move it to another location. The accident pilot was in the process of finding another place, and the third owner offered to relocate it with his trailer, but the accident pilot had planned to fly it to the new location. The third owner also noted that the accident pilot had been working on the airplane, as well as flying it recently.

The third owner of the airplane also stated in a telephone interview that some time prior to the accident, he had seen that the propeller gearbox retaining bolts were loose, and advised the accident pilot that they needed to be tightened. The third owner later saw the accident pilot attempting to retorque the bolts without torque wrench, and advised him to buy one, which he subsequently did. The torque settings used could not be determined.

According to the manufacturer of the airframe kit, the accident pilot called him on the Wednesday [September 2, 2009] before the accident and stated that the gearbox had been loose, but that he had cleaned and retorqued the bolts.

The engine distributor stated that he had never spoken to the accident pilot.

- Engine/Gearbox Information -

Parts diagrams revealed that aft of the engine there was an estimated 3-inch-deep gearbox adapter plate, attached to the engine case by four 10 mm studs with retaining nuts. Aft of the adapter plate was the gearbox, held to the adapter plate by ten 6 mm bolts. Per the engine distributor, the bolts should have been secured with a threadlocker substance, normally Loctite

242 "Blue" and torqued to 86 inch-pounds.

Within the adapter plate, there was a cylindrical area that housed the output end of the engine drive shaft. The drive shaft was connected to a steel coupler with a three-pronged flange. Aft of the coupler flange was an approximately-circular rubber damper, and aft of that was another coupler flange, which in turn, connected to the gearbox entry shaft.

The rubber damper had six holes located circumferentially toward the outer edge. Three of the holes would have normally contained 10 mm bolts that screwed forward, into the engine-side coupler flange, while the three other holes would have normally have 10 mm bolts that screwed aft, into the gearbox-side coupler flange.

According to the engine distributor, the attaching bolts should have been screwed completely through and slightly beyond the threaded holes in the coupler flanges. The distributor also noted that those bolts should also have been coated with a threadlocker substance, normally Loctite 242 "Blue" to help maintain bolt torque.

PERSONNEL INFORMATION

The pilot, age 26, held a private pilot's certificate with an airplane single engine land rating. Logbook excerpts did not contain the pilot's total flight time; however, on his latest FAA second class medical certificate application, dated July 21, 2009, the pilot indicated 250 hours of total flight time.

The pilot's logbook also indicated that he had flown the accident airplane three times from/to Lake Seminole before the accident flight: a 1.0-hour flight with six water takeoffs and landings on Saturday, August 29, 2009; a 0.5-hour flight with one takeoff and landing on Monday, August 31, 2009; and a 0.8-hour flight with six takeoffs and landings on Saturday, September 4, 2009.

The pilot's logbook also indicated that the third owner provided the pilot with flight training in an airplane other than the accident airplane on August 24, and 28, 2009. It also indicated that the accident pilot received additional training by another CFI in a third airplane on September 1 and 3, 2009.

WRECKAGE AND IMPACT INFORMATION

According to the sheriff's report, the wreckage was located in the Intercoastal Waterway, in Boca Ciega Bay, near channel marker #8, in the vicinity of 27 degrees 47.598 minutes north latitude, 082 degrees, 46.762 minutes west longitude. The pilot/owner was found in the left seat.

From photographs, the airplane came to rest mostly submerged in relatively shallow water. The owner of the company that recovered the airplane noted that tubular portions of the tail

section of the airplane, as found, were detached from the main wreckage and was only loosely connected to it by wire cables.

After the wreckage was examined by the FAA inspector, and unknown to the pilot's wife, the recovery company discarded it. The pilot's wife subsequently reacquired the engine, but after moving out of state, she later disposed of it as well.

Additional wreckage photographs were obtained from the county sheriff's department, with some of those revealing that the structural tubes to the tail section were sheared, and that at least one stranded wire was broomstrawed, consistent with overload.

Another photograph showed that the gearbox adapter was fractured near the engine mounts, but that all of the adapter-to-engine mounting studs and nuts were present. It also revealed that everything aft of the engine-side coupler flange was missing. The flange was intact, and none of the three prongs was bent. Threads appeared to be pristine in the forward (bottom) portion of all three bolt holes, while rusting of the threads had occurred in the aft (top) portion of all three bolt holes to varying degrees. One of the bolt holes appeared to be slightly elongated at the bolt-entry surface (plane), with some flange material torn outward.

There was no evidence of threadlocking residue noted in the photograph.

MEDICAL AND PATHOLOGICAL INFORMATION

An autopsy was completed on both pilots at the Florida District Six Medical Examiner's Office, Largo, Florida, with the cause of death listed for both as "blunt trauma." Subsequent toxicological testing for both pilots was performed by the FAA Biomedical Research Team, Oklahoma City, Oklahoma, with no anomalies noted.

ADDITIONAL INFORMATION

According to the engine distributor, 3.33 gearbox ratios had been previously utilized on airplanes, but rarely, and with no problems noted. He also stated that a rescue boat manufacturer had manufactured 38 units with a different gear ratio but with the same four-bladed Warp Drive propeller, again with no problems noted.

Federal Air Regulation (FAR) 43 prescribes the rules that govern the maintenance, preventive maintenance, rebuilding, and alteration of any aircraft having a U.S. airworthiness certificate. FAR 43.1(b) exempts experimental aircraft from FAR 43, unless an aircraft had previously been issued a different kind of airworthiness certificate.

Per FAR 91.409(c), the airplane was exempt from annual inspection requirements. However, FAR 91.319(e) stated that additional airworthiness requirements could be imposed within the airplane's Operating Limitations.

The Operating Limitations for the airplane included the statement that, "no person may operate this aircraft unless within the preceding 12 calendar months unless it had a condition inspection...." It also noted that, "an experimental LSA owner/operator as a repairman for this aircraft under 65.107 or an appropriately rated FAA-certificated mechanic may perform the condition inspection required by these limitations."

The pilot/owner did not hold a repairman certificate for the airplane and was not a certificated mechanic.

Pilot Information

Certificate:	Private	**Age:**	26,Male
Airplane Rating(s):	Single-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	
Instrument Rating(s):	None	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	Yes
Medical Certification:	Class 2 Without waivers/limitations	**Last FAA Medical Exam:**	July 21, 2009
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	
Flight Time:	(Estimated) 250 hours (Total, all aircraft), 2 hours (Total, this make and model), 9 hours (Last 30 days, all aircraft)		

Information

Certificate:		**Age:**	44,Male
Airplane Rating(s):		**Seat Occupied:**	Right
Other Aircraft Rating(s):		**Restraint Used:**	
Instrument Rating(s):		**Second Pilot Present:**	Yes
Instructor Rating(s):		**Toxicology Performed:**	Yes
Medical Certification:		**Last FAA Medical Exam:**	
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	
Flight Time:			

Aircraft and Owner/Operator Information

Aircraft Make:	M-SQUARED	**Registration:**	N185SQ
Model/Series:	SPRINT 1000	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Experimental light sport (Special)	**Serial Number:**	0554
Landing Gear Type:	Float	**Seats:**	2
Date/Type of Last Inspection:	January 14, 2008 Condition	**Certified Max Gross Wt.:**	1400 lbs
Time Since Last Inspection:		**Engines:**	1 Reciprocating
Airframe Total Time:	515 Hrs as of last inspection	**Engine Manufacturer:**	Hirth
ELT:	Not installed	**Engine Model/Series:**	3701
Registered Owner:	Marc J. Young	**Rated Power:**	100 Horsepower
Operator:	Marc J. Young	**Operating Certificate(s) Held:**	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	PIE,10 ft msl	**Distance from Accident Site:**	7 Nautical Miles
Observation Time:	09:53 Local	**Direction from Accident Site:**	120°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	3 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:		**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.04 inches Hg	**Temperature/Dew Point:**	28°C / 23°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Seminole, FL (NONE)	**Type of Flight Plan Filed:**	None
Destination:	Seminole, FL (NONE)	**Type of Clearance:**	None
Departure Time:		**Type of Airspace:**	

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Substantial
Passenger Injuries:	1 Fatal	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	2 Fatal	**Latitude, Longitude:**	27.793056,-82.779441

Administrative Information

Investigator In Charge (IIC):	Cox, Paul
Additional Participating Persons:	Ric Riccardi; FAA/FSDO; Orlando, FL Paul Mather; M-Squared, Inc.; St. Elmo, AL Matt Dandar; Recreational Power Engineering; Tiffin, OH
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