APPLICATION OF SOLID STATE FLIGHT DATA RECORDERS TO FLIGHT OPERATION ANALYSIS

Dr. Mihály **Tóth** - Béla **Magyari**
Institute of Aviation Technology of the Hungarian Army
H-1855 Budapest, P. O. Box 25, Hungary

Dr. László **Czövek**
Hungarian Army

Gábor **Érseki**, Tibor **Farkas**, Gábor **Lipták**, Tamás **Maróti**, Péter **Márton**
Aviatronic Ltd.
H-1121 Budapest, Konkoly Thege út 29-33, Hungary

Summary

The development of digital data processing made it possible to upgrade the Flight Data Recorders (FDRs) of the aircraft and helicopters used by the Hungarian Army. The original FDRs of the older aircraft and helicopter types (MiG-21, MiG-23, Mi-8, Mi-24) were changed to semiconductor-based ones, and computer programs were developed for the processing of data (the SIROM system).

The TISZA data processing and visualisation system was developed for the magnetic tape FDRs of the Su-22 aircraft.

The TAVASZ system was developed to provide both fast go-no go testing and detailed data analysis for both Su-22 and MiG-29 aircraft.

The ROBAR system was developed as a maintenance aid in the adjustment and verification of autopilots after periodic maintenance.

Introduction

For historical reasons the fighting aircraft of the Hungarian Army (MH) flying troops are of Soviet manufacture, equipped with basic versions of Flight Data Recorders (FDRs):

- The SARP system is used on the MiG-21, MiG-23, Mi-8, Mi-24. It records flight data on photographic film.
- The TESTER is used on the Su-22, and recently on the MiG-29 aircraft. It records flight data on magnetic tape.

It was soon realised that the present systems are inadequate. The processing of the photographic film in the SARP system was a lengthy an cumbersome process. The analogue data were of limited accuracy. The amount of data was inadequate for the full evaluation of aircraft performance.

The data recorded on the TESTER tapes is more comprehensive, but the evaluation of data was still a lengthy and cumbersome process.

With the advances in computer engineering ways and means opened up for upgrading the systems.

The possibilities were:

- Trying to improve the basic units of the system, while leaving the basic architecture intact;
- replacing the whole system.

The process of upgrading was complicated by the fact that it had to be designed to provide continuous availability of the aircraft. As will be shown later, a compromise of the two approaches was made.

The status of the system was reported at the 1992 ICAS congress in Peking (pp. 361-366 of the Proceedings).

1. The SIROM system

A detailed description of the system can be found in the Proceedings mentioned above. Here a very short one will be given.

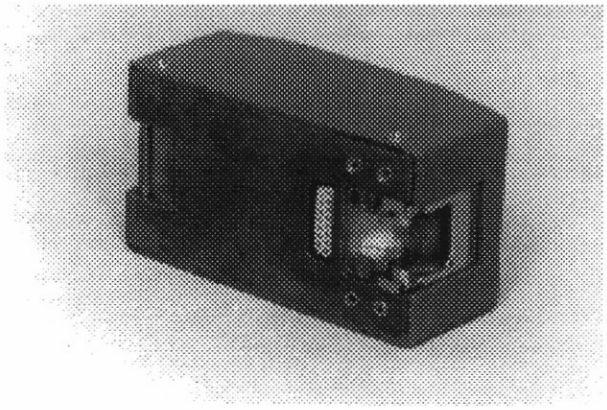
1.2. Data recording

The film data recorder block of the older system (SARP) was replaced by semiconductor FDRs. These size and shape of the recorders is the same as that of the older units, and they are electrically compatible, making a one-to-one replacement possible if necessary. The recorder records data supplied by the analogue and digital transducers built into the aircraft, the latter after analogue/digital conversion. There are versions of the data recorders tailored to specific aircraft types and different performance levels. The recorder block is crash, fire, and water-resistant within specified limits (Pictures 1 and 2). There are versions of the data recorder block with extended recording capability too.

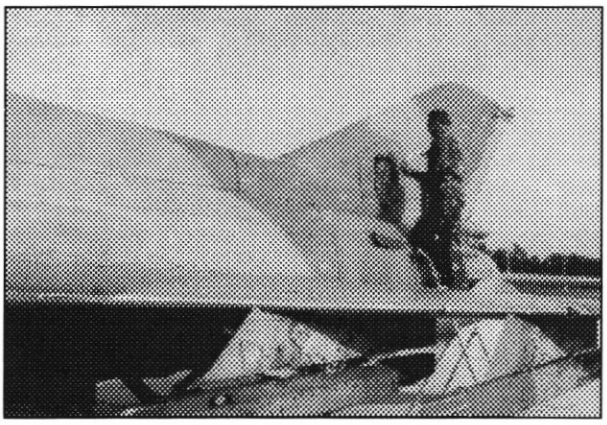
1.2. Data processing

The processing of data is performed in two passes. The first pass is a fast processing to find any irregularities, human mistakes, engineering errors.

The engine run times in different modes of operation are found and recorded. A report is generated containing the date, time and duration of the flight, the name of the pilot, the identifier



Picture 1.
SIROM data block



Picture 2.
Location of the SIROM data recording block

of the exercise performed, the identification number of the aircraft, errors (if any), the maximal and minimal values of important parameters and the engine run times. The data are archived on floppy disks. A full evaluation of data can be performed any time.

The second pass, if necessary, looks up the identification number of the aircraft, reads the calibration data of the transducers of that aircraft

from its data bank and converts the measured values to physical units (speed in km/h, height in m, etc.) for the operator in graphical format.

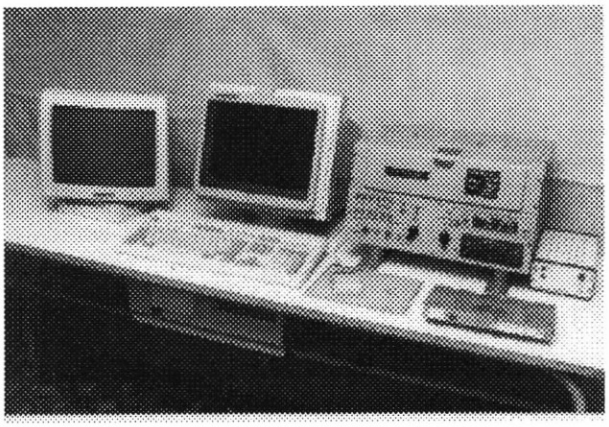
The full evaluation from reading data box to report generation graphic output on the monitor and archiving takes less than one minute.

Picture 3.
Parts of the SIROM system

The SIROM system is a very powerful and up-to-date diagnostic system for data acquisition about the aircraft, the behaviour of the crew. It helps in the training of the crew, increases flight safety. Experience shows that the system works reliably, the accuracy of data is high, and it is easy to learn the operation of the system (Picture 3).

2. The TISZA system

The Su-22 and MiG-29 aircraft in service at the Hungarian Army have an on-board magnetic tape data recorder. It records 33 analogue and 52 digital (two-valued) signals, all in digital form. Neither the tape deck nor the tape itself is removable from the aircraft. In the normal operation of the system a mobile tape recorder with removable tape cartridge is brought to the aircraft after a mission and the contents of the tape in the plane are copied to the mobile tape deck. The tape cassette is taken to the evaluation centre, read by a tape drive, loaded into a PC and analysed by the TISZA (Picture 4).



Picture 4
The TISZA data evaluation system

TAVASZ system

The TAVASZ system uses the on-board tape recorder, but replaces the other parts of the system. Its components are:

- TAVASZ data transfer and rapid evaluation device
- TEMES detailed evaluation system.

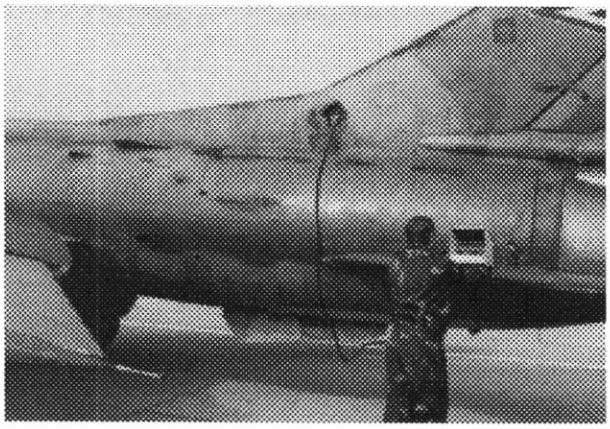
The TAVASZ device

The TAVASZ device is a light mobile one (it can be carried in one hand). It is taken to the aircraft, and connected to it to copy data from the on-board tape deck to its semiconductor memory and perform a fast go-no go test. If the result is go, the aircraft can be refuelled and can take off again (Picture 5.). A detailed evaluation of the flight data is performed by the TEMES system.

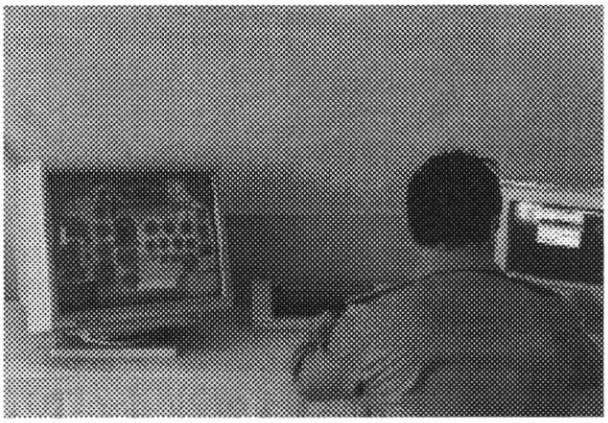
TEMES

The data taken from the TAVASZ device is analysed by a computer with two monitors.

One of them shows the instrument panel of the plane, the throttle, the upper end of the joystick, and an outside view of the plane. The recorded



Picture 5.
The TAVASZ device in use



Picture 6.
The TEMES monitors

flight can be played back; the instruments show the changing values during the flight; the throttle and the joystick move and the outside picture shows the attitude of the plane (Picture 6).

The other monitor shows either the spatial movement of the plane in a perspective view or the values of selected parameters in graphical form as they change during the flight.

The flight data can be played back at normal speed, accelerated or in slow motion, and can be stopped for detailed study.

The application of the TEMES system is easy to learn and use. Playing back the flight on the instrument panel is very convenient for pilots, since they can easily interpret the values shown.

Further advantages of the system:

- It makes the flight preparation easier by shortening the checking time between missions of the same aircraft.
- The mechanical errors occurring during flight are easily shown.

These all contribute to flight safety.

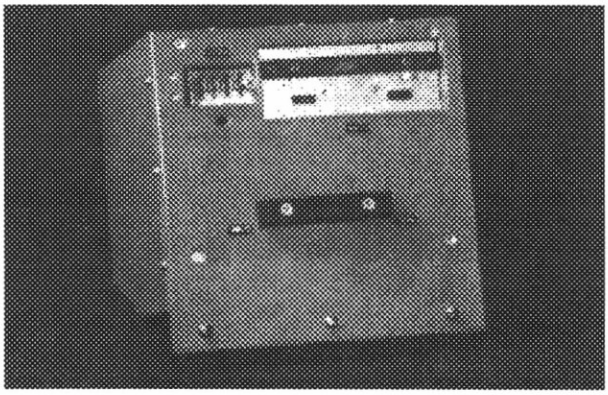
3. The ROBAR system

The SIROM system, mentioned earlier is a general purpose data recording system, it does not record all data required for verification of systems, e.g. the autopilot.

The ROBAR system was developed as an aid in the maintenance of autopilots for MiG-21bis and MiG-23 aircraft, but it can be easily adapted for other types using the same type of autopilot.

After a periodic maintenance or repair the operating parameters of aircraft systems must be adjusted. It is lengthy process, 35-40 interdependent parameters must be adjusted, while the tolerance fields of the individual parameters are very wide. In spite of all the parameters being within their tolerance ranges the system still may not work well in the air. The information given by a pilot after a test flight is often a subjective one. Data recording is required to collect all data necessary for the adjustment and verification of complicated systems such as the autopilot.

The ROBAR system records the operating parameters (16 analogue and 19 two-valued ones) of the autopilot and processes them after flight. The on-board part of the system is made up of transducers, cabling, data recorder and memory cassette.



Picture 6.
The ROBAR data recorder.

The memory cassette can record 63 minutes of flight data. Picture 6 shows the data recorder with the plug-in memory cassette in the upper right corner. The on-board equipment is not built permanently into the plane; it is used only after maintenance or periodic check flights. Building it into the plane takes about 30 min. It is fitted into the ammunition bay and connected to the autopilot (Picture 7). It does not require any modifications of the plane, it is simple to use and reliable in any operating environment.

The ground equipment is made up of the cassette readout, and a PC/AT compatible computer with peripherals, together with the necessary software.

The system dramatically decreases the necessary maintenance time and effort. Archivig the data is fast and reliable.

The experience gained by the system shows that the system fulfils the expectations towards it, increases flight safety. The system is an up-to-date one by world standards for checking both the operation of the pilots and the in-flight errors occurring.

Picture 7.

The ROBAR data recorder in place

Summary, conclusions

All the systems described above are in use by the flying troops of the Hungarian Army.

The data recording and processing systems introduced at the Hungarian Army help to increase flight safety. To use efficiently all the data collected by the systems, further processing and analysis programs have to be developed and used.