

SFTE Exchange Report

Madeleine Schmidt – Saab Aerosystems
Jamie Wright – BAE Systems

2005

Remark. The views expressed below are those of the two exchange participants and conveys impressions they have got and information they have received from people in the organisation they have visited. It does not necessarily give a complete or absolutely correct picture or coincide with the views of the management in the two organisations.

1 Introduction

During January and February of 2005 Madeleine Schmidt from Saab Aerosystems (Linköping, Sweden) and Jamie Wright from BAE Systems (Warton, England) 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. Madeleine works as a flight test engineer (rig-, ground- and flight tests) for the fuel system in the Gripen aircraft. Jamie works at the Operations and Planning Section for the Nimrod.

1.1 Aim

During the initial application and planning phase a number of personal aspirations were identified for the exchange by both applicants, the achievement of which being the main aim of the exchange. These aspirations included gaining knowledge of the following:

- Processes used to create test specifications and how these are turned into test schedules.
- Short, medium and long term planning within Flight Test Engineering.
- Communication and interaction between Flight Test Engineers and Test Pilots before, during and after test flights.
- Processes by which safety of a test is handled.
- Level of integration and liaison between Flight Test Engineering and the design departments.
- Flight Test Instrumentation systems available for use during flight and for post flight data analysis.
- Types of Ground Test Verification and simulations performed prior to flight.

In addition to these ‘knowledge’ based aspirations both candidates expressed an interest in ‘softer’ aspects such as the networking opportunities and learning about the different cultures that exist in the two companies.

2 Table of Contents

1	Introduction	1
1.1	Aim	1
2	Table of Contents	2
3	Exchange Discussion.....	3
3.1	General Organisation	3
3.2	Exchange Timetables	3
3.3	Departmental Organisation	6
3.4	Flight Test Responsibilities.....	6
3.5	Daily Programme Planning.....	7
3.6	Long Term Planning	8
3.7	Activity Briefing and Test Schedules	8
3.8	Pre-Flight Predictions	9
3.9	Pre-Flight Safety Reviews	10
3.10	Use of Telemetry (TM).....	10
4	Conclusions	11

3 Exchange Discussion

3.1 General Organisation

Upon entering the office of the exchange company the differences are immediately obvious – BAE Systems has large open plan offices that appear loud to someone not used to it, whereas Saab's Flight Test and Verification department has small 1-2 person offices which are quiet and personal. Each approach has its own advantages and disadvantages and drives the culture within the work place.

At Saab coffee breaks are held at roughly the same time daily and provide an informal occasion for the teams to get together and discuss work and social activities. This is not the case at BAE, where the open plan system makes it easier for everyone to stay up to date with the day-to-day occurrences within the office.

During initial introductions and discussions the scope of the work carried out by the two Flight Test departments was seen to differ. Saab's department is called 'Flight Test and Verification' and the responsibility of the team takes into account all of the ground and rig testing, as well as flight testing; meaning that flight test is only a part of their work. At BAE the Flight Test team are only rarely involved in rig testing and the responsibility for testing generally only begins with Engine Ground Running, Taxi and then Flight. This is another difference that has far reaching consequences on the processes and culture within the companies.

The flight test engineer's at Saab therefore often have a 'deeper' knowledge in the different aircraft systems and also a greater ability and possibility to affect the software development etc., since they are involved in most of the steps in the testing. On the other hand, the flight test engineers at BAE, in general have a more 'wide' knowledge about the entire aircraft, which probably isn't that common at Saab Flight Test.

3.2 Exchange Timetables

This difference in the scope of work lead to two very different and varied programmes of activities being produced for the exchange visit. The BAE programme, shown in Table 1, involved only a brief look at the rigs available to the projects whereas at Saab, shown in Table 2, the programme reflected the bias of the work towards rig and ground testing.

At BAE Jamie was available to take part in most of the activities and give context to the work that Madeleine was being introduced to. Unfortunately it was impossible for Madeleine to participate in the different activities at Saab, due to work priorities, and the majority of activities and presentations were carried out by people who were responsible for each aspect of the programme and were therefore very experienced within that area. This resulted in a situation whereby Madeleine was unaware of exactly what Jamie had been told and how detailed the presentations were. This was of course not a good solution and should be avoided in future exchanges.

Table 1. Madeleine's activities at BAE Flight Test

Monday	Tuesday	Wednesday	Thursday	Friday
	Check in Welcome and Intro.	Demonstration of Nimrod (PA1)	Test Cards and Briefing	Air Traffic Control and the Airfield
	BAE and Flight Test overall presentation	Quick-look into Telemetry Room and RTAS	Participation during flight test with Nimrod.	Testing in the Flight Deck Assessment Rig (Nimrod)
	Flight Deck Assessment Rig (Nimrod)	Introduction to Post Flight Analysis (ISIS)	FTMS (s/w tool for Test Cards)	Checklists for pilots (and others)
		Demonstration of Nimrod (PA2)		
		Mini Fuel Rig for s/w testing		
		Pathfinder (planning program)		
		<i>Dinner with some people from the office</i>		
Monday	Tuesday	Wednesday	Thursday	Friday
Debriefing (Flight Test Hot Debrief Report and Flight Report)	The Fuel System in Typhoon	Telemetry Ground Station	Visit to Woodford (about 60 miles from Warton). Production Hangar for the Nimrod a/c.	Avionic System Test Rig (Nimrod)
Typhoon Simulator	"Spin Table" (practice for personnel before Spin Flight Tests)	Flight Trials Concept Review and Flight Safety Review		Hydraulic Rig for Nimrod, 'The Iron Bird'
Post Flight Analysis (ISIS)	Hangar Tour Typhoon	Flight Test Instrumentation. Installation and Maintenance Section.		Summary of the visit.
Brief Hangar Tour (Harrier, Tornado, Typhoon)	Flight Test Instrumentation			Farewell dinner at an English Pub.
Briefing and participation during flight test with Typhoon		<i>Dinner at an Indian restaurant with some people from the office</i>		

RTAS = Real Time Analysis
 ISIS = Interactive Secondary Analysis
 FTMS = Flight Trials Management System

Table 2. Jamie's activities at Saab Flight Test

Monday	Tuesday	Wednesday	Thursday	Friday
Check in Security info. Welcome and Intro.	Fuel System Rig Testing	Hydraulic Rig Testing	Test Plans	Post Flight Analysis and Data-handling (Probotools)
Presentation of the General Systems Department	UAV info. and demonstration	The Director of Flight Test & Verification	Secondary Power System Testing (Rig)	SYSIM (System Simulator Gripen)
Ground Test Fuel System (in a/c)		The Flight Test Process at Saab		
Saab and Flight Test overall presentation		Measuring System in a/c (Comet) and telemetry room (VU-soft)		
	<i>Dinner together with some people from the office</i>	Test conducting and Test Cards. Briefing /Debriefing		<i>Participation in afternoon training together with the General Systems Department (Badminton)</i>
Monday	Tuesday	Wednesday	Thursday	Friday
KURT (s/w tool for Test Cards)	Hangar Tour. Test a/c and aviation maintenance	Environmental testing, Flutter etc	Delivery and modification Hangar (run-up and delivery flights)	Participation during flight test with Gripen.
Final Assembly Gripen	Operative Planning and Flight Operation Centre	ECS Rig Testing	Flight Dynamics Simulator	Farewell Party with cake and Saab gifts
Flight Test Management. Planning and Scheduling		Simulation Tests in SYSIM	Air Force Museum	
Gripen a/c demonstration				
Flight Dynamics		<i>"Curling evening" together with General Systems Department</i>		

SYSIM = System Simulator
 ECS = Environmental Control System

3.3 Departmental Organisation

The structure of the Flight Test teams is broadly similar, with each containing General Systems, Handling and Performance, Avionics and Mission Systems sections. At BAE an additional 'Operations and Planning' section exists, this is discussed in detail in a later section. Within Saab Flight Test there is also an 'Instrumentation and Software Systems' section which is responsible for the measuring systems in the aircraft and also the data processing before, during and after the flight tests. The equivalent department at BAE Systems is the Flight Test Instrumentation section, a separate department within the Engineering organisation. Flight Test then acts as an internal customer, buying the required equipment and capability.

The management structure of the two organisations differ. At Saab, Aviation Maintenance, Flight Test Operations and Flight Test Management are all parts of the Flight Test and Verification department and together with the individual Flight Test Disciplines, (General Systems, Avionics etc.) they are managed by the Director of Flight Test and Verification. At BAE, Flight Test Engineering is a part of the Engineering Discipline and separated from Flight Operations. Despite this fundamental organisational difference, there were no times when this was seen to alter the processes used or testing that took place during the period of the exchange.

3.4 Flight Test Responsibilities

At Saab Flight Test, troubleshooting of aircraft failures is handled within the department (for the test aircrafts). The flight test engineers are responsible for interpreting failure codes and analysing different failure cases. This is performed with support from the Engineering Department. At BAE the 'failure reports' are generally handled by the appropriate Design Authority.

At BAE Flight Test, the Test Conductor, (the connection between the telemetry room and the pilot during test activities), is called 'Boffin'. The Boffin has the role of an 'Operations and Planning Engineer' and is therefore also responsible for the planning, co-ordination, management and day-to-day safe conduct of the aircraft Flight Test programme. The Operations Engineers are located in the same building and forms one section within BAE Flight Test ('Operations and Planning'). The Operations Engineer also writes the test cards (test schedules), and is responsible for briefing the relevant restrictions that concern the test. The 'Operations Engineers' are supported by 'Specialist Engineers', who write the flight test plans and flight test reports. The 'Specialist Engineers' also participate in the telemetry room during flight tests.

At Saab the Test Engineers (for different aircraft systems) are responsible for the planning, the test cards and the restrictions, for their 'own' flight test. For each test task there is a 'Test Task Manager' (a Flight Test Engineer) who is responsible for the test task, from the verification tests in rigs, simulators and at ground test, but also for the flight test. The 'Test Task Manager' is also responsible for ensuring that the test plans and test reports are issued.

The Test Task Manager decides, with support from the other personnel involved, the content of each flight test; therefore there is no corresponding 'Operations Engineer' at Saab. The Test Conductors at Saab are not located in the same building and belong to different sections within the Flight Test department. The Test Conductors are not necessarily tied to one specific Test Task, but it is often easier to have the same Test Conductor for all flights within the same Test Task. The Test Conductors perform the Briefing and Debriefing together with the test leader for the flight test. The test leader is often the Test Task Manager for the specific test task.

3.5 Daily Programme Planning

At Saab Flight Test the day-to-day planning is handled and presented by a software tool that is accessible to all people involved in Flight Test. All the activities planned for each day are listed for each aircraft. For example; briefing time, start of flight test, flight test type, telemetry room, chase aircraft, test pilot, test conductor and also planned maintenance activities and failures on the aircraft, are listed. This plan is continuously updated during the day and the test engineers also get the latest information sent to their mobile phones.

At BAE the plan is created using Pathfinder and contains less information due to its more rigid structure. Pathfinder includes information on the status of the aircraft such as the time 'Shops' are promising it to be available, and the planned briefing time. Pathfinder is used for more than just displaying the daily aircraft plan, it is used to log crew hours for their log books, charge for airfield usage and also as a diary for the aircrew.

Due to the rigid nature of Pathfinder a lot of this information is instead communicated by the aircraft 'Runner' loudly announcing it to the office. This way of communicating the latest information would not work at Saab, since the test engineers are located in different buildings or could perhaps be performing a rig or simulator test. It appears that the two methods have been developed based on the way that the flight test departments are organised.

At Saab there is also a planner for each test aircraft, who plans all the activities for 'his aircraft'. The aircraft planners create programmes for each test aircraft and they are updated continuously. Each week a planning meeting is held with pilots, flight test engineers, personnel from aircraft maintenance, flight test instrumentation and flight test management etc., to plan the activities for each aircraft for the next week, but also for the coming 2-3 weeks.

3.6 Long Term Planning

At Saab Flight Test the long term planning is summarized in an overview schedule, which at least is updated once every six months. In this schedule all planned flight trials (and time-consuming ground tests) are listed per test aircraft and per month. This plan covers the planned flight trials for about 1-2 years.

At a daylong conference personnel from the involved departments meet and put together this rather complex schedule. A lot of requirements, desires and dependences from different flight test teams (test tasks), shall be combined with aircraft software editions, workshop maintenance, hardware accessibility, project milestones etc. A lot of planning work is also done in the Flight Test Organisation before this conference, to be able to provide all the necessary information for this planning meeting. The main purpose is to get an even allocation per aircraft over the year, but also to get an overview of all the planned flight trials.

This schedule is then, among other things, used to follow-up how the work progress during the year. The long time schedule is used as an overview plan, but the flight test management and the weekly planning meeting, described earlier, decides the final short term plan per aircraft. Accordingly also the flight test engineers (Test Task Managers) have a great possibility to influence the planning process.

The long term planning within the Nimrod programme is carried out in a broadly similar way to that at Saab. The issues that drive the content and ordering of the programme are the same. Within Nimrod a formal agreed programme is issued approximately every 6 months, however, a working copy is kept updated with changes being made whenever they are necessary.

3.7 Activity Briefing and Test Schedules

Prior to any activity, both organisations carry out a pre-activity briefing to give an opportunity for all those involved in the testing to look through the planned activity and allow for comments to be made prior to the activity taking place. In both flight test departments this may often be the first opportunity for the crew to review the schedule in full, although every effort is made to present draft schedules to the crew prior to briefings.

During the briefing at BAE a 'briefing witness' is present, whose task is to ensure that a satisfactory briefing is completed; this includes reviewing a check list with a number of questions and discussion points, such as 'Is the purpose of the test understood', 'Has testing to limitations been discussed'. The 'briefing witness' isn't involved in the days testing and following the briefing he signs the checklist along with the captain. At Saab Flight Test there is no such process and briefings are generally a much more informal process than they are at BAE. This also applies to the production of schedules. A standard schedule at BAE contains a lot of information that can result in it being a relatively large document including a review of the pertinent limitations, aircraft loading information, take-off figures and special notes for the aircraft. The equivalent Saab document is much smaller leaving the focus on the aircrew to be aware of limitations and other aspects of the aircraft. Only particular restrictions which are valid for the present flight trial and special remarks are noted in the schedule.

The BAE schedule also completes a review process prior to being presented to the brief. The schedule is signed by the FTE who writes it, then it is reviewed and authorised by a senior member of the Flight Test team. During the brief any amendments made are annotated into the original schedule which is then signed as 'Accepted' by the Captain. This copy is then filed. At Saab the flight test plan, which is a reference in the test schedule, is the valid document, and is signed by a number of people with different authorities. Only deviations from the valid flight test plan are approved by the Flight Operations Manager, by signing the test schedule. Otherwise the schedule is not signed before flight (only reviewed/briefed). Generally the schedule is based on only one flight test plan, but sometimes also two or several flight test plans are used as input to the same schedule. When it's considered as necessary also a Frame Test Plan is written, to summarize the general conditions, restrictions etc. for two or more flight test plans, which are tied to particular flight trials and schedules. Both companies use a software tool (data base) to create the schedules.

Within both companies the content of a schedule is driven by the requirements listed within a Flight Test Programme document. These documents contain a detailed description of each test point and are authorised by senior members of the Flight Test team. At Saab there are a large number of signatures required in order to authorise an FTP, including all of the relevant design authorities. At BAE the authorisation is much simpler, although during a review period design teams are given the opportunity to comment on the document through a formal mandatory review process.

The FTPs written for the Nimrod project include all of the test points to be flown. These are entered into a database called FTMS which allows rapid combination of test points to create a schedule. Saab has a similar system called KURT. During the exchange there was no opportunity to look at a comparison of the two systems in detail, further more the little time that was available to see KURT was hindered to due to it being one of the few pieces of software that was in Swedish.

3.8 Pre-Flight Predictions

At BAE Systems pre-flight predictions of handling maneuvers are carried out by the relevant Flight Test 'Specialist'. These often take the form of 'boundaries' which are created to show the maximum and minimum expected values of parameters such as alpha, beta, zeta, etc. Real time re-predictions are carried out by the aerodynamics team using a link to their office. This is only carried out when there is some doubt over the validity of the previous maneuver and is only pseudo-real-time as the testing must be paused whilst the re-prediction takes place.

Saab have a more integrated system whereby the telemetry software drives inputs into the prediction software which outputs the expected aircraft behaviour given the system inputs (throttle, control column, etc) back into the telemetry software. This is fully real time and allows for instance two lines to be plotted on a real time scrolling chart, actual and expected Alpha.

3.9 Pre-Flight Safety Reviews

At BAE Systems there is up to a 4 stage process for reviewing the safety of forthcoming trials. Initially the Flight Test Programme is written and the author recommends it as either Low, Medium or High risk. Following this, a review takes place involving senior engineers from across the different projects, who either accept or modify this risk categorisation. The process that follows depends on the risk categorisation agreed.

For low risk trials there is no further reviews required other than those associated with the standard authorisation of the Flight Test Programme. High risk trials require a 'Concept Review'. This is an informal meeting that looks at the 'big picture' of the trial, identifying the risks and providing initial proposals of solutions. The test policy and the strategic direction for the preparation of the trial is understood and agreed. In general the attendees are the same as those that attend the subsequent safety review.

Safety Reviews are carried out for all Medium and High risk trials. The safety review identifies all perceived risks and reviews the mitigating actions. The output of these reviews is an agreement to conduct the trial, although in most cases this will be pending the outcome of a number of actions.

At Saab a similar flight safety process is performed. A Flight Safety Assessment (a preliminary risk assessment within the test team) and a Flight Safety Review (final risk assessment), are performed for all flight test plans. The purpose of the Flight Safety Assessment is to define suggestions for actions to increase the flight safety. The minutes are included as a reference in the flight test plan and shall also be presented at the Flight Safety Review.

At the flight safety review, the 'responsible test leader' presents the content in the flight test plan (test positions), for a designated flight safety review board. Each flight test plan assigns a risk index from 1-24. The risk index is given from a combination of the probability that a special event occurs and the consequence if the event occurs. The flight safety review board then decides necessary actions to increase or maintain the flight safety. Actions such as chase aircraft, envelope expansion in steps, criteria for aborting the tests, simulations before testing etc. could be demanded. The minutes from the flight safety review is always attached as an appendix to the flight test plan.

3.10 Use of Telemetry (TM)

Use of TM on the Nimrod project is irregular due to the ability to carry up to 4 Flight Test Observers (FTO) on board the aircraft to monitor the Instrumentation System during flight. This can be supplemented by the use of Telemetry which allows additional people to view the data from one of two rooms. Telemetry is used much more frequently on fast jet programmes (such as Typhoon) where almost every flight is supported by a full team of flight test specialists.

At Saab it TM appeared to be used regularly in the same way as it is used on the BAE fast jet programmes, although with only those people whose tests are being conducted being present. During a flight with TM both organisations use a 'Test Conductor' (or 'Boffin') to control the flight. When a Nimrod flight takes place without TM the role of Boffin is assigned to one of the onboard FTOs.

4 Conclusions

The exchange provided an excellent opportunity for both candidates to experience the processes and organisation of a different flight test department. The contrasting views on the way that a test should be written and presented caused a great deal of discussions and thoughts not only between the candidates, but also with all those associated with the exchange.

The actual completion of a test was largely the same. A Sideslip is still a sideslip no matter where in the world you go, however, the process of getting the aircraft into the air to carry out the sideslip is largely different between the two companies. Both of these sets of processes reflect the climate that the teams work within, simple things such as the small offices at Saab compared to the large open plan layout of BAE lead to large differences in the organisation of the teams.

On a number of occasions during the exchange both candidates asked themselves, 'how is this actually performed in my own Flight Test organisation'. This often resulted in having to investigate this upon returning to the parent organisation.

It is now almost a year since the exchange took place and both candidates regularly find themselves in situations whereby comparisons can be made to events seen whilst partaking in the Exchange Programme.

Although at there have been no direct changes due to the exchange, the lessons learnt have helped in the development of the candidates as a flight test engineers. The experience has also provided an opportunity to learn about the different cultures that exist in the two countries and companies.

In summary it is evident that the two companies have a lot to offer each other in terms of their operating processes, although as expected the actual testing methods are very similar.

The aims of the exchange, as stated on in Section 1, are considered as being fulfilled and the opportunity to take part in this kind of exchange has been a privilege. Both exchange candidates would like to take the opportunity to thank the SFTE, BAE Systems and Saab Aerosystems for providing this opportunity. Both candidates would not hesitate to recommend others to take every possible steps to become involved.