Hi Tech Investigations

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There are some investigations that must be conducted in laboratories and very specialized experts must do them. This brief explanation is to only suggest the availability of the technologies for such sophisticated endeavors.

Cockpit voice recorders (C.V.R.s), flight data recorders (F.D.R.s) and digital flight data recorders (D.F.D.R.s) are all painted yellow, international orange or florescent red. They are designed to withstand crash impacts.

Cockpit voice recorders: The voice recorder is a primary investigative tool even though the recording quality is uniformly poor. It is a metal tape that is rerecords on the same tape and it is low on fidelity and high on ambient noise. A Radio Shack Cheapo is far better. The parabolic cockpit microphone is mounted overhead and is pointed down at the crew and control areas. It does pick up most cockpit sounds unless the overhead radio speakers are in use, as they tend to overpower all other reception. The tape is reused every thirty minutes.

Since the same wire tape is a closed a closed loop, it is sometimes possible to retrieve data from greater than thirty minutes. This is known as print over retrieval. Good labs are sometimes able to retrieve data from the previous tape run especially if nothing was currently being recorded on that segment.

Sound Analysis: Sound analysis is a specific discipline that has burgeoned far beyond voice print identification. Good private laboratories that specialize in the art can derive much beneficial data through sound analysis techniques.

The more sophisticated methods analyze sound amplitudes and frequencies from 0 to 2,000 hertz as they divide each second into incremental parts. By utilizing sophisticated computer programs, the sounds create three dimensional models particular to their source. The lab can compare stored exemplar sounds to the accident sound analysis. Sound analysis done by a professional lab may be attempted for the following purposes:

1. Identify pilots' voices.
2. Identify fatigued pilots.
3. Identify O2 starved pilots.
4. Identify impaired pilots.
5. Identify stressed voices. (Lie detection)
6. Identify sound sources.
7. Identify vibration frequencies. (Useful in flutter)
8. Subtract artifact noises.
9. Subtract exemplar sounds.
10. Delete unwanted frequency ranges
11. Scan specific frequency ranges.
12. Differentiate fuel explosions from high explosive noises.

Don't expect the N.T.S.B. to be able to do much of this. Even the F.B.I. is behind the state of this art.

Flight Data Recorders: These recorders come in three varieties:

a. Tape data recorders: These are metal tape devices that only record about 4 or 5 channels. These are sent to a lab and analyzed. The biggest trick here is to correlate the data retrieved to real time events external to the tape so that actual events are recorded in real time. For instance, it is imperative to correlate the data recorder to the Cockpit voice recorder, the radio transmissions, A.T.C. tapes, A.T.C. tapes of activities on landline and in particular to the radar reconstruction of A.R.T.S. flight path data.

b. Digital data recorders: record about 60 different parameters sequentially and print out 0 and 1 for performance. It takes true experts in the particular variety of recorders to do a credible job reconstructing the meaning of the data stored. The military have several advanced varieties in addition to those standards on the newer airliners.

c. Analog data recorders: These are an older variety of computer data storage. The type of data stored is identical to that stored in the digital system. Only the format is different.

Computer chip analysis: Some systems store information only as long as electricity is applied while others store information in memory. It is from the systems that retain memory that information can be retrieved. This retrieval is a job a qualified lab or the manufacturer is best able to do.

A general method for retrieval of data is suggested. This general method of data retrieval from computers, computer cards, computer memories, hard drive memory storage, memory computer chips are all similar in general protocol. The general rules are simple to follow and understand. The rules are similar in concept to other mechanical data retrievals. The methods are different.

In electronic devices that store retrievable data the rules are:

1. If you do not understand the system D.F.W.I. (do not fool with it)
2. Remove components carefully and quickly. Store them in static free wrappers and cover the connectors with static free wrappers as well.
3. Protect the components from hostile environmental conditions.
4. Take the components to a laboratory that has the technology to do retrievals

correctly.

5. Set up data retrieval quickly since computer chip memory may decay with time. (Some systems have internal batteries and battery decay can cause anomalies.)

6. Be aware that any attempted data retrieval may be totally successful, partially successful, or a total failure.

7. Be aware that any attempted data retrieval may result in the destruction of some or all of the evidence to be retrieved.

8. Because of the potential for data destruction, all parties should be present and an agreed upon protocol should be established.

Rules for the retrieval protocol include:

1. That an identical working exemplar be available to be utilized as a potential test bed for components from the wrecked system. The exemplar part should be functionally tested to prove that it meets all test requirements.

2. Complete photography or videotaping is accomplished.

3. The test bed and worker should be grounded.

5. A schematic should be utilized to determine which chips within the system contain the actual memory. Assume we have a single memory chip identified. Assume this chip is soldered to a computer card. Assume this card is contained within a box of several such cards. Assume the box utilizes a connector and then that is attached to an amplifier section, a drive logic section, a power supply section and display system.

6. There are choices to be made. All we need to test is the memory chip, but to remove it we must unsolder the chip. The heat may ruin the memory so this is a bad choice unless it is the only choice. The choices might be:

a. Plug the whole thing in and run it as is.

b. Examine the components and change out certain parts and run it.

c. Remove the box and run it in the exemplar.

d. Remove the card from the box and place the card in the exemplar and run it.

e. Remove the memory chip from the card and solder it into an exemplar card and run the exemplar.

The preference is to run as much of the original component as is thought appropriate depending upon its condition. Obvious damage to the parts will make the decision simpler. Anything that looks damaged should be considered a potential short circuit and not included in the retrieval test.

The first step is visual examination of the part. If the part seems totally intact, there are no deficiencies noted and the system does not rattle test the accident equipment as is.

Hard drive retrievals: Certain systems utilize storage in hard drive memories similar to your pc computer. This is especially true in some military systems where war games are retrieved and replayed for debriefings. These systems are very specialized and complex. You must rely on the labs set up for this type of reconstruction and unfortunately many such systems are classified. The same protocol guidelines should be followed for hard drives and memory systems as for computer chips.

Broken Computer Chip Data Retrieval: Any chip, hard drive, or C.D. that is designed to store information for retrieval after the electric power is turned off is amenable to forensic retrieval even after the chip is broken by the crash. The only area that retrieval is totally precluded is across the fracture surface itself. The leading facility of such retrieval capability is General Dynamics, Fort Worth. Lockheed now owns it. Many computer nerds at repair shops do routine retrievals of memories of hard drives and C.D.s. The important part is to protect the chip from moisture, contaminants, and static electricity. If it was retrieved from under water, ship it in fresh water to the laboratory. Be sure that the laboratory knows what the protocol will be before starting.

Light Bulb: The basic concept is that a hot light bulb filament will stretch at ground impact. A cold light bulb filament will show brittle fractures on ground impact. A light bulb that was illuminated and whose globe breaks at impact will show Tungsten oxides under S.E.M. analysis. A cold light bulb that breaks will not.

Black Light: Certain instruments that have luminous pointers and dials may exhibit a phenomenon known as needle slap on ground impact. The needles hit the face of the dial and some paint is transferred by this slap. An ultraviolet light and a darkroom may make such a needle slap evident even when it was not noticeable to the naked eye. This methodology is old and easily done.

Simulator reconstructions: Flight simulators may be flown through the various possible variations of the accident flight path. Often it is possible for the investigator to eliminate certain maneuvers and hone in on probable sequence of events and flight path possibilities. Simulators that are flown through each maneuver will record all parameters and therefore can be replayed as data. Usage of flight simulators is a valuable tool since it can be done quickly and cheaply. Most importantly, it can be done safely, something that cannot be said about flight test reconstructions.

When an investigator relies on a flight simulator, he must research the simulators computer to understand whether the simulator actually simulates or only guesses at reactions. Most certified flight simulators simulate throughout the normal flight envelope. In other words, the data in the computer has been derived through actual test flight or it has been derived through representative math modeling and then verified by test flight results. Such is not the case in maneuvers outside the flight envelope. Once a stall is reached, or a spin is entered, it is very possible that the simulator is only programmed with math models or W.A.G.s. Thus if the reconstruction includes flight outside the design envelope, the investigator must ascertain whether the simulator is giving valid data or simply an engineers best guess.

An investigators dilemma ...is hi tech safer? The new gadgetry is beautiful when it works. What is it when it fails? An airplane that automatically lessens workloads and makes the crew member a performance monitor and a computer operator is not without a human factor downside.

Total computerized flight and computer managed auto flight does four bad things and the very reliability of equipment exacerbates the bad. It does one good thing when it is working properly. It flies the airplane better than a pilot can.

The bad results are:

Total auto flight replaces manual skills.

Total auto flight creates boredom.

Total auto flight creates complacency.

Total auto flight reliability creates problems when it fails simply because it is such a rare occasion that the pilot has not practiced for regularly.

The prevailing industry sentiment was since the equipment was reliable the pilot should rely on it. As a result of this new equipment whole cadres of crews were very skilled in operating the system. They didn't do as well operating the aircraft when the computerized functions were taken away or failed.