The Use of Advanced NDI to Reduce the Duration and/or Frequency of Preventative Maintenance – German Air Force Experience

Holger Manzke and Ernst Grauvogl
EADS Military Air Systems
Material Testing – CQMM33
85077 Manching
GERMANY

holger.manzke@eads.com / ernst.grauvogl@eads.com

1.0 INTRODUCTION

The EADS, Military Air Systems is one of the biggest aircraft manufacturer and service provider for military aircraft in Germany. Some of the important tasks at Manching plant are the repair and overhaul of the German Air force fleet as well as the final assembly of new generation fighter aircraft. The tasks of the NDI-department reach from crack and corrosion detection in metallic structures to delaminations and disbonds in composite materials like CFRP.

The aircraft fleets of all NATO air forces have to be maintained to assure mission reliability. With the proceeding age of some aircraft types the part of NDI during maintenance terms will grow up permanently and so the NDI-part of cost and time during maintenance increases more and more. This is in contrast to the main goal of the NATO partner "improving the availability of aircraft fleet during maintenance". This paper shows some examples how to tackle this general problem.

2.0 AIRCRAFT STRUCTURAL PROBLEMS

With the rising age of the aircraft fleet the structural problems like:

- corrosion,
- fatigue cracks,
- delaminations / Impacts,

which have to be examined with NDI methods increases significantly. To assure mission reliability life cycle extension arrangements has to be implemented. Such arrangements are mostly:

- additional non destructive inspections or
- shortened intervals of tests.

This means the volume of NDI will be grown up in the future but this is in contrast to the main goal "Reduction of downtime during maintenance". So the role of NDI for saving arrangements during maintenance becomes more and more important. But where are the saving potentials inside NDI?

3.0 IMPROVED NDI METHODS

Before improving NDI methods two essential questions has to be answered:

1) **What is about the spare part availability?**

   Especially for aging aircrafts spare parts (mostly metallic) are barely available or cost intensive to provide (single part manufacturing).

2) **How can we reduce the inspection program or inspection time during maintenance?**

Using improved NDI methods defects can be found in an earlier stadium. This means the structure reliability would be increased but the costs and time for repair or part exchange and thus aircraft downtime rise. This is in contrast to our main goal. To solve this problem we have to leak the ball to the structure people for discussing the following questions:

- Is it really necessary to improve the sensibility of inspection methods to find smallest defects?
- Can we enlarge allowable defect sizes without endanger the flight safety of aircraft to extend inspection interval?

This paper emphasise more the answer of the second question, "Reduction of inspection time".

Regarding the inspection method and its performance without data treatment and documentation three essential items come to the fore:

1) Reduction or avoiding of preparation:
   a) Surface treatment.
   b) Disassembly.

2) Reduction of testing time:
   a) Test speed.
   b) Building up of the test systems in situ.
   c) Analysing test results.

3) Reduction or avoiding of post-processing:
   a) Surface cleaning.
   b) Surface treatment (e.g. corrosion prevention).
   c) Reassembly.

These items has to be consider while development of new NDI techniques.

4.0 CASE STUDIES

Application of improved NDI methods during inspection terms of aircraft maintenance offers a great potential of time saving effects. The following case studies should show possibilities where improved NDI methods can be successfully applied.

4.1 Mission Aircraft AWACS E3A (Corrosion Detection at Wing Fixed Skin)

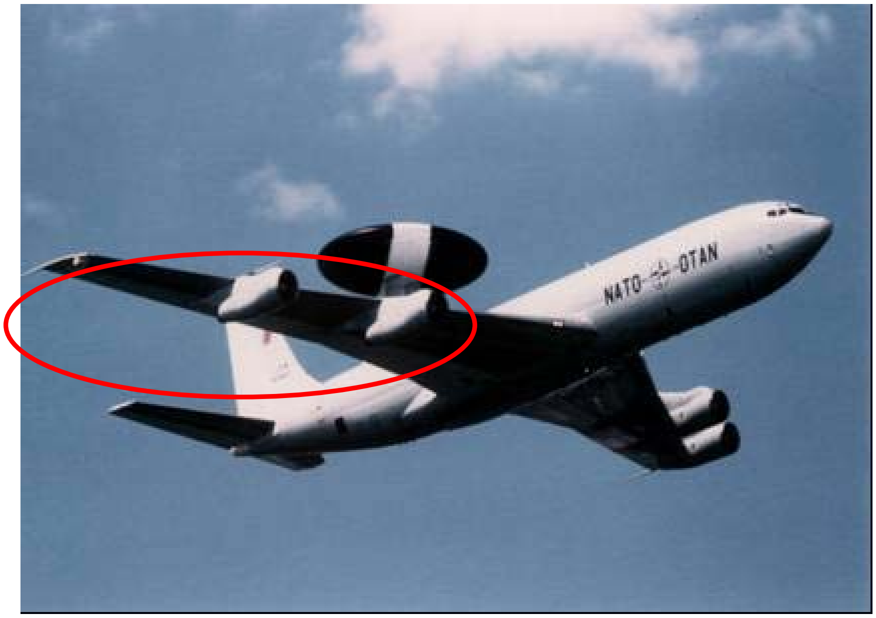

Figure 1: Mission Aircraft AWACS E3A (Corrosion Detection at Wing Fixed Skin).

The test procedure for this inspection envisages a visual inspection of areas around the fasteners. Corrosion has to be worked out and the repair has to be evaluated by a wall thickness measurement by means of a dial gage. Using an ultrasound scanning system the measurement time can be reduced significantly (it aggregates up to 50%) and besides the whole area can be mapped. This provides more information about the structure behind the surface and the wall thickness of each point inside the test area. Especially for corrosion detection based on wall thickness measurement at large areas ultrasound scanning systems has to be the first choice. Before using such a system some qualification work has to be done.

4.2 Mission Aircraft AWACS E3A (Detection for Debonds in ROTODOME Structure)

Figure 2: Mission Aircraft AWACS E3A (Detection for Debonds in ROTODOME Structure).

This case study deals with the application of a new optical measurement system (shearography) in the military aviation to detect debondings in the double honeycomb structure of the rotodome. The technical order prescribed a resonance inspection technique with multiple sensors. This is a quick inspection with a moderate defect resolution. But applying an optical test system which works contactless has special charm and the testing time can be reduced over again.

At the moment shearography is not qualified for such an inspection yet. Further more the free of failure of the coverage paint caused by the vacuum excitation has to be verified. Due to this presently some examinations will start at Manching site.

4.3 Fighter Aircraft F4-F Phantom (Detection of Fatigue Cracks in Wing Stiffener at Lower and Upper Skin)

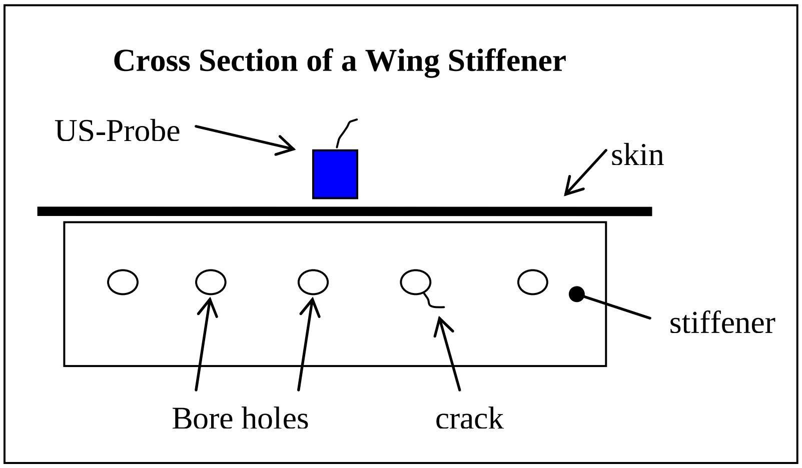

Figure 3: Fighter Aircraft F4-F Phantom (Detection of Fatigue Cracks in Wing Stiffener at Lower and Upper Skin).

According to the technical order the wing stiffener has to be checked for cracks periodically. The actual approved NDI method is manual ultrasound. The inspection consists out of three steps:

1) Locate the stiffener position and marking.
2) Ultrasound test in longitudinal mode.
3) Ultrasound test in transversal mode.

This is very time consuming and the long work overhead is very strenuous for the inspector.

All this work can be done by ultrasound phased array in on step. The phased array probe provides a c-scan of the test area. The test can be done in a few second per stiffener and the evaluation of the data can be done to a later point of time at a desk. Further more the circumstantially marking and particularly the removal of the marks can slipped: The estimate time savings amount about 50%.

4.4 Fighter Aircraft TORNADO (Detection of Corrosion at the Wing Diffusion Joint)

Figure 4: Fighter Aircraft TORNADO (Detection of corrosion at the wing diffusion joint).

Similar to the first case study corrosion detection at the diffusion joint of the fighter aircraft TORNADO should be performed at the back wall of the structure. This inspection will be performed by means of endoscope yet. The problem of this inspection is that the corrosion cannot be removed. So the complete wing has to be changed by severe indications of corrosion.

Using ultrasound scan equipment on the basis of a wall thickness measurement from the lower side of the skin, corrosion can be detected earlier. The C-scan images out of the ultrasound scan provide the possibility of a mapping and so the comparison between result images out of prior inspections is possible. This will help to monitor the corrosion growth.

4.5 Mission Aircraft Breguet Atlantic (Detection of Debondings in Honeycomb Structure)

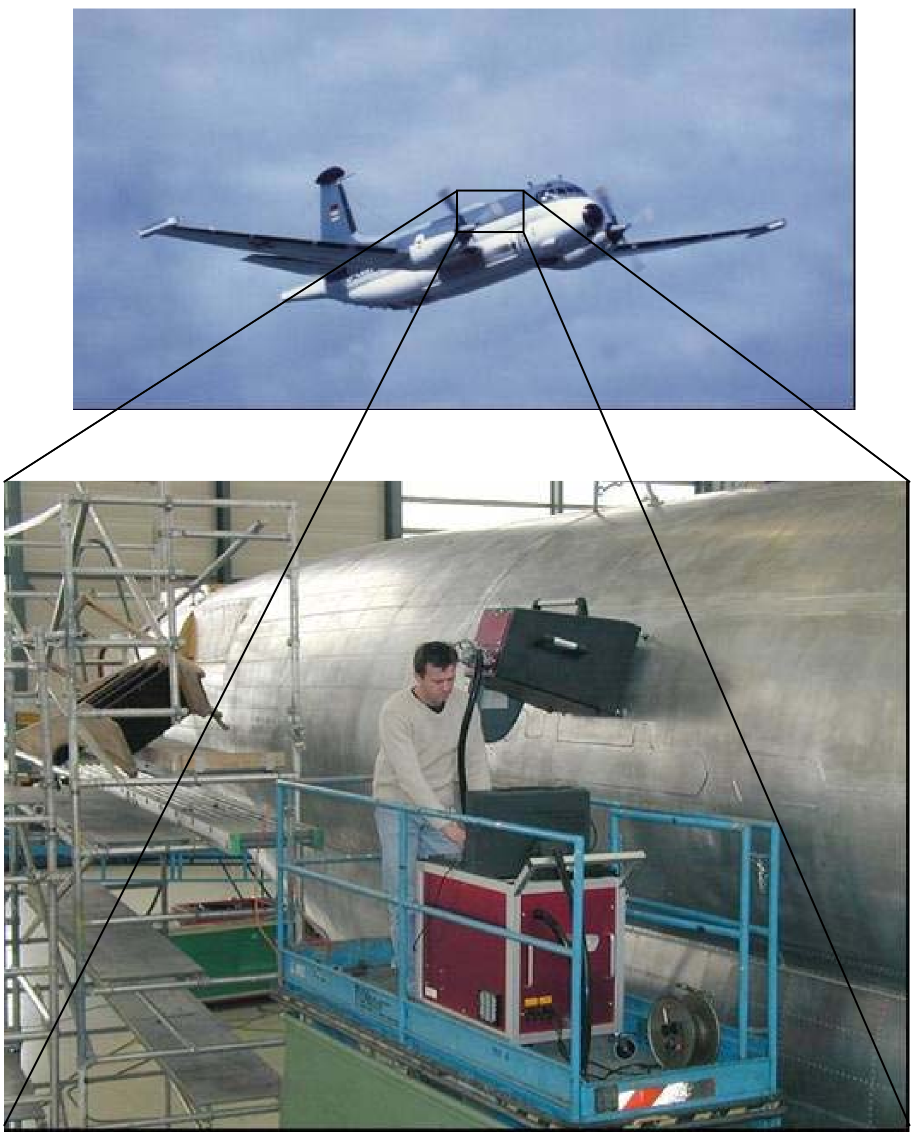

Figure 5: Mission Aircraft Breguet Atlantic (Detection of debondings in honeycomb structure).

In a European technical project named INCA a shearography demonstrator has been developed. The main goal was to exchange the actual Inspection methods (manual ultrasound and resonance inspection at the fuselage and wings) with shearography. In this study it was demonstrated that shearography can be applied at aircraft under maintenance conditions. Only suspect areas have to be examined closer with manual ultrasound or resonance inspection. The time savings were estimate to 50%.

Such test systems are available on the market now. But there are many things to improve before the system can be applied for such tasks.

5.0 SUMMARY

All case studies shown before are a choice of many possibilities where the application of new NDI methods and concepts can improve mission availability.

To advance the activities in improvement of NDI methods the following items have to be regarded:

- Qualification and approval of new NDI methods for maintenance work of NATO aircrafts.
- Reconsider defect tolerances for a better prevention or avoidance of useless works.
- Reconsider the spare part supply to make critical decisions easier (Changing of the part or not).
- Improvement of repair processes of new materials like composite to make assessments of the repair easier.
- Improvement of the reporting (fill in data semi automatic).