Flight Data Gathering for Simulator Development

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Abstract

For the development and qualification of flight simulators, data acquisition on ground and in flight is required. The 11Flight Test Program is defined in accordance with the EASA certification standard of the simulator: CS-FSTD(H) or CS-FSTD(A). Common practice in simulation industry is the procurement of data models with the OEM of the air vehicle. Reiser Simulation and Training GmbH (Reiser ST) decided to perform the data acquisition themselves. For that the RS Flight Systems GmbH (RSFS) – founded out of Reiser ST - has developed an efficient flight data acquisition system that can be easily adapted for integration in a wide range of helicopter types and fixed wing aircraft. In doing so Reiser ST optimizes the way forward of having the best possible result in quality and completeness of the collected data, combined with reasonable investment in helicopter charter. Challenges that come with such projects need innovative and dynamic solutions respecting the major requirements on quality and safety. RS Flight Systems GmbH way forward is presented in the following paper.

Abbreviations

AFLS	Advanced Flight Log System
CS	Certification Standard
EASA	European Aviation Safety Agency
FAA	Federal Aviation Administration
FSTD	Flight Simulation Training Device
FTI	Flight Test Instrumentation
FTPP	Flight Test Program Plan
ICAO	International Civil Aviation Organisation
IMU	Inertial Measurement Unit
NLR	Netherlands Aerospace Centre
OEM	Original Equipment Manufacturer
QTG	Qualification Test Guide
Reiser ST	Reiser Simulation and Training GmbH
RSFS	RS Flight Systems GmbH
SIMD	Specifications for Simulator Data

1 Introduction

The data gathered on the aircraft is partially used as input for flight model development and partially as reference data for simulator qualification. The main focus of a flight data gathering campaign is on collecting data of sufficient quality. Therefore RS Flight Systems GmbH uses a self-developed flight test instrumentation.

2 Approach

As for every kind of flight test a flight test program plan is the leading document that describes the campaign and lists all planned tests. Flight test cards are created combining the information out of the FTPP with operational and safety aspects. Since all tests are conducted within the envelope and the focus is on data gathering the campaign is usually categorized as a low risk level by a Part 21 organisation.

The data is gathered with the use of a flight test instrumentation fitted to the set of parameters needed. Sensors and recorders are installed on the aircraft by a Part 145 organisation. The mechanical and electrical design for the installations is approved by Part 21.

The data gathered during the campaign is evaluated live in flight as well as on ground according to different quality aspects for its suitability and further used for modelling during simulator development and for qualification.

2.1 Flight Test Program

The flight test program is mainly defined by the simulator certification standard. The EASA standards are CS-FSTD(A) [2] for aircraft and CS-FSTD(H) [1] for helicopter. As well as the FAA standard [5] they are developed out of the ICAO standard [4]. The tests are similar to performance and handling quality tests, as they are done during aircraft certification flight testing. Conclusions to the flight tests needed are drawn from the list of simulator test cases.

The flight model development requires a wide range of different test point throughout the flight envelope. Some test cases for complex and non-linear aircraft behaviour are conducted in much more variations than those given by the standard. One example is the hover test case. The Helicopter EASA standard asks for a minimum of four different hover heights [1] but a minimum of ten are needed as input for the model development.

2.2 Flight Test Instrumentation

The flight test instrumentation is adapted to the specific aircraft type and suitable for the planned flight test program.

2.1.1 FTI System Architecture

The Flight Test Instrumentation (FTI) is based on a modular CAN-based system architecture that can be easily adapted to different aircraft types and purposes of flight test. The main components gather the following flight data required for simulator development:

1. Inertial Data
2. GPS
3. Independent Air Data
4. Control Positions & Forces
5. Engine Data
6. Laser Altitude
7. Meteorological data (i.e. wind data)
8. Sound & Vibration Data
9. Video

Fig. 1 shows an example for a basic system architecture as it would be used for a small helicopter flight data gathering. The central unit is the CANFlight as main recorder that is connected to other recorders or interface units with sensors. The system is connected to helicopter power but can be operated with an independent power supply if needed for example during start up and shut down procedure.

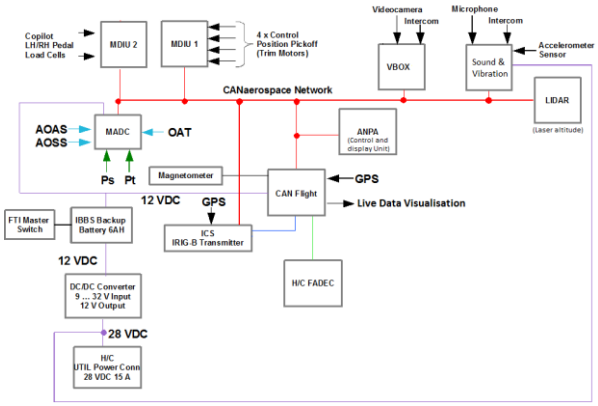

Fig. 1 FTI System Architecture

A core unit host most components of the FTI (see Fig. 2). A control unit allows status tracing and change settings. The unit is relatively small and easy to install in a cabin.

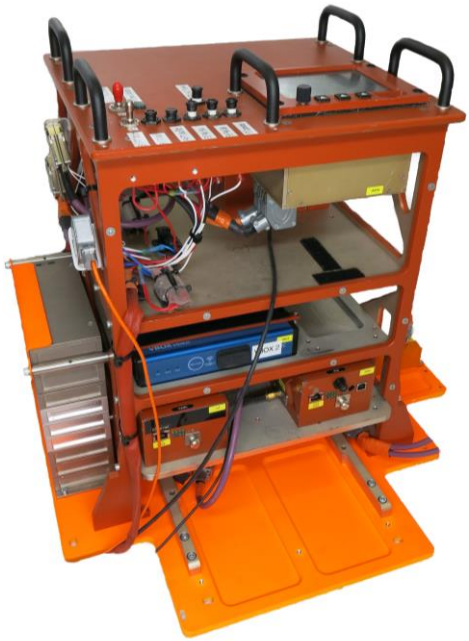

Fig. 2 FTI Core Unit

2.1.2 Sensors Flight Test Instrumentation

The data quality depends mainly on the selected sensors. Generally the sensors are selected by the known or expected parameter results limited for example by the envelope and needs for modelling.

Partially the sensors are self-developed like the Flight Log, which is a pitot-static tube with gimballed mounting that provides independent air data as well as angle of sideslip and angle of attack. Fig. 3 shows an example of a mounting of the flight log (AFLS) on a nose boom. The carbon fibre and metallic ring orients itself towards the air flow. That way the pitot-static tube provides very reliable data without sideslip influence. For the application case on a helicopter the boom needs to be relatively long for not being influenced by the rotor downwash.

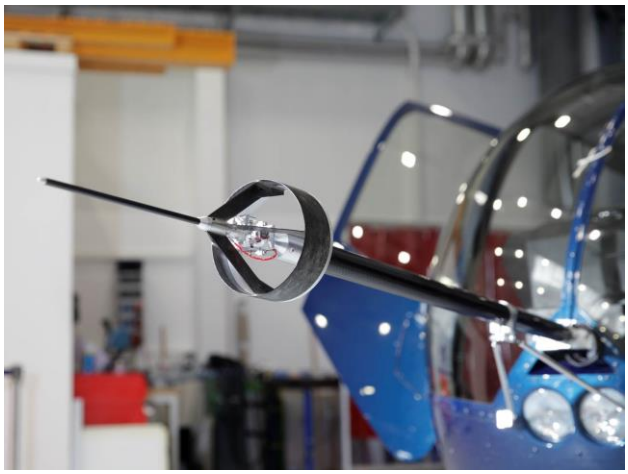

Fig. 3 AFLS mounted on nose boom

Since all sensors have a specific range for application it might be needed to combine different sensors in order to cover the whole range of data required. One example would be the inertial measurement unit (IMU) when it is used on helicopters. Normally the IMU uses GPS information as reference data. For heading information during hover test cases the GPS signal is not sufficient, since there is no forward speed. Instead a magnetometer can be used as reference sensor. Fig. 4 shows an installation sketch of the IMU in helicopter configuration.

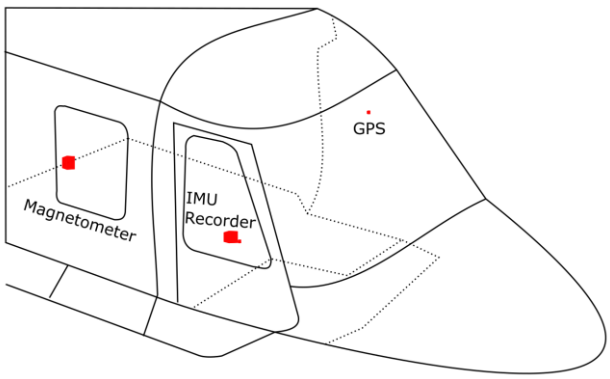

Fig. 4 IMU with reference sensors

2.3 Flight Test Campaign

For the flight test campaign an aircraft in the suitable configuration is equipped with the flight test instrumentation. The flight test team is a group of engineers with a background in the simulation industry and special education in flight testing at the same time. The overall process of the campaign is similar to what is done in flight test campaigns for every purpose. The focus is on data quality though.

2.3.1 Safety during flight test campaign

The flight test campaign is conducted under the flight conditions and permit to fly provided by a Part 21 organisation. Safety for test flights that could be either influenced by the flight test instrumentation installations or the way test points are flown are observed by an independent and approved organisation. The tests points are categorized and according to that for example the crew composition is defined.

2.3.2 Independent evaluation of flight test campaign

The suitability of the flight test data for simulator qualification is evaluated by an independent organisation. The main focus lies on the flight test plan and its compliance to the certification standard. In addition all related processes, related tools or hardware that assure the required data quality are assessed.

EASA published a new certification standard called CS-SIMD [3] that provides regulations for the evaluation of data suitability for simulator certification.

2.4 Data Quality

As well as the general flight test program the quality checks are driven by the requirements of the certification standard and those from modellers.

Quality aspects are the following:

- Resolution of parameters
- Accuracy of parameters
- Meeting the purpose of a tests
- Repeatability
- QTG suitability

3 Results and Discussion

Conducting flight campaigns specifically for simulator development generally increases the suitability of data used for simulator development and qualification. The advantage is that data quality checks as they are required for simulators are done during the campaign and results can be corrected.

The main challenge in such campaigns is the compatibility of the following requirements:

- Safety
- Quality
- Efficiency

While for flight testing during aircraft certification safety is the standalone high requirement, equivalent requirements in flight data gathering campaigns seem to be easier to be fulfilled. Data quality instead is highly focussed during flight data gathering, when again for flight testing the data is an accompanying tool in order to improve safety during a test flight as well as for the certified aircraft in general since they allows a detailed analysis of aircraft behaviour. An increased pressure on efficiency can be observed in flight tests for simulator development which is mainly caused by the percentage the flight tests consume of the project budget for the related product.

4 Lessons Learned

Finding a balance between the requirements on safety, quality and efficiency is surely part of a lessons learned process. It is connected to the classification of the test flights for flight data gathering especially on risk. Nevertheless it is possible to achieve improvement for all three of them at the same time. RS Flight Systems is aiming to develop tools and processes that assure efficiency as well as support in data quality analysis with respect to safety issues.

5 Future Work

RS Flight Systems offers already a wide range of flight tests for different purpose. Adapting to different purposes needs continuous improvement with different focus. The effort may also pay back for different projects.

6 Conclusions

Flight data gathering as it is done at RS Flight Systems uses a reliable and suitable flight test instrumentation. Tools and processes fit to the purpose of flight and are improved continuously with special focus on safety, quality and efficiency in preparation as well as in conduction of flight campaigns. The approach of gathering flight data for simulator development in dedicated campaigns instead of reusing a data package recorded during aircraft certification flight tests improves model development and improves the quality of reference data for simulator qualification.

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References

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Author/Speaker Biographies

As a M.Sc. aeronautic engineer **Regine Pattermann** is Head of Flight Test at RS Flight Systems GmbH and Reiser Simulation and Training GmbH. With participating and leading flight test campaigns for different types and purpose, she contributes a wide range of experience especially in data gathering for simulation purpose.