SFTE Exchange Report

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1. Introduction

During October and November of 2007 Andrea Marey from Military Air System (Manching, Germany) and Alexandre Buisson from Airbus (Toulouse, France) took part in the SFTE exchange programme. This short report provides some details of the exchange and gives an overview of any lessons learnt by both parties. Andrea works as a system engineer in flight test for the Tornado Defensive Aids Subsystem and Alexandre works on the test means development and maintenance for all Airbus programs.

1.1 Aim

The main goal of this exchange was to get an overview of flight and ground test activities on the respective test organizations at Airbus and Military Air Systems.
The general organization of the two test centre was presented as well as the different test levels (Integration Bench, Simulators, test aircrafts) and the test means associated to each level.
Both attendees could participate in a test flight during the exchange. They were able to attend to briefing and debriefing and monitor the actual flight in the telemetry.
The design and development of the flight test installation (FTI) could be studied thoroughly and the installation on the aircraft was visited as well.
During the training course, Andrea and Alexandre were immersed in the daily work, in order to understand the ways of working and to experience first hand the different working environments.
The exchange was a good opportunity to discover new methods of work, particularly the differences in the processes which are due to different sizes of the companies. It was possible to gain new and additional experiences in the field of flight testing and to see the different ways of working in military and civil flight testing.

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3. Exchange Discussion

3.1 General Organisation

Broadly speaking, the main differences we can notice between the general organisation of Airbus France (AI) and EADS Military Air System (MAS) are due to the size of the two companies and the difference between civil and military industries.

First, the main consequence of the difference of size is that all the services are more dedicated to a specific task in AI. Moreover, most of the tool developments (rigs, analysis software) are subcontracted in AI while these activities are still carried out in-house in MAS.

Then, the development time of civil A/C is far shorter (for example only 3 years between A380 and A400M), whereas for military A/C, weapons and sensors integration last for many years after the A/C development (the first flight of the Eurofighter was in 1994). Military constraints are also harder in terms of confidentiality and security, as shown by the frequent limited access in the site of MAS.

Concerning the customer relationship, the differences are also significant. In Manching, the German Air Force not only takes part in the flight test activities, but also in rig testing (they have their own facilities at MAS). At AI, customers are only involved in cabin design. Customers are more and more involved in the preliminary specifications of the aircraft, mainly on HMI/Cockpit aspects but also on operational aspects such as maintenance.

Regarding the international aspects, both companies are part of a complex international work sharing. For the Eurofighter, each partner has its own Final Assembly Line in order to manufacture the A/C for its own customer, while in AI we find only one FAL for each programme.

3.2 Exchange Timetables

First Week	Monday, 15th	• Registration • Introduction to the service • Overview of the Manching plant
	Tuesday, 16th	• Participation of Tornado flight test • Analysis process
	Wednesday, 17th	• Flight test ground station • Quicklook rooms • Onboard data acquisition systems
	Thursday, 18th	• Flight test instrumentation
	Friday, 19th	• Participation of Eurofighter flight test
Second Week	Monday, 22nd	• Presentation of Eurofighter flight test programs • Visit of Eurofighter simulator
	Tuesday, 23rd	• Presentation of system engineering department • Flight test planning process
	Wednesday,24th	• Flight dynamics, handling • Structures, general systems
	Thursday, 25th	• Flight test safety • Series production/ MRO-activities/ -avionic • Visit of the Messerschmitt museum • Virtual flight test project
	Friday, 26th	• Integration facilities and test systems • Eurofighter AVS Integration facilities/Operation • Summary of visit

Table 1. Alexandre's activities at MAS flight test

During the exchange a very interesting and varied programme was realized at both sites. Both participants were able to follow a flight in the telemetry room and get a good overview of the working

environment in general. The different departments and levels of flight test were presented by the respective members of staff. Rig installations as well as test aircrafts could be visited and the maintenance departments like flight test instrumentation or ground station were also covered.

First Week	Monday, 5th	• Registration • Introduction to the service • Overview of the service activity • Conference with Fedex Airlines
	Tuesday, 6th	• Visit of Iron Bird A400M • Visit and presentation of the Telemetry Room
	Wednesday, 7th	• Flight Test of A380 (briefing/telemetry/debriefing) • Presentation of data processing activities
	Thursday, 8th	• Visit of the A380 Development Aircraft • Visit of the EDIB (Electrical Distribution and Integration Bench)
	Friday, 9th	• Visit of the A340 Final Assembly Line • Presentation of A380 Simulator • Visit of the A380 Final Assembly Line
Second Week	Monday, 12th	• Visit of FTI Integration room • Visit of Iron Bird A380 • Presentation of ground processing tools
	Tuesday, 13th	• Presentation of FTI Architecture • Presentation of Flight Test Data Analysis
	Wednesday,14th	• Meeting with presentation of the high speed data link • Presentation of Flight Test activities on A/C Structure
	Thursday, 15th	• Presentation of the A/C –1 • Presentation of Flight Test Engineer Stations • Presentation of FT on Handling Qualities
	Friday, 16th	• Meeting with a Flight Test Engineer • Summary of visit

Table 2. Andrea's activities at AI flight test

3.3 Departmental Organisation

Test activities in MAS are made in OPEF domain, which represents about 350 people whereas the Test Centre in AI (EV) represents 1100 people. Actually, these two domains don't have exactly the same responsibilities, so we can't really compare these figures.
At MAS, the test centre is divided in three main departments: OPEF1 (Integration Facilities and Test Systems), OPEF2 (Test Engineering) and OPEF3 (Flight Operations/Flight Test Operations).
At AI the organisation has just changed before the exchange. Before this change, Flight Test Operations (EVC, EVT and EVR: Pilots and Flight Test Engineers) was not in the same organisation as the other test activities (EYT). Since the latest reorganization, all these departments have been grouped in the same entity, and the two main departments of EYT (EYTM and EYTX) have become EVX (Test Analysis), EVI (Test Instrumentation) and EVM (Test Means).

For both organisations, the Test Centre not only includes Flight Test operating and analysis, but also ground test facilities development. The main difference concerns rig testing activities: at AI they are under the responsibility of people in charge of Flight Test analysis (EVX), whereas at MAS they are made by people in charge of the system design (OPEM). That is the reason why all ground test facilities at MAS were in Ottobrun for many years, about 100 km from the flight test centre and have just been moved recently to Manching to allow a better cooperation between flight and ground testers.

3.4 Ground test on RIG

Both test centres also include rig testing in order to provide integration at system level on specific benches dedicated to one system (System Integration Bench) and integration between several systems on a general rig with all A/C Systems (Simulator).
At both companies, each rig is equipped with a generic tool, which provides the S/W part and the graphical user interface (GUI) to the tester. This generic tool is called AIDASS at MAS, and it's not only used on SIB, but also on the Final Assembly Line and for unitary test (done by the supplier). At AI, there is a first tool used for A380 and A400M programmes (Generic SIB), and a second one for Single Aisle and Long Range programmes (SYGAM). The latter is based on AIDASS system, with a specific GUI according to AI needs.
In both organisations Rig development and maintenance is part of the Test centre activities (OPEF1 at MAS and EVM at AI). These departments are in charge of test facilities specification, taking into account requirements from system designers (and also from customers at MAS), and they are also responsible for the validation of the rig. There are 230 people in OPEF1 at MAS, and 400 people in EVM at AI. These figures show that the part of OPEF1 is more important in MAS Test Centre that the part of EVM in AI Test Centre. This can be explained by the differences in the rig development process and in the test performing.

3.4.1 Development

The main difference in rig development is that most of the rig is made within company at MAS, whereas many parts are subcontracted at AI. For example, this is the case for the generic part of the rigs: AIDASS has been developed by MAS (some electronic boards are supplied by CES), whereas Generic SIB is provided by an external supplier (ISIS MPP).
On the general rig (where all the real systems are tested), the architecture is different: at AI, there is a Generic SIB for all data acquisition and visualisation, and all the simulation (environment, aerodynamics, simulated systems…) is made by a specific simulation host, connected with the rig by an electronic interface, which convert simulation parameters into avionic data (ARINC, AFDX, Analog…). This simulation part is provided by EYY, the electronic department of AI (which doesn't belong to the test centre).
At MAS, the simulation part is also realized by OPEF1: all the models are running directly on AIDASS CPU, so AIDASS is not only the data acquisition system, but also the simulation host and the electronic interface.
Concerning data recording, MAS plans to use FTI recorders for rig testing. This has been done at AI for all programmes until A380, but for the A400M programme, a specific storage function has been developed on the Generic SIB to fulfil storage needs.
On the System Integration Bench (rig dedicated to a specific sub-system), models are also used for simulation in both companies, but there is the same difference: models are running on AIDASS at MAS, whereas there are running on an external host at AI (but in this case, the Generic SIB is the electronic interface between the simulation and the equipments under test). The integration and validation of the simulation is under the responsibility of OPEF1 at MAS, and of EYY at AI.

3.4.2 Performing tests

Generally speaking, the responsibilities of people in OPEF1 are wider than those of EVM: in addition to the rig development and maintenance, OPEF1 is also in charge of rig configuration for SIB, which is not the case at AI (this is done by people of EVX). This activity mainly includes database upgrades (loading of the right ICD version) and configuration management of the system under test. The consequence of this organisation is that tests have to be prepared with more accuracy at MAS, because no change of ICD is possible during tests.
On the global rig, rig configuration is made by OPEF1 at MAS and by EVM at AI. At MAS, a specific tool called TRAC is used to manage test facilities shared between several rigs (for example the cockpit or cabinets with real equipment). This tool enables the user to make a request for test facilities reservation (with specific needs), and the tool answers if the test means is available.
At both companies, on the global rig, there is the possibility to choose for each system if it's simulated for the test or if the rig is connected to the real equipment. At AI, this configuration possibility is manual: people from EVM put the real computer in the dedicated cabinet, or plug in a connector linked to the simulation host, where the associated model is running. At MAS, all this commutation is automatic: real computers are installed in cabinets called modules, which can be connected to any of the rigs. As it can be considered as a shared test mean, it can be managed by TRAC. After the request for connecting a module to a rig, all the commutations are automatic.
The last important difference that has been noticed concerns the possibility of Virtual Flight on the rig: at AI, critical flight test are prepared on the rig by pilots by using the whole A/C configuration (all real

computers) and the Iron Bird coupling. This aspect is very important for flight test safety, particularly before first flight. At MAS, no virtual flight is done on the rig, because MAS isn't responsible for all system integration (only integration at sub-system level). In the Eurofighter work sharing, this task is under BAE's responsibility.

3.5 Flight test

Several different departments connected to the flight test were visited during the exchange. More or less the whole chain from flight test instrumentation at the beginning, over the telemetry installations used during the flight, up to the post flight analysis done by the system engineers was covered. Several interesting differences in the work descriptions of several people (e.g. the flight test engineer) as well as a lot of similarities in both organizations were detected.

3.5.1 Flight test instrumentation (FTI)

This field is a good example of the more specific department structure at Airbus. There exist several departments which are responsible for the FTI in a test aircraft, one is dedicated to the design of the system for future aircrafts, another is responsible for the installation while a third is working on the verification of the sensors and systems. At MAS on the other hand there is one department responsible for the sensor side of the instrumentation from the design to the verification and maintenance phase.
Another interesting difference clearly seen is simply due to the size of the aircrafts. At military aircrafts real equipment – mainly armament equipment – has to be removed in order to put in FTI equipment, furthermore there is also the possibility to install an external pod under the aircraft. In civil aircrafts, especially in the A380 which we were able to visit thoroughly, there is more than enough space to install several recorders, work station to do a pre-analysis during the flight and even a working place for the flight test engineer, the so called CUB.
In an A380 up to 6000 measurements with more than 260 000 parameters are made during a test flight. The communication between the different FTI-equipments is done via an ethernet network with data rates of 40 to 80 Mb/s.
Nevertheless for specific needs similar equipment is used in AI and in MAS, e.g. Heim digital recorders are used in both companies as FTI-recorder or the ACRA system is used for data acquisition. However at AI only analogue signals are handled by the ACRA system while at MAS all kind of signals are processed.
One further specialty at AI is the so called METRO. Here the cabin parts of the FTI, i.e. everything besides the actual sensors and their wiring, is constructed outside the aircraft and validated and verified before installing it in the test aircraft.

3.5.2 Telemetry

As already pointed out at AI a flight test engineer workspace (CUB) is installed on the aircraft. Therefore he can conduct the test from the aircraft. Since this possibility does not exist in military fighter aircrafts, there always had to be a possibility to conduct tests from ground. Therefore the use of the telemetry is much more common at MAS.
At AI the telemetry is only used more recently. The goal here is to reduce the analysis time for the system specialist who can act on the one hand as support of the flight test engineer on the aircraft and on the other hand the system engineer can see problems and events right when they happen and can afterwards easily focus his analysis on this time slices.
The telemetry data is transmitted with a data rate of 5 Mb/s to the ground. Since this rate does not cover all the recorded data, a selection of several parameters for the telemetry has to be made. However this selected list can be changed during the flight if another parameter is necessary for a real time analysis. On three different locations alongside the French western coast a telemetry antenna is installed so quite a wide coverage can be reached for test flights (there is a total of six antennae).
At MAS the flight test engineer conducting the flight is on ground in the telemetry room together with the responsible system engineers. Due to this fact a lot more conversation between aircraft and ground happen. The system engineers at MAS have the same tasks as at AI. They support the flight test engineer if necessary and they can get a first impression of their test and the problems to be analyzed.
Specific parameters have to be selected at MAS as well since a transmission of all recorded data is not possible with a data rate of 500 kbit per sec. Three telemetry antennas are installed at Manching so three different aircrafts can be measured at the same time with a coverage of approx 200 km. No fix outer locations of antennas exist, however there is the possibility to use a portable telemetry system

for campaigns and transmit the data from this portable ground station via a telephone line to the telemetry rooms in Manching.
Quite similar tools for display generation in the telemetry room are used at AI and MAS. Both provide a graphical tool box which incorporates numerical displays, gauges, xy-plots, etc to which the user can assign specific parameters to get an overview of his system.

An interesting opportunity presented itself during this exchange since AI showed some interest in a research study on a wide band data link which was conducted by MAS last year. A short presentation on this project along with a very interesting discussion was realized during Andrea's stay at Toulouse.

3.5.3 Flight test

Task of flight test engineer and system engineer
In both organizations the flight test engineer is responsible for conducting a flight test, organization and lead of a briefing.
At AI the flight test engineer is a lot more involved in the actual system tests since he is the one on the aircraft and gets the first impression of a test. Therefore each engineer is specialised on a specific system and responsible for these tests. He writes a log document during the flight about the system under test with his comments about results and problems. This handwritten log is put online after the flight test to provide the system specialists with details of the test apart from their own impression in the telemetry.
At MAS the flight test engineer is not so involved in the actual system tests since the system engineers get the same information he has available in the telemetry. The responsibility of the flight test engineer is more centred on an aircraft type. He is responsible for the configuration control and flight security of each flight.

Flight test program and flight cards
The flight test program (FTP) defining the flight test for a specific system test is written by the flight system engineers at MAS, at AI the tests are defined by the design office. The general composition of the program is similar at both companies. In general the different test points are described rather generally whereas the exact manoeuvres etc. are defined in a flight card for each flight. At AI these flight cards are written by the flight test engineer whereas at MAS the system engineer takes a more active part and define their own runs, whereas the flight test engineer is responsible for the general restrictions of the flight.

Ground tests on aircraft
The ground tests on the aircraft are performed at MAS by the same system engineers who are responsible for test flights of their system. They are mostly performed before and / or after a flight to ensure the operation of a system.
At AI a specific service (MAP mise-au-point) performs the ground test on the aircraft and is more related to the design office directly than to the flight system engineers.

3.5.4 Post flight analysis

In both organizations the system engineer makes the post flight analysis. There exist several general tools to facilitate the analysis process (e.g. graphical displays, generation of tables,...) which are provided by the ground station and data processing departments. While there is a specific department at AI which is solely responsible for the development of analysis software defined by the needs of the system engineer, at MAS this task is done by the team of the flight test ground station which are also responsible for the telemetry and the whole data acquisition process.
It is more common at MAS that only one or two engineers are responsible for a specific analysis – also due to the overall size of the flight test department. Therefore it is more accepted, that the system engineers themselves develop small analysis software rather than writing a specification of that program for the specialised software programmers. This is only done for more general tools which could be used by more engineers.
At both organizations the system engineers focus their analysis first on problems they have already seen during the flight. They can write problem reports for the design office, if they encounter a problem which needs to be clarified. Moreover at AI the flight test engineer himself has the opportunity to write a problem report if he sees a problem during the flight. This report is first handled by the system engineer and then – if needed – transformed into a problem report for the design office. At AI all information about the analysis are sent to the design office which writes the flight test report after completion of a flight test program. At MAS this reports are written by the system engineers themselves and then sent to the design office.

4. Conclusions

The aims and expectations as presented in chapter 1 have been more than fulfilled. The exchange was a perfect chance to gain new and additional experiences in the field of flight testing and a very interesting opportunity to share knowledge and skills in the flight test domain.

The comparison of the two different flight test organizations, their differences and similarities were presented in detail in this report. However in principal the two organizations are very comparable to each other. In general the challenges of flight testing are the same and only the approach to the duties differ slightly due to external reasons like the size of the company and the different expectations of civil or military customers.

Several times during this exchange we learned something new about our own flight test organization since the presentation of the different departments due to the exchange programme also gave a deeper insight into the work of the other departments in our own working environment. Furthermore by getting to know the partner company we asked ourselves questions about the realization in our own departments and working field. A great deal of discussion took place during and also after this exchange - not only between the candidates but also with all those associated with the exchange. Such discussions and suggestions can lead to a more effective work in many ways.

In general the exchange gave a great possibility to gain new experiences, motivation and suggestions for our own work. This programme enabled us to compare technologies, methods and techniques to those used by ourselves.

Taking part in this exchange programme provided a future benefit for the personal and professional experience as well as a truly valuable benefit for the two companies. More than just improving the professional skills this exchange programme was a very enriching human experience and an opportunity to discover new methods and processes from another country.

Both exchange candidates are thankful for the opportunity to take part in this programme and would like to thank SFTE, Military Air Systems, Airbus France and all people involved in this exchange. We can both recommend this opportunity without any reservations to others as it was a truly enriching experience.