

Crash of Flight 111

PROGRAM OVERVIEW

Note: This program contains information that may be upsetting to students. Please preview it to determine its appropriateness for your classroom.

NOVA follows the four-and-a-half year, \$39 million investigation into why Swissair Flight 111 crashed on September 2, 1998, killing all 229 passengers.



The program:

- reviews the series of events that led up to the crash of the McDonnell-Douglas MD-11 plane in the waters off Nova Scotia.
- chronicles how scientists used evidence to establish how and why the crash occurred.
- follows the salvage and sorting of hundreds of thousands of pounds of wreckage—such as metal pieces, wires, burnt rugs, and other airplane debris—from 55 meters (180 feet) below the ocean surface.
- shows the recovery of the black box and the subsequent finding that it did not record the final six minutes of flight.
- details the reassembly of the plane in a hangar in Halifax and the creation of a three-dimensional computer model of the aircraft.
- demonstrates a variety of tests that investigators conducted, including exposing metal to different levels of heat to determine color changes and performing materials flammability tests.
- shows how investigators came to reconstruct the series of events that led up to the crash—a damaged wire in the entertainment system gave rise to an electrical arc-generated fire that spread out of sight in the plane’s attic area.
- reviews the recommendations made by the Transportation Safety Board of Canada upon completion of its investigation.
- notes that the Federal Aviation Administration has given airlines five years to implement the most important recommendation resulting from the investigation—replacing the type of flammable insulation materials found in Swissair Flight 111.

BEFORE WATCHING

- 1 Have students locate New York, Halifax, and Geneva on a map. Explain to students that Swissair Flight 111 was bound from New York to Geneva but tried to make an emergency landing in Halifax.
- 2 As students watch, have them do the “Piecing It All Together” activity found on page 2.

AFTER WATCHING

- 1 Ask students why it is important to spend time, resources, and money on a plane crash investigation. What are the short- and long-term benefits of learning about the cause of a plane crash? Why is it important to study how different plane systems interact rather than just studying individual parts of a plane?
- 2 An investigation like this one relies on experts from many different areas. Discuss with students what kinds of experts were needed to conduct this investigation (e.g., a former pilot led the investigation, scuba divers helped collect wreckage from the ocean floor, engineers tried to piece the aircraft back together, a technologist created a virtual plane on the computer, and pilots retraced the route flown by the Swissair Flight 111 crew).

Taping Rights: Can be used up to one year after the program is taped off the air.

CLASSROOM ACTIVITY

Objective

To learn about the techniques and reasoning used to determine the cause of the 1998 crash of Swissair Flight 111.

Materials for each team

- teams 1–4: copies of the “Piecing It All Together” student handout
- teams 5–6: notebook paper

Procedure

- 1 To determine the cause of the Swissair Flight 111 crash, investigators meticulously studied salvaged plane parts and computer models and tested different features of the plane. In this activity, students will track the evidence scientists found and the information and conclusions they gathered from that evidence.
- 2 Organize the class into six teams and provide each team member with copies of the student handout.
- 3 Assign four teams to take notes on the information learned and conclusions drawn for the following numbered areas on the chart—team 1: numbers 1–4; team 2: numbers 5–7; team 3: numbers 8–10; team 4: numbers 11–13. Have team 5 take notes on the recommendations made by the Transportation Safety Board of Canada and team 6 take notes on each of the specialists who took part in the investigation.
- 4 After they watch the program, ask students to compare their charts or notes with those of other teams members and resolve any differences among their recorded information.
- 5 Hold a class discussion about the investigation. First discuss with students what specialists were involved in the investigation and what each specialist did. Then review the information discovered and conclusions drawn in the investigation. Using the chart in the Activity Answer on page 3, help resolve any differences among student answers. What were the key pieces of evidence? After four and a half years of searching, what explanation did investigators find for the crash? What recommendations did investigators make to ensure future safety?
- 6 As an extension, have students research the status of the safety measures recommended by the Transportation Safety Board of Canada after completion of the investigation into the crash of Swissair Flight 111.

STANDARDS CONNECTION

The “Piecing It All Together” activity aligns with the following National Science Education Standards.

GRADES 5–8

Science Standard E:

Science and Technology

Understandings about science and technology

- Perfectly designed solutions do not exist. Risk is part of living in a highly technological world. Reducing risk often results in new technology.
- Technological solutions have intended benefits and unintended consequences. Some consequences can be predicted, others cannot.

GRADES 9–12

Science Standard E:

Science and Technology

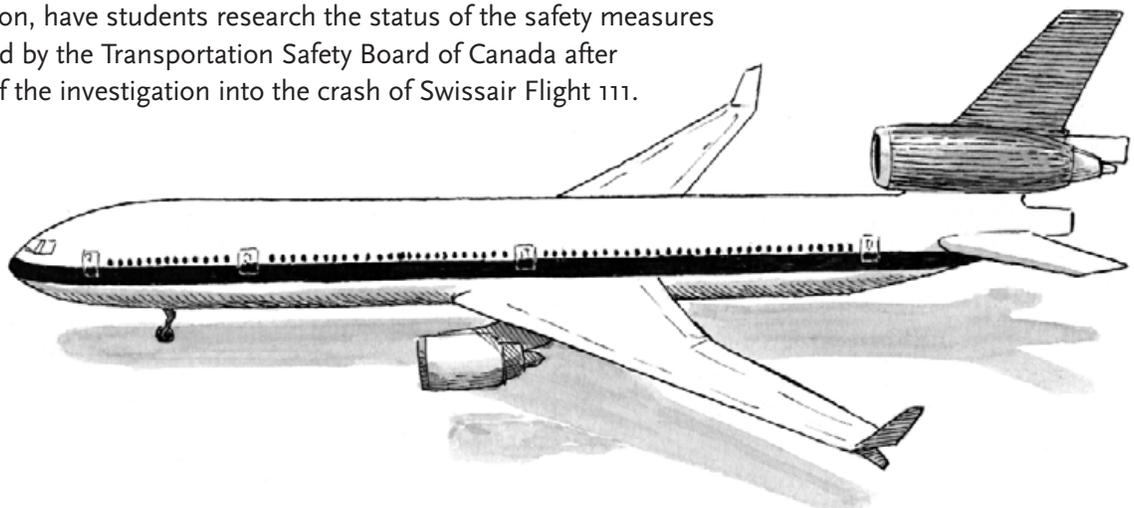
Understandings about science and technology

- Creativity, imagination, and a good knowledge base are all required in the work of science and engineering.

*Video is required
for this activity.*

Classroom Activity Author

Developed by WGBH Educational Outreach staff.



ACTIVITY ANSWER

Investigation Chart

Steps Taken	Information Learned	Conclusion Drawn
1 Listened to communications during the emergency.	Smoke was in the cockpit.	Fire may have been the cause of the crash.
2 Analyzed flight data recorder.	Recorder did not capture data from final six minutes of flight.	An event occurred that shut off the data recorder.
3 Heated paint samples identical to those on Swissair Flight 111.	Metal changes color based on the heat intensity it has been exposed to.	The darker the metal, the closer it was to the fire; high temperatures only found in plane's forward section.
4 Studied remnants of kitchen galley.	Heat damage came from top down, not bottom up.	Ovens not responsible for fire.
5 Noticed melted plastic drip marks on carpet in flight cabin.	Extreme heat from above melted the plastic.	Area where plastic melted was extremely hot.
6 Sorted through 240 kilometers of wire.	Twenty-three wires showed indications of electrical arcing.	Fire may have been caused by an electrical system failure.
7 Retrofitted an MD-11 for smoke and air flow tests.	How air circulates in the MD-11.	Fire was probably raging unseen in attic.
8 Conducted flame tests on metallized Mylar.	Mylar readily ignited.	Mylar may have provided fuel for the fire.
9 Conducted flame tests on ventilation end caps.	End caps readily ignited.	Fire was exposed to the plane's fresh air supply; a blast of air would have fanned the flames.
10 Studied wiring in computer image of plane.	Entertainment system wiring found in probable fire area.	Entertainment wiring could have been cause of fire.
11 Found entertainment wire with arc and brackets near wire.	Brackets showed no evidence of arcing.	Unclear whether this wire may have caused fire.
12 Surveyed all wires near newly found arc wires.	Surrounding bundle of wires indicates fire damage.	Arced wire may have caused the fire.
13 Retraced flight path of Swissair Flight 111.	Pilots had to fly by instruments alone; "black hole effect" makes horizon seem to disappear.	Co-pilot trying to see out of right window may have veered plane into a right roll and crashed it into the water.

ACTIVITY ANSWER cont.

The key clues in the investigation were the wire with evidence of two arcing events and the flammable Mylar insulation. The spark likely caused the Mylar insulation to catch fire. The fire then likely moved above the ceiling toward the back of the plane. When the air recirculation ducts were turned off, the fire likely moved into the cockpit ceiling, causing the autopilot to malfunction. Heat then melted the plastic cockpit liner, and fire came through the opening. This is probably when the pilot and co-pilot simultaneously issued emergency alerts.

Investigators recommended an integrated fire-fighting philosophy that included adding smoke detectors and video cameras to seek out hidden fires before they spread, increased visibility of standby instruments, a streamlined pilot's smoke checklist, increased cockpit voice recorder recording time and backup power supplies, seeking out cracks in wire, and creating a standard to prevent future cracks from occurring. Investigators also recommended removal of all flammable materials, including the Mylar insulation.

Major funding for NOVA is provided by the Park Foundation, Sprint, and Microsoft.

PARK
FOUNDATION

 **Sprint**

Microsoft

LINKS & BOOKS

Links

NOVA Web Site—Crash of Flight 111

www.pbs.org/nova/aircrash/

In this companion Web site to the NOVA program, learn about the possibility of wireless black boxes, find out what happens inside an investigation, discover post-crash safety measures, and explore the anatomy of a jetliner.

Aviation Safety Network Accident Description

aviation-safety.net/specials/sr111/main.htm

Features a preliminary accident description of Swissair Flight 111 and lists significant smoke- and fire-related incidents and Swissair accidents since 1945.

The Crash of Swissair 111

www.swissair11.org/

Includes news articles and discussion groups about the crash and investigation.

The Herald: Swissair Flight 111

www.herald.ns.ca/swissair/Swissair.html

Provides photos and news stories from the local paper that covered the investigation.

Indepth: Swissair Flight 111

www.cbs.ca/news/indepth/swissair/

Contains the transcript from the flight data recorder, a timeline of the investigation, and recommendations issued by the Transportation Safety Board of Canada.

Summary of Safety Action Taken in Response to TSB SR 111 Investigation Safety Communications

www.tsb.gc.ca/en/media/fact_sheets/ah980003/MatrixTable_a98h0003.asp

Charts the steps taken by FAA, Boeing, and Swissair following the recommendations issued by the Transportation Safety Board of Canada.

Swissair Flight 111 Investigation Report

www.tsb.gc.ca/en/reports/air/1998/a98h0003/01report/index.asp

Details the Transportation Safety Board of Canada's complete report of the investigation into the crash of Swissair Flight 111.

Books

Faith, Nicholas

Black Box: The Air-Crash Detectives—Why Air Safety Is No Accident

Osceola, Wisconsin: Motorbooks International, 1997.

Provides an in-depth look at air-crash detectives and their investigations of fatal plane crashes.

Gaffney, Timothy R.

Air Safety: Preventing Future Disasters

Berkeley Heights, NJ: Enslow 1999.

Examines the causes of plane crashes, including human error, weather, mechanical failure, and terrorism, and explores current views on preventing future accidents.



Piecing It All Together

On September 2, 1998, Swissair Flight 111 crashed into the Atlantic Ocean near Halifax, Nova Scotia, killing all 229 passengers. For the next four and a half years, investigators searched through the wreckage seeking answers to what happened. Follow the investigation with this chart. As you watch, fill in the blank areas.

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