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The Evolution of the Airplane Black Box

Flight data recorders (FDRs) and cockpit voice recorders (CVRs) are located in the tail section of all large commercial and some smaller commercial aircraft. (See Photos 1 and 2.) They are also required on private aircraft if an airplane meets certain size specifications. They are placed in the tail because that is the part of an airplane that is usually least damaged if an airplane crashes.

When a commercial airplane crashes, its FDR (Photo 3) and CVR (Photo 4) need to be recovered from the accident site so that investigators can retrieve the data recorded before the airplane went down. The analysis of this data hopefully will allow them to determine the cause of the airplane crash.

New airplanes now have solid-state FDRs that digitally record flight characteristics including altitude, time, airspeed, heading, auto pilot mode, power systems, hydraulics, smoke alarms, and even flap positions. These newer FDRs can constantly update their data recording to reflect the moment-by-moment status of more than one thousand airplane flight characteristics.

At the same time, the airplane's CVR digitally records voice communications. Its microphones pick up radio transmissions made between the plane and ground stations and banter between the pilots and other members of the flight crew. The CVR also picks up other airplane noise especially sounds from the engines.

The black boxes that are installed on airplanes today are termed reactive devices because they must be recovered after an airplane crash to acquire the information that they have recorded. To help find them after an airplane crash, these black boxes are bright orange in color.

Photo 1 (above)—Flight data recorder

Photo 2 (left)—Cockpit voice recorder

So why are they called black boxes? The Internet provides many different reasons for their nickname. The one I liked the best is that their content is a mystery. As far back as the 17th century, writers often described a mystery that needed to be solved as a "black box" that needs to be opened. These writers alluded to the fact that the secrets held inside the box were safe because no one knew the location of the secret locking mechanism. The writers made the box itself as much a mystery as its contents.

The parallel here is that no one knows if airplane black boxes will contain useful information into the cause of the crash until after they are recovered. Some are never recovered and some that are recovered are so damaged that investigators can't decipher their contents.

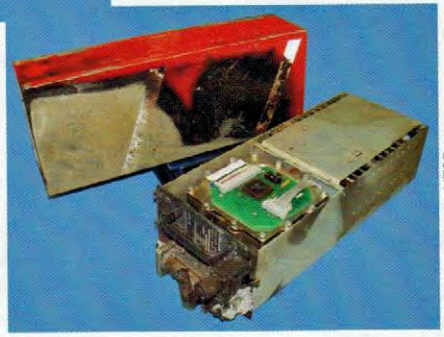
To help find these reactive conventional black boxes after a crash, an acoustical signal is transmitted if the airplane crashes in water. The pinger on the device transmits a pinging noise that serves as a homing beacon. It can be detected with special equipment even if the black box rests on an ocean floor at a depth of 14,000 feet.

Since it is now easy to retrieve the data from a digital FDR, the information that it recorded during a flight is now sometimes used during routine airplane inspections and scheduled maintenance. The recordings, however, are not proactive, which means that the airplane's flight crew or instruments cannot access them during a flight to find a problem that is not yet detected.

Star Navigation Systems Group Ltd. has recently announced its new Terrastar in-flight monitoring system. The company hopes to sell its system initially as an extra black box that will transmit the data that it collects during the actual airplane flight. Company leaders feel that their system can pick up flight anomalies and provide the information to the flight crew and ground crew while the plane is flying long before a catastrophic problem causes an airplane to crash. (See Photo 5.) At the time

Photo 3 (left)—CVR from a plane that crashed, cut open to access its data

Photo 4 (below)—The FDR from the same plane, removed from its casing



Photos 1-4 courtesy NTSB.gov

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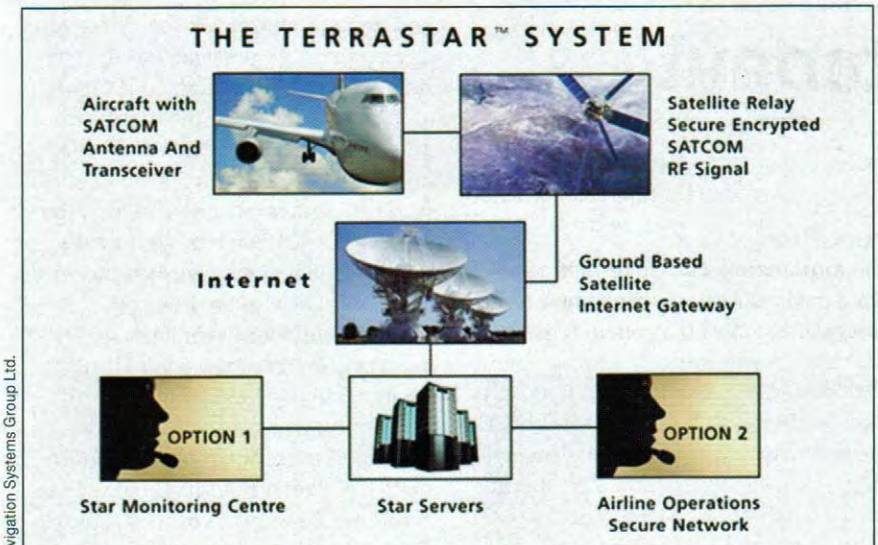

Star Navigation Systems Group Ltd.

Photo 5—Terrastar transmits collected data during the flight.

this column went to press, this system was being tested on a couple of planes that are flying in Asia and about 36 helicopters that are flying in Afghanistan.

Terrastar collects the same information as that collected by a conventional black box, but it transmits what it collects at defined intervals during the flight. If it picks up a significant anomaly that could endanger the flight, it quickly warns the flight crew and ground station that a catastrophic failure is about to happen.

If a Terrastar-equipped airplane should encounter a catastrophic failure the system would automatically start sending out a "Mayday signal" that includes the airplanes current location, heading, airspeed, and altitude. It would continue to transmit this information in real time for as long as it can. This constant signal, which begins to be transmitted before the plane actually hits the ground, should give rescuers the most accurate information possible when they start to search for the airplane.

Recalling the Facts

1. Do you feel pilots and flight crews would want ground stations to constantly be aware of what is going on inside their cockpits? Why?
2. Since so few planes actually crash do you feel that this technology could be cost effective? Why?
3. What is the difference between a reactive and a proactive black box?
4. Internet research—Find at least one other reason why FDRs and CVRs might be called "black boxes." In your own words, describe the reason given and also provide the web address of the site at which you found your answer.