Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT

A00O0111

CONTROLLED FLIGHT INTO TERRAIN

GRAND AIRE EXPRESS INC.
DASSAULT-BREGUET FALCON 20E N184GA
PETERBOROUGH AIRPORT, ONTARIO 0.5 NM W
13 JUNE 2000

Canada

Aviation Investigation Report

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Synopsis

The Dassault-Breguet Falcon 20E aircraft was on an unscheduled charter cargo flight from Detroit Willow Run, Michigan, USA, to Peterborough, Ontario. The flight was being conducted at night and under instrument flight rules in instrument meteorological conditions. Nearing the destination, the flight crew received a clearance to conduct a non-directional beacon runway 09 approach at Peterborough Airport. The flight crew did not acquire the runway environment during this approach and conducted a missed approach procedure.

They obtained another clearance for the same approach from Toronto Area Control Centre. During this approach, the flight crew acquired the runway environment and manoeuvred the aircraft for landing on runway 09. The aircraft touched down near the runway midpoint, and the captain, who was the pilot flying, elected to abort the landing. The captain then conducted a left visual circuit to attempt another landing. As the aircraft was turning onto the final leg, the approach became unstabilized, and the flight crew elected to overshoot; however, the aircraft pitched nose-down, banked left, and struck terrain. As it travelled 400 feet through a ploughed farm field, the aircraft struck a tree line and came to rest about 2000 feet before the threshold of runway 09, facing the opposite direction. The aircraft was substantially damaged. No serious injuries occurred.

Ce rapport est également disponible en français.

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1.0 Factual Information

1.1 History of the Flight

The aircraft departed Louisville (KSDF), Kentucky, and flew to Marion (KMZZ), Ohio, where it was loaded with approximately 900 pounds of auto parts. The aircraft then departed KMZZ and landed at Detroit Willow Run (KYIP), Michigan, for refuelling and to clear United States customs outbound. The first officer called the Lansing, Michigan, flight service station, checked the weather for Peterborough (CYPQ), Ontario, and the alternate airport, Muskoka (CYQA), Ontario, and filed the instrument flight rules (IFR) flight plan. The first officer was seated in the left seat and was the designated pilot flying. The captain was seated in the right seat and was the pilot not flying for the departure from KYIP. Due to the reported instrument meteorological conditions (IMC) weather at Peterborough, the flight crew decided, at the top of the descent for Peterborough, that the captain would be the pilot flying and the first officer would be the pilot not flying.

The flight crew briefed for the non-directional beacon (NDB) runway (RWY) 09 approach at Peterborough Airport. Included in this briefing was the published missed approach, which was to be followed in the event that the aircraft did not complete the landing at the airport. At 2214 eastern daylight time,[1] Toronto Area Control Centre (ACC) issued the approach clearance to the flight crew. During the first approach to the airport, the aircraft reportedly descended to the minimum descent altitude (MDA). The flight crew observed the airport south of their position and elected to conduct the published missed approach. Airport ground personnel who were waiting for the flight to arrive did not see the aircraft, but they heard it fly overhead as it transitioned to the missed approach. Toronto ACC issued the second approach clearance at 2230.

During this approach, the flight crew acquired the runway environment while they were positioned south of the inbound track. The captain manoeuvred the aircraft to align it to runway 09 for landing. The aircraft touched down near the runway midpoint, and the flight crew elected to abort the landing. Rather than transition to the published missed approach, the captain flew the aircraft in a left visual circuit, reportedly at 1300 feet above sea level (asl), which is the minimum circling altitude for this category of aircraft. The circuit procedure was conducted near the airport, such that the aircraft completed a continuous turn from downwind leg to final leg. As the aircraft was turning onto the final leg, the precision approach path indicator (PAPI) indicated that the aircraft was too low. The captain advised the first officer that they had to go lower. When the PAPI was completely red, the flight crew elected to conduct a missed approach, and the captain applied full power for the overshoot. Seconds later, the aircraft pitched nose down, banked left, and struck terrain.

The accident occurred at about 2250 during the hours of darkness at latitude 44°14' north, longitude 078°22' west, at an elevation of 628 feet asl.

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[1] All times are eastern daylight time (Coordinated Universal Time [Z] minus four hours) unless otherwise noted.

1.2 Injuries to Persons

	Crew	Passengers	Others	Total
Fatal	-	-	-	-
Serious	-	-	-	-
Minor/None	2	-	-	2
Total	2	-	-	2

1.3 Damage to Aircraft

The aircraft was substantially damaged during the impact with the trees and ploughed farm field.

1.4 Other Damage

Some minor environmental damage was caused by jet fuel, oil, and hydraulic fluids leaking into the ground.

1.5 Personnel Information

	Captain	First Officer
Age	52	30
Pilot Licence	ATPL	ATPL
Medical Expiry Date	01 November 2000	01 April 2001
Total Flying Hours	11 800	2300
Hours on Type	9400	150
Hours Last 90 Days	100	120
Hours on Type Last 90 Days	100	120
Hours on Duty Prior to Occurrence	4.5	4.5
Hours off duty prior to work period	72	72

1.5.1 Captain

The captain was the company training pilot and had recently been assigned the new post of company flight safety officer. He had a valid pilot proficiency check on the Falcon 20 aircraft, and he was certified and qualified for the flight in accordance with existing regulations.
The captain was well rested prior to the start of the flight. He had the previous three days off, and this was his first flight of the day.

1.5.2 First Officer

This flight was a training flight for the first officer, who had recently rejoined the company after having left in 1997. He was receiving training for this aircraft type. The first officer had recently been type-rated on the Falcon 20 aircraft at Flight Safety International in Teterboro, New Jersey. He was certified and qualified for the flight in accordance with existing regulations. The first officer flew as an additional crew member on two trips, riding in the jumpseat and observing the day-to-day flying operations. It was during these two trips that the first officer and the captain became acquainted.

The first officer was well rested prior to the start of the flight. He had the previous three days off, and this was his first flight of the day.

1.6 Aircraft Information

Manufacturer	Dassault-Breguet
Type and Model	Falcon 20E
Year of Manufacture	1972
Serial Number	266
Certificate of Airworthiness (Flight Permit)	06 December 1994
Total Airframe Time	15 798 hours
Engine Type (number of)	General Electric CF-700-2D2 (2)
Maximum Allowable Take-off Weight	28 660 pounds
Recommended Fuel Type(s)	Jet A, Jet A-1, Jet B
Fuel Type Used	Jet A-1

The aircraft was complete, intact, and functioning normally before it struck the trees.

1.6.1 Weight and Balance

The weight and centre of gravity were within the prescribed limits.

1.7 Meteorological Information

The first officer obtained a weather briefing from the Lansing flight service station. The weather information for the departure (Detroit Willow Run) and destination (Peterborough) airports and the forecast weather information for the alternate (Muskoka) airport and for Toronto were relayed.

Peterborough Airport is serviced by an automated weather observation system (AWOS), which is designated and approved for aviation use and is operated and maintained by Environment Canada on behalf of and under contract to Nav Canada. The AWOS reports for Peterborough (CYPQ) were as follows:

METAR CYPQ 140000Z AUTO 09009KT 9SM OVC006 16/15 A3001

SPECI CYPQ 140018Z AUTO 09006KT 9SM OVC004 16/15 A3002

SPECI CYPQ 140054Z AUTO 06005KT 3 1/2SM OVC003 15/15 A3001

METAR CYPQ 140100Z AUTO 07006KT 3 1/2SM OVC003 15/15 A3002

METAR CYPQ 140200Z AUTO 05005KT 5SM OVC003 15/15 A3002

SPECI CYPQ 140237Z AUTO 07006KT 9SM OVC005 15/15 A3003

SPECI CYPQ 140238Z AUTO 07005KT 9SM OVC004 15/15 A3003

SPECI CYPQ 140259Z AUTO 05005KT 9SM OVC003 15/15 A3002

The alternate airport for this IFR flight was Muskoka (CYQA). The forecast weather for CYQA was 1500 feet scattered and 3000 feet overcast, visibility greater than 6 statute miles (sm), occasionally 600 feet overcast ceilings and visibility of 3 sm in light rain.

1.8 Aids to Navigation

The Peterborough Airport is serviced with the NDB RWY 09 and global positioning system (GPS) RWY 27 approaches. For the NDB RWY 09 approach, the airport is equipped with a non-directional beacon, approximately 3.8 nautical miles (nm) west of, and aligned with, runway 09. The MDA for this non-precision approach is 1200 feet asl (575 feet above the runway touchdown zone elevation) and requires a minimum visibility of 2 sm.

The aircraft was also equipped with a Trimble 2000 approach GPS unit. This unit was forwarded to the TSB Engineering Laboratory with furtherance to the unit manufacturer for data download. The GPS database was valid and showed waypoints for Peterborough Airport and its various approaches.

The following TSB Engineering Laboratory Report was completed:

LP 66/00—*GPS Download.*

This report is available upon request from the Transportation Safety Board of Canada.

1.9 Communications

No communication problems were reported concerning the Toronto ACC frequency, 134.25 megahertz, or the aerodrome traffic frequency, 123.0 megahertz.

1.10 Aerodrome Information

The Peterborough Airport is southwest of the City of Peterborough at an elevation of 628 feet asl. The airport has two runways, runway 09/27, which is 5000 feet long and asphalt covered, and runway 13/31, which is 2000 feet long and turf covered. The runway lighting system was operational and was activated by airport personnel. The airport is also equipped with PAPI for runway thresholds 09/27. Both pilots reported visually sighting the PAPI as the aircraft turned onto the final leg, and no problems were reported with the system before or after the occurrence. Runway 09 is equipped with unidirectional flashing strobe runway identification lights, which were functioning at the time of the accident.

1.11 Flight Recorders

The aircraft was not equipped with a flight data recorder or a cockpit voice recorder, nor was either required by regulation.

1.12 Wreckage and Impact Information

While flying on a heading of about 090 degrees magnetic, the aircraft's left wing struck terrain and a tree line immediately before entering the farm field. The impact cuts on the trees left standing indicated that the aircraft struck the tree line while in an approximate 45-degree, left-banked attitude. Ground scarring indicated that the aircraft struck the ground initially with the left main landing gear, which created a furrow one to two feet deep for most of the 400 feet travelled. The right wing struck another tree line, which caused the aircraft to swing 180 degrees and come to rest on a heading of 270 degrees magnetic. The outer 10 feet of each wing was torn off, and the landing gear was damaged. Both engines sustained substantial damage, and multiple fan blades were missing as a result of mud and tree ingestion. Some of the refuelling switches were found in abnormal positions for landing, but this did not affect aircraft operation. The first officer's altimeter setting did not agree with the captain's altimeter setting: the first officer's altimeter was set to 30.90, and the correct altimeter setting was 30.02. This represents a difference of 880 feet for which the altimeter was over-reading. The aircraft was not equipped with an emergency locator transmitter, nor was one required by regulation.

1.13 Fire

There was no fire before or after the occurrence.

1.14 Organizational and Management Information

The operator holds a valid air operator certificate dated 23 July 1986, which was issued by the United States Department of Transportation / Federal Aviation Administration. The operator's base of operations is at the Toledo Express Airport in Swanton, Ohio. The company fleet consists of 24 aircraft, 13 of which are Falcon 20 aircraft. The Falcon 20 is operated under *Federal Aviation Regulations* (FARs) Part 135.

1.15 Additional Information

1.15.1 Crew Resource Management

During the flight, the flight crew briefed for the approach and the missed approach procedure. In the event that the aircraft did not complete a successful landing, the aircraft would proceed on the published missed approach, which was to climb to 2700 feet on a track of 087 degrees, return to the YPQ NDB, and hold east of the NDB on an inbound heading of 267 degrees. During the first approach, the aircraft was north of the desired track when the flight crew observed the airport, and they conducted the missed approach; this is the expected IFR procedure. During the second approach, the flight crew were south of the intended inbound track when they acquired the runway environment and had to manoeuvre the aircraft to align it to the runway for landing. The crew had to perform pronounced bank and pitch changes to position the aircraft for landing. Company standard operating procedures (SOPs), based on FAR 91.175(c)(1), stipulate the criteria for aircraft operation below decision height (DH) or MDA as follows:

> Where a DH or MDA is applicable, no pilot may operate an aircraft, except a military aircraft of the United States, at any airport below the authorized MDA or continue an approach below the authorized DH unless the aircraft is continuously in a position from which a descent to a landing on the intended runway can be made at a normal rate of descent using normal manoeuvres, and for operations conducted under part 121 or part 135 unless that descent rate will allow touchdown to occur within the touchdown zone of the runway of intended landing.

After the aborted landing, the aircraft was flown in a left circuit pattern. The first officer was not expecting this manoeuvre; he expected that the aircraft would begin the published missed approach. The first officer did not challenge the captain on this manoeuvre, nor did he question why they were not conducting the published missed approach, for which they had previously briefed. While flying the circuit, the first officer and the captain maintained visual reference to the runway environment. As the aircraft was turning onto the final leg, the first officer observed the PAPI and warned the captain that the aircraft was too low. The captain's scan, while flying the aircraft, was to monitor the flight instruments and reference the runway environment. After the first officer's reference to altitude, the captain contradicted this comment and advised the first officer that they would have to go lower. The first officer was confused with this announcement; however, again he did not challenge the captain. Seconds later, the captain observed the PAPI indicating the aircraft altitude was too low, and he initiated a missed approach.

1.15.2 Somatogravic Illusion

All pilots are vulnerable to the effects of spatial disorientation while flying in IMC. The degree to which a pilot may be affected by this phenomenon depends on many factors, including the performance of the aircraft and the pilot's medical condition and experience. The following excerpt is taken from *Fundamentals of Aerospace Medicine,* which details a particular spatial

disorientation/illusion to which the accident pilot may have been subjected as a result of acceleration forces encountered in the go-around:

> The otolith organs (inner ear) are responsible for a set of illusions known as somatogravic illusions. The mechanism of illusions of this type involves the displacement of otolithic membranes on their maculae by inertial forces in such a way as to signal a false orientation when the resultant gravitoinertial force is perceived as gravitational (and therefore vertical). The most common example of the somatogravic illusions, the illusion of pitching up after taking off into conditions of reduced visibility, is perhaps the best illustration of this mechanism.
>
> Consider the pilot of a high-performance aircraft holding his position at the end of the runway waiting to take off. Here, the only force acting on his otolithic membranes is the force of gravity, and the positions of those membranes on their maculae signal accurately that down is toward the floor of the aircraft. Suppose the aircraft now accelerates down the runway, rotates, takes off, cleans up gear and flaps, and maintains a forward acceleration of 1 g until reaching the desired climb speed. The 1 g of inertial force resulting from the acceleration displaces the otolithic membranes toward the back of the pilot's head. In fact, the new positions of the otolithic membranes are nearly the same as they would be if the aircraft and pilot had pitched up 45 degrees, because the new direction of the resultant gravitoinertial force vector, if one neglects the angle of attack and climb angle, is 45 degrees aft relative to the gravitational vertical. Naturally, the pilot's percept of pitch attitude based on the information from his otolith organs is one of having pitched up 45 degrees, and the information from his nonvestibular proprioceptive and cutaneous mechanoreceptive senses supports this false percept, because the sense organs subserving those modalities also respond to the direction and intensity of the resultant gravitoinertial force.
>
> Given the very strong sensation of a now-high pitch attitude, one that is not challenged effectively by the focal visual orientation cues provided by the attitude indicator, the pilot is tempted to push the nose of the aircraft down to cancel the unwanted sensation of flying nose-high. Pilots succumbing to this temptation characteristically crash in a nose-low attitude a few miles beyond the end of the runway. Sometimes, however, they are seen to descend out of the overcast nose-low and try belatedly to pull up, as though they suddenly regained the correct orientation upon seeing the ground again.
>
> More than a dozen air transport aircraft are believed to have crashed as a result of the somatogravic illusion occurring on take-off. A relatively slow aircraft, accelerating from 100 to 130 knots over a 10-second period just after take-off, generates 0.16 g on the pilot. Although the resultant force is only 1.01 g, barely perceptibly more than the force of gravity, it is directed

9 degrees aft, signifying to the unwary pilot a 9-degree, nose-up pitch attitude. Because many slower aircraft climb out at 6 degrees or less, a 9-degree downward pitch correction would put such an aircraft into a descent of 3 degrees or more, the same as a normal final approach slope. In the absence of a distinct external visual horizon or, even worse, in the presence of a false visual horizon (e.g., a shoreline) receding under the aircraft and reinforcing the vestibular illusion, the pilot's temptation to push the nose down can be overwhelming. This type of mishap has happened at one particular civil airport so often that a notice has been placed on navigational charts cautioning pilots flying from this airport to be aware of the potential for loss of attitude reference.[2]

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[2] Roy L. DeHart, *Fundamentals of Aerospace Medicine* (Philadelphia: Lea & Febiger, 1985), p. 347–48.

2.0 Analysis

2.1 Introduction

The flight crew was certified and qualified for the flight, and the aircraft was complete, intact, and functioning normally before it struck the trees. Consequently, the analysis will deal with the following factors: weather information, crew decision making and resource management, and spatial disorientation.

2.2 Weather Information

The current weather information for Peterborough Airport was relayed to the flight crew by the Toronto ACC controller when the initial approach clearance was given at 2214. The AWOS reported ceiling at this time was 300 feet overcast, but, as reported on special reports before and after the occurrence, this ceiling was fluctuating between 300 and 500 feet, with good visibility. This explains why, on the initial approach, the aircraft could not be seen from the ground, but could be heard when it flew over the airport at 1200 feet asl (575 feet above ground level (agl)).

2.3 Crew Decision Making and Resource Management

In accordance with the approach briefing, the flight crew conducted the published missed approach when the initial approach was unsuccessful. During the second approach, the aircraft was south of the approach track, and it was necessary for the captain to manoeuvre the aircraft to align it on runway 09. The aircraft attitudes during this manoeuvring, and the point where the aircraft touched down on the runway, indicate that during the second approach the aircraft was never positioned properly for the flight crew to attempt a landing and that a second missed approach would have been prudent. The continuance of this unstabilized approach to landing was contrary to company SOPs and FAR 91.175(c)(1).

As the aircraft touched down near the runway midpoint, the captain elected to abort the landing, because there was insufficient runway remaining. The first officer was expecting the captain to proceed with another published missed approach at this point; however, the captain flew a left visual circuit reportedly at circling approach altitude of 1300 feet asl (672 feet agl). Based on the AWOS weather reports, the ceiling at the time of the accident was at 400 feet agl. It is unlikely that this circling altitude was ever captured for the visual circuit; the aircraft would likely have been in cloud. The first officer did not challenge the captain when he realized that the aircraft was not proceeding as they had previously briefed.

Due to the close proximity of the left circuit to runway 09, it was necessary for the aircraft to be flown in one continuous turn from downwind leg to final leg. The first officer, seated in the left seat, scanned the outside environment while the captain scanned the flight instruments and the outside environment. During the turn onto final leg, the first officer observed the PAPI and advised the captain that the aircraft was too low. When the captain expressed that he wanted to go lower, the first officer was confused and, again, did not challenge the captain. When the

captain saw that the PAPI was indicating that the altitude was too low, he initiated a missed approach.

In-house crew resource management (CRM) training has been, and is being, provided to the flight crews by the company. Although this was a training flight and the first flight that this particular flight crew had conducted together, basic procedures—such as the completion of checklists and setting of altimeters to the appropriate altimeter setting—were contrary to company SOPs. This breach of company SOPs and the lack of crew coordination/challenge that existed after the aborted landing indicate a need for enhanced CRM.

2.4 Spatial Disorientation

The aircraft was operating in a dark IMC environment with limited visual cues to the airport. During the missed approach from the third attempt to land at Peterborough Airport, the captain applied full power to the aircraft. It is likely that the captain misinterpreted the acceleration forces to which he was subjected and, as a result of inadequate monitoring of the flight instruments, the aircraft banked left and pitched nose-down. Tree cuts indicated that the aircraft was in an approximate 45-degree, left-banked attitude at impact. The ground scarring indicates that, at the point of ground impact, the aircraft pitch attitude had changed to nose-up.

3.0 Conclusions

3.1 Findings as to Causes and Contributing Factors

1. The captain's attempt to continue the landing during the second approach was contrary to company standard operating procedures and Federal Aviation Regulations, in that the approach was unstable and the aircraft was not in a position to land safely.

2. Following the aborted landing, the flight crew proceeded to conduct a circling approach to runway 09, rather than the missed approach procedure as briefed.

3. The pilot lost situational awareness during the overshoot after the third failed attempt to land, likely when he was subjected to somatogravic illusion.

4. Breakdown in crew coordination after the aborted landing, lack of planning and briefing for the subsequent approach, operating in a dark, instrument meteorological conditions environment with limited visual cues, and inadequate monitoring of flight instruments contributed to the loss of situational awareness.

4.0 Safety Action

4.1 Action Taken

Following this occurrence, the company directed its flight operations department to develop a list of restricted airports where inclement weather and/or aircrew experience may present unacceptable risk factors.

The company further directed Falcon aircraft crews that cross-cockpit manoeuvring[3] is not acceptable in airport terminal areas when weather is below visual flight rules minimums.

The company provided the following direction to all aircrews:

A: Clarification that an instrument flight rules clearance for a straight-in approach does not constitute a clearance for a circling manoeuvre unless specifically authorized by air traffic control (ATC).

B: If weather or execution of approach procedures precludes landing after two attempts, a third approach procedure shall not be executed until the weather improves. Crews shall execute the published missed approach, enter holding, or divert to the alternate airport, as directed by ATC. This does not preclude a third or subsequent approach procedure if the published missed approach or balked landing was due to airport traffic or other runway obstacle.

C: Review the process for calculation of a visual descent point (VDP) or calculated descent point (CDP). This applies only to straight-in non-precision approaches. If the VDP/CDP is reached and the airfield is not in sight or the aircraft is not in a position to begin a descent to land, missed approach procedures must be initiated, unless specifically cleared by ATC for alternate procedures.

The company directed its director of training to coordinate with Flight Safety International or SimuFlite for an on-site cockpit/crew resource management course. Subsequent courses will be developed by the company training department for inclusion into initial and recurring training programs.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 17 May 2001.

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[3] In a "cross-cockpit manoeuvre", a pilot performs a left manoeuvre while seated in the right seat or a right manoeuvre while seated in the left seat.

Appendix A—Glossary

ACC	area control centre
agl	above ground level
asl	above sea level
ATC	air traffic control
ATPL	airline transport pilot licence
AWOS	automated weather observation system
CDP	calculated descent point
CRM	crew resource management
CYPQ	Peterborough Airport, Ontario
CYQA	Muskoka Airport, Ontario
DH	decision height
FAR	*Federal Aviation Regulations*
g	G-load factor
GPS	global positioning system
IFR	instrument flight rules
IMC	instrument meteorological conditions
KMZZ	Marion Airport, Ohio
KSDF	Louisville Airport, Kentucky
KYIP	Detroit Willow Run Airport, Michigan
MDA	minimum descent altitude
NDB	non-directional beacon
nm	nautical miles
PAPI	precision approach path indicator
RWY	runway
sm	statute mile(s)
SOPs	standard operating procedures
TSB	Transportation Safety Board of Canada
VDP	visual descent point
Z	Coordinated Universal Time
'	minute(s)
"	second(s)
°	degree(s)