A

Seminar report

On

Black Box

Submitted in partial fulfillment of the requirement for the award of degree
Of ECE

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Preface

I have made this report file on the topic **Black Box**; I have tried my best to elucidate all the relevant detail to the topic to be included in the report. While in the beginning I have tried to give a general view about this topic.

My efforts and wholehearted co-corporation of each and everyone has ended on a successful note. I express my sincere gratitude to ……..who assisting me throughout the preparation of this topic. I thank him for providing me the reinforcement, confidence and most importantly the track for the topic whenever I needed it.

Content

Introduction

In science, computing, and engineering, a **black box** is a device, system or object which can be viewed in terms of its inputs and outputs (or transfer characteristics), without any knowledge of its internal workings. Its implementation is "opaque" (black). Almost anything might be referred to as a black box: a transistor, algorithm, or the human brain.

The opposite of a black box is a system where the inner components or logic are available for inspection, which is most commonly referred to as a white box (sometimes also known as a "clear box" or a "glass box").

What is a Black Box?

Often one of the first pieces of techno-speak that springs to mind when we hear of an aviation disaster - and a catch-all phrase popular with the media - is 'Black Box,' but how much do you really know about these vital pieces of equipment?

Any commercial aeroplane or corporate jet is required to be equipped with a cockpit voice recorder and a flight data recorder. It is these two items of separate equipment which we commonly refer to as a 'Black Box.' While they do nothing to help the plane when it is in the air, both these pieces of equipment are vitally important should the plane crash, as they help crash investigators find out what happened just before the crash.

Often, for example when a plane crashes into the sea, as happened with the 1985 bombing of Air India flight 182 by Sikh terrorists over the Atlantic Ocean just west of Ireland, investigators have very little to go on – on this specific occasion the plane crashed before the pilot could even issue a mayday signal and much of the debris sank into the sea, leaving few clues.

Today, the Black Box is still just as vitally important in helping piece together the causes of a plane crash, as seen by the discovery of the Black Box in the Mexico plane crash that killed fourteen, including the interior minister of Mexico on 4th November, 2008.

To help locate the cockpit voice recorder and a flight data recorder in the aftermath of a plane crash that occurs at sea, each recorder has a device fitted to it known as an Underwater Locator Beacon (ULB). The device is activated as soon as the recorder comes into contact with water and it can transmit from a depth as deep as 14,000 feet. Also, to help investigators find them; a Black Box is not actually black at all, but bright orange.

All recorders undergo countless tests. For example, one Black Box recorder, the L-3 FA 2100 underwent testing that includes exposure to a 1,110°C fire for an hour and 260°C heat for 10 hours. It is also able to operate between -55° to +70°C and it can carries a minimum 25 hours of flight data.

History

The modern term "black box" seems to have entered the English language around 1945. In electronic circuit theory the process of network synthesis from transfer functions, which led to electronic circuits being regarded as "black boxes" characterized by their response to signals applied to their ports, can be traced to Wilhelm Cauer who published his ideas in their most developed form in 1941.

Although Cauer did not himself use the term, others who followed him certainly did describe the method as black-box analysis. Vitold Belevitch puts the concept of black-boxes even earlier, attributing the explicit use of two-port networks as black boxes to Franz Breisig in 1921 and argues that 2-terminal components were implicitly treated as black-boxes before that.

In cybernetics, a full treatment was given by Ross Ashby in 1956. A black box was described by Norbert Wiener in 1961 as an unknown system that was to be identified using the techniques of system identification. He saw the first step in self-organization as being to be able to copy the output behaviour of a black box.

Inside the Black Box

Cockpit Voice Recorder (CVR)

Flight Data Recorder (FDR)

The Cockpit Voice Recorder (CVR)

The main purpose of the Cockpit Voice Recorder is, unsurprisingly, to record what the crew say and monitor any sounds that occur within the cockpit. While investigators might be interested in any witty banter between pilots that went on just before an explosion or plane malfunction, trained investigators are keen to pick up on sounds such as engine noise, stall warnings or emergency pings and pops.

Investigators are so skilled that they are then able to work out crucial flight information such as the speed the plane was travelling and engine rpm and can sometimes pinpoint the cause of a crash from the very sounds the plane was making before it crashed. The Cockpit Voice Recorder is also extremely important for determining the timing of events as it contains information such as communication between the crew and ground control and other aircraft. The Cockpit Voice Recorder is usually located in the tail of a plane.

The Flight Data Recorder (FDR)

Of equal, if not more significance to the Cockpit Voice Recorder, is the Flight Data Recorder. This piece of equipment is essential to the work of Air Crash Investigators as it records the many different operating functions of a plane all at once, such as the time, altitude, airspeed and direction the plane is heading.

But these are just the primary functions of the recorder, in fact, modern Flight Data Recorders are able to monitor countless other actions undertaken by the plane, such as the movement of individual flaps on the wings, auto-pilot and fuel gauge. Information stored in the Flight Data Recorder of a plane that has crashed is invaluable for investigators in their search for determining what caused a specific crash. The data stored on the recorders helps Air Crash Investigators generate computer video reconstructions of a flight, so that they can visualise how a plane was handling shortly before a crash.

The Flight Data Recorder and the Cockpit Voice Recorder are invaluable tools for Air Crash Investigators worldwide and will continue to play a major role in finding out the causes of aviation accidents, as well as offering plane manufacturers and government's considerable ideas to help make air travel as safe as possible.

Flight data recorder

Longer base

Cockpit voice recorder

Smaller power supply unit

Technology Used

- **Magnetic Tape** - The introduction of the CVR in the late 1960s and DFDRs in the early 1970s made magnetic tape the recording medium of choice until the introduction of solid-state flight recorders in the late 1980s. There were a variety of tapes and tape transports used by the various recorder manufacturers. The most widely used tapes were mylar, kapton, and metallic. The tape transports were even more varied, using designs such as coplaner reel to reel, coaxial reel-to-reel, endless loop reel packs and endless loop random storage. Tape CVRs record four channels of audio for 30 minutes, and the DFDR records 25 hours of data. CVRs and FDRs record over the oldest data with the newest data in an endless loop-recording recording pattern.
- **Digital Recording** - Most DFDRs require a flight data acquisition unit (FDAU) to provide an interface between the various sensors and the DFDR. The FDAU converts analog signals from the sensors to digital signals that are then multiplexed into a serial data stream suitable for recording by the DFDR. Industry standards dictated the format of the data stream, which for the vast majority of tape-based DFDRs is 64 12-bit data words per second. The recording capacity of the tape DFDR is limited by the length of tape that can be crash-protected and the data frame format. The capacity of the tape DFDRs was adequate for the first generation of wide-body transports, but was quickly exceeded when aircraft like the Boeing 767 and Airbus A320 with digital avionics were introduced.
- **Solid State Technology** - The introduction of solid-state flight recorders in the late 1980s marked the most significant advance in evolution of flight recorder technology. The use of solid-state memory devices in flight recorders has expanded recording capacity, enhanced crash/fire survivability, and improved recorder reliability. It is now possible to have 2-hour audio CVRs and DFDRs that can record up to 256 12-bit data words per second, or 4 times the capacity of magnetic tape DFDRs.

Advantages of Black Box Testing

- Black box tests are reproducible.
- The environment the program is running is also tested.
- The invested effort can be used multiple times.
- More effective on larger units of code than glass box testing
- Tester needs no knowledge of implementation, including specific programming languages
- Tests are done from a user's point of view
- Will help to expose any ambiguities or inconsistencies in the specifications
- Efficient when used on Larger systems
- As the tester and developer are independent of each other, test is balanced and unprejudiced
- Tester can be non-technical.
- There is no need of having detailed functional knowledge of system to the tester.
- Tests will be done from an end user's point of view. Because end user should accept the system. (This is reason, sometimes this testing technique is also called as Acceptance testing)
- Testing helps to identify the vagueness and contradiction in functional specifications.
- Test cases can be designed as soon as the functional specifications are complete

Disadvantages of Black Box Testing

- The results are often overestimated.
- Not all properties of a software product can be tested
- The reason for a failure is not found.
- Only a small number of possible inputs can actually be tested, to test every possible input stream would take nearly forever
- Without clear and concise specifications, test cases are hard to design
- There may be unnecessary repetition of test inputs if the tester is not informed of test cases the programmer has already tried
- May leave many program paths untested
- Cannot be directed toward specific segments of code which may be very complex (and therefore more error prone)
- Most testing related research has been directed toward glass box testing
- Test cases are tough and challenging to design, without having clear functional specifications
- It is difficult to identify tricky inputs, if the test cases are not developed based on specifications.
- It is difficult to identify all possible inputs in limited testing time. So writing test cases is slow and difficult
- Chances of having unidentified paths during this testing
- Chances of having repetition of tests that are already done by programmer.

Future of the Black Box

As technology continues to develop it is likely that Black Boxes, or flight data recorders, will become more and more sophisticated and more reliable, giving Air Crash Investigators more to go on when painstakingly trying to piece together what caused a plane crash.

Potentially, the humble MP3 player – adored by music fans the world over - could become part of the flight data recording software. In 2007, US light aircraft manufacturer LoPresti Speed Merchants announced that it planned to fully integrate the device as flight data recorder on all of its Fury piston aircraft. The company believes that if suitable software was used then MP3s would be capable of recording over 500 hours of flight time data.

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