The Airbus A340. 4 engines, 4 long haul.

The Airbus A340 is the only modern 4-engined, long-haul aircraft in service today. So unlike its twin-engined competitors it can fly the most direct routes, no matter how far from civilisation. Flying up to 18 hours non-stop, the A340 takes you a lot farther, yet makes long haul seem a great deal shorter. Airbus. Setting the standards.
This issue of FAST has been printed on paper produced without using chlorine, to reduce waste and help conserve natural resources. Every little helps!

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**JULY 2002**

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**Around the clock... Around the world**

'Flight operations monitoring' part 2

Cover illustration:
A340-600 cold weather testing, Iqualit, Frobisher Bay, Canada in January 2002
JUST HAPPENED…

37th Airbus Flight Operations Monitoring & Safety Development Conference
Hong Kong, 12-13 March 2002
(In association with Cathay Pacific)

220 participants attended the 1st conference of this kind of which the main objective was to share flight operations monitoring concepts in order to improve proactive and reactive approaches to safety. The driving forces in this programme were operations and safety issues, in which participants enjoyed constructive exchanges and included presentations of operators experiences. This first conference was addressed mainly to the Middle East, Asia, China, Australia and Russia, and confirmed the great involvement of operators in safety approaches and moreover their wish to work closely with Airbus in implementing efficient monitoring systems.

38th Airbus Technical Symposium
Montreal, 26-28 July 2002

This very positive event was attended by 375 participants including representatives from 50 airlines and 30 engine and feedback has shown that expectations were exceeded. Topics covered included all technical issues affecting the A330 and A340 fleet. They also included inputs from A330 and A340 operators. One of the core issues was the A340-600 flight test and maturity programme and there was also discussions on non-technical more general matters. Following tradition the event included a social evening. The next A330/A340 technical symposium will take place in 2004.

1st Airbus Flight Operations Monitoring & Safety Development Conference
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This event welcomed a range of delegates including academic consultants, representatives from industry and 91 participants from eleven different airlines (mainly the Middle East). This overwhelming success was driven by the motto of safety and included sessions on situational awareness, threat and error management, Crew Resource Management (CRM) and fatigue and alertness management. Participants enjoyed much interacting with the Airbus team during Q&A sessions and feedback shows that these events highlight an evolution of our products, our brand and our communication strategy.
Airbus Corporate vision has always included as its basic tenet: 'Flight safety first'.

We are very aware at Airbus that safety is the single most important asset of our business. Corporate shareholders, customers and employees depend on it for the success of our products and for continued belief in our philosophy and knowledge. We believe that the most strategic and effective way to promote safety is to establish, maintain and develop a positive safety culture in all areas of design, manufacture and operations.

Within the frame of its Flight Operations Monitoring program, Airbus has undertaken the definition of a world standard with world safety institutions and authorities whilst working in close partnership with the market’s key actors in developing industrial co-operation programs, and supporting a network of third parties using its methods and standards.

Today, Airbus is confident its program will satisfy airlines’ specific needs. Whether already equipped with a Flight Operations Monitoring program or wishing to implement such a system internally, Airbus offers a complete and efficient set of services for Flight Operations Monitoring.

Anne Fabresse, Line Assistance Director
Airbus Customer Services
Flight Operations Support and Line Assistance
Flight Operations Monitoring
An integrated approach

**OBJECTIVE**

The Flight Operations Monitoring (FOM) program implements a prevention system based on identifying accident and incident precursors. The program increases the understanding of the root causes of safety instability in the system enabling the operator to formulate counter strategies.

Three main steps are needed to build an FOM program:

- accurate measurement of deviation from normal operations,
- situation analysis, identification of risk precursors and of root causes,
- launching of preventive and corrective actions to improve safety.

**Measurement tools & techniques**

The accurate measurement of deviations from normal operations requires complementary tools and techniques in order to understand not only what deviations occurred but why deviations occurred.

**FLIGHT DATA MONITORING**

This approach pertains to the routine collection and analysis of flight data to provide more information about, and greater insight to, the total flight operations environment. The aim is to provide a feedback for safety management, raising to the surface errors and operational deviations that can be considered as “precursors” of accidents or incidents but which are not always directly visible.

**FOQA**: Flight Operations Quality Assurance is another designation for this part of the FOM system. Flight data analysis requires equipping aircraft with specialised devices (Quick Access Recorders, PCMCIA cards, wireless connection systems…) in order to systematically capture flight data collected on the aircraft’s flight data recorder.

Data is processed in a centralised ground station, in order to qualify and quantify deviations from standard operating procedures and company policies. These deviations are compiled in a database as events and then statistically processed to produce reports performing trend analysis and identifying potential risks.

**FLIGHT CREW OBSERVATION**

An essential part of FOM program is crew observation. It is only through actual crew observations that we can see the whole picture: the way a deviation from normal occurred, why it happened and how the crew managed the situation.

Evaluation sheets are compiled to produce statistical reports on crew performance in:

- crew resource management and communication,
- application of Special Operating Procedures (SOPs),
- use of aircraft management systems.

**FLIGHT CREW REPORTING**

It provides the individual crewmember or collective group with a perception of the event occurrence. Crew reporting is an essential element in establishing a diagnosis when looking for causes from symptoms.

A reportable occurrence is understood to be any incident, fault, malfunction, deviation or technical defect that endangers or could endanger the safe operation of the aircraft or its occupants or which could lead to an unsafe condition in the aircraft.

Mandatory and voluntary incident reporting, here we distinguish both:

The mandatory channel is obligatory; reports have to be submitted in the name of the whole cockpit crew and may be forwarded by the airline to the airworthiness authorities if safety has been significantly threatened.

In the voluntary channel, reports may be submitted at the discretion of an individual crewmember and could become invaluable information if a safety hazard and/or safety precursor was encountered, and also, if safety was imperiled it helps to understand why an event occurred.

**FLIGHT OPERATIONS REPORTING**

Based on Airbus methods and expertise, built through close teamwork with its operators and with world safety institutions, the Airbus FOM support offers a broad range of scalable, modular software tools, data and methods as well as operational services adaptable to each airline’s needs.
**FOM tools**

Airbus proposes a range of tools to airlines who are not already equipped. These tools have been designed to be the most operational-oriented possible. Solutions to ease analysis and decision-making process.

**LOMS statistical reporting**

It is a measurement, analysis and reporting software tool processing the aircraft flight data. It automatically provides statistical reports on flight operation performance and potential risks assessment. LOMS integrates the Airbus flight profiles and can be applicable to the whole fleet of the operator.

Currently LOMS is being merged with the Flight Data Monitoring software from Teledyne called FLIDRAS. The new system will be available in 2003.

**AIRCRIWICDENCE REPORTING SYSTEM**

It is a measurement, analysis and reporting software tool processing the aircraft flight data. It automatically provides statistical reports on flight operation performance and potential risks assessment. LOMS integrates the Airbus flight profiles and can be applicable to the whole fleet of the operator.

From data to trends and lessons learned

**AIRCREW INCIDENT REPORTING SYSTEM**

It is part of the BASIS Safety Information System developed by British Airways. It can interface with existing BASIS modules.

Further to flight data analysis and crew performance, AIRS allows a voluntary crew report which will enable the operator to understand why some deviations have occurred and will give rise to relevant recommendations.

**LINE OPERATIONS ASSESSMENT SYSTEM**

It covers the following domains of flight operations:

- cockpit crew operations,
- operations Support,
- cabin operation,
- operating environment.

LOAS uses the University of Texas Data Collection Methodology for some aspects of crew operations assessment. This methodology is called “LOSA©” (Line Operation Safety Audit) and is based on threat and error management which is considered by the Airbus specialists in Human Factors and by many other world specialists as the most efficient means for identifying risk precursors.

LOAS has been designed to be a stand-alone system, used by an operator to perform crew observations.

A generic tool that an operator can customise from the evaluation forms to the key word dictionary and to the desired set of reports.

**LOAS data process in 3 stages**

Stage 1: Fulfillment of standard worksheet by the observer

Stage 2: Data is processed through LOAS

Stage 3: Automatic statistical reporting

LOAS© copyright the University of Texas at Austin 2001

**FLIGHT OPERATIONS MONITORING PROGRAM**

FLIGHT OPERATIONS MONITORING PROGRAM

**Safety and FOM training course**

In addition to the FOM Handbook, Airbus has developed a one week Safety and FOM training course, dedicated to the safety and flight operations managers and those responsible for FOM in the airlines, as well as those in the regulatory authorities.

**FOM Handbook**

Airbus, in cooperation with Cathay Pacific, Air France and Aeroscopia, has developed standard methods contained in the FOM Handbook, which describes the Flight Operations Monitoring concept and provides guidelines to successfully implement such a process within airlines.

**DATA**

Flight profile specifications

Because the accurate definition of the deviations from normal operations is a key element for a comprehensive flight data analysis, Airbus proposes its flight profile specifications, to be integrated in any Flight Data Monitoring system.

A flight profile is the set of references to which the flight data is compared in the Flight Data Monitoring process. Each time the flight data deviates from a reference value, an event is triggered. The flight profile includes parameter filters, additional parameter computation, and event detection algorithms. On a scale of risk, deviations from the standard flight profile are classified into three severity levels allowing risk assessment of events and trends as a basis for remedial actions to be implemented.

- low severity green
- medium severity amber
- high severity red

The severity levels have been set to ensure compliance with the flight operations regulations, the aircraft limitations and the Airbus standard procedures.

The events and deviations have been defined by operational and flight engineers and have been validated during specific flight tests. They are finalised and validated through thousands of flights in partnership with some Airbus operators. The events triggered could be single punctual events (around 100 are monitored).

As well as potential risk situations resulting from the combination of single events, the following situations are currently monitored.

(see table below)

The standard flight profiles are implemented and operational on LOMS.

Airbus provides operators with the specifications of the standard flight profile related to all the configurations of the aircraft.

Having the specifications available allows the Airlines to programme them in their own flight data management system.
The Airbus policy on a comprehensive FOM package should make a lasting contribution to the installation of safety cultures by its customers. The packaged approach of FOM is well aligned with contemporary safety initiatives seen at ICAO and at the Flight Safety Foundation.

Airbus FOM provides an integrated approach to inject lessons learned from:
- several other safety methods and means,
- both airline and manufacturer’s experience,
- risk assessment activities and safety performance metrics based on measurements of safety performance and real operational performance data.

The FOM Assessment gives a clear picture of the current FOM system in an airline, reviewing the organisation methods and tools in place.

**FOM assessment activities:**
- review of the airline’s Flight Operations Monitoring and safety policy,
- study of the company organisation and skills for FOM
- methods and means for Flight Data Monitoring
- methods and means for airline incident reporting tools
- methods and means for crew observation
- review of risk assessment and reporting process,
- organisation of the communication on lessons learned and on the impact of actions taken.

**FLIGHT DATA MONITORING (FDM) ENTRY-INTO-SERVICE**

After two or three months of data processing with LOMS (at least 200 flights are required), or any other FDM system on which the Airbus flight profiles are implemented, Airbus proposes specific services.

The objective is to support the first step of LOMS data interpretation, and to optimise the use of LOMS functions to get accurate results and make pertinent risk assessments.

This assistance is directed towards the airline pilots and analysts who are participating in the FOM program. This service is highly recommended to the operators implementing LOMS as their first Flight Data Monitoring tool.

**FOM OPERATIONAL SUPPORT**

For a smooth and efficient implementation of the FOM program the operational support is highly recommended and is tailored according to the FOM assessment results.

**FOM engineering assistance** performed by an FOM engineer: the assisting engineer helps the airline Information Technology department, Operational, Safety and Maintenance departments with the design and implementation of the process and techniques needed to support the Flight Operations Monitoring program.

**FOM pilot assistance** provided by a pilot experienced in FOM: the assisting pilot helps in the observation and interpretation of flight data. He or she also discusses the FOM program with the pilot community so they agree and support the decision making process and the implementation of adequate corrective and preventive actions.

**Conclusion**

The Airbus policy on a comprehensive FOM package should make a lasting contribution to the installation of safety cultures by its customers.

The packaged approach of the Airbus FOM makes more sense than a modular one as it adds value to the management of potential risks. It is well aligned with contemporary safety initiatives seen at ICAO and at the Flight Safety Foundation.
Tool-loan service in Airbus

While the major part of Airbus’ tool business is concerned with selling tools and GSE (Ground Support Equipment), a significant part of the business deals with leasing tools. Airbus stocks tools and GSE for structural and other modification programmes, retrofit programmes, incidents or other repairs, and periodical checks.

WHY LEASE TOOLS?

Very expensive or rarely used tools are the most commonly leased by Airbus.

Advantages in leasing instead of buying:
- customers can avoid capital investment and eliminate redundant stock.
- the tools may be expensive and needed once only.
- the Airbus tool-loan service is reliable (98-99% tool availability).
- as tool quality requirements increase to the same level as GSE, Airbus takes care of calibration, repair and test reports, which means lower costs and less administration.

WHY USE RF/ID?

The Radio Frequency Identification (RF/ID), able to store and retrieve essential data for high value, high usage items, which require close tracking, recently found a new application within the aerospace industry. Airbus decided, in collaboration with a research institute, to use the chip technology to optimise its tool-loan process.

This article explains why and how the RF/ID was introduced into the Airbus tool-loan process and how it can improve the tool-loan service for its customers as well as providing improvement in other areas of logistics management.

Maintenance centres, not airlines, are the biggest tool loan customers. This may, in part, be explained by the reasons above and partly because the variety of customers managed leads to a need for a wider range of tools.

New goals were defined as tool availability became more reliable. Other factors and issues in the process came under the spotlight:
- reduce TAT, so increase tool availability with reduced inventory;
- reduce paperwork, increased data security, quality and consistency for safety and efficiency;
- possession of all relevant data at any time;
- earlier decisions on repair, ability to use integrated forwarders.

From this analysis it was clear that a more transparent system was required, allowing greater access to relevant data and clearer instructions that required less human intervention at each step (i.e., to make the process as automatic as possible).
How can the Radio Frequency Identification* improve the tool-loan process?

CHIP DEVELOPMENT IN THE AIRBUS TOOL-LOAN PROCESS

Airbus Materiel Support was approached by the Fraunhofer Institute, a research company, who analysed the logistics system supply chain and recommended the use of a data tag transponder chip. 

Chip technology allows secure data to be carried on the tool, instead of on paper documents.

Two types of data loaded:

- **Static**
  - Permanent data i.e., part number, serial number, date of manufacture, manufacturer.
  - **Dynamic**
    - Variable/modifiable data i.e., date of last inspection, etc.

Before the tool is loaned out for the first time, Airbus inputs the static and initial dynamic data on the chip. The chip then follows the supply chain to customers, forwarders and workshops, each of whom are able to read, depending on their access rights, the part of the chip which holds information relevant for their business.

In order to read or change the dynamic data, all that is required is a computer and reader, ideally a standard handheld computer, such as those already used for reading bar codes, and a reader pen. A standard interface can be attached to any computer, e.g., handheld, PC or laptop to download the chip’s data into the company’s main computer system. The same computer and reader pen can be used to write data on the chip (by those who have the authority). Text typed into the computer is transferred to the chip through the reader pen held against the chip.

Over 16,000 Airbus tools are available for loan, out of which around 3,000 (plus their respective boxes, if applicable) are equipped with a chip. These tools have serial numbers and require close tracking and will often need repairs and/or calibration. They are typically very expensive and many have special boxes that require special shipping instructions. Other smaller tools such as drills or pins that are loaned as part of a package are not included. Chips are attached to tools (and their respective box) by simply dishing a hole in the surface and gluing it in a location where it avoids damage.

WHAT TOOLS ARE GIVEN CHIPS?

- Tool identification/manufacturing data
- Quality data (calibration)
- Life cycle information

CHIP USE IN TOOLS

- Identification/manufacturing criteria
- Tool box information (dim., weight, n° of boxes, vol., etc.)
- Transportation data (tracing & tracing of transport units, AWB, PO#)
- Tool management information (storage place)

CHIP USE ON TOOL BOXES

- Identification/manufacturing criteria
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IN SERVICE EXPERIENCE OF USING THE RF/ID IN THE TOOL-LOAN PROCESS

Reduction of TAT
Since the introduction of the test phase of the chip in 1998 the reductions in TAT have been dramatic. GSE TATs fell from an average of 53 days in 1998 to 12 days in 2000 and Tool TAT fell from 31 to 8 days, overall a 75% reduction.

Savings in transport costs
Forwarders send tools straight to calibration/repair shops without sending them first to Airbus.

Reduction of stock level
This reduction in cycle time means that fewer tools are required to provide the same level of availability, thus less inventory investment.

Less parts blocked at goods inwards meaning increased availability
Improvement in data quality meaning less errors, less defects, etc...

RADIO FREQUENCY IDENTIFICATION FOR TRACKING TOOLS

In this Airbus application was created for use on the handheld computer and PC database was programmed.

To read the chip, one requires a reader pen and computer as well as a personal ID card. This means that it is always known who last changed data on the chip. For extra security a password can be added to the chip. The chip will give the latest changes made but this data can be downloaded to a main system to keep track of the tool's history. Data can be viewed, saved and modified depending on the access rights assigned to that particular user, preventing access to functions that are closed.

This reduction in cycle time means that fewer tools are required to provide the same level of availability, thus less inventory investment.

The chip holds 2kB of data but will probably increase to 8kB in the future, allowing more functions.
- dimension: diameter 8mm
- data security: 10 years if not read
- temperature range: approx. 150ºC
- resistance against temperature and aggressive media
- safe from Electo-Magnetic Interference (EMI).

Vendor equipment: the one application with the greatest potential is vendor equipment (line replaceable units (LRUs), and other components that require traceability, i.e., not standard hardware etc).

The chip has completed its test phase with Airbus and its supply chain partners and over 3000 Airbus tools and boxes have already been equipped with a chip. The next step is to extend the application to a wider range of airlines, MRO, repair shop and forwarder partners, as well as organising training for users and support for the reader.

REPAIR KITS/TOOLS KITS
Repair kits/tools kits: list of Bill of Material (BOMs) with ‘Master’ chip linked to data from each individual chip.

NEW TOOLS
New tools: customers can load data into their system and reap the same benefits for their own internal process chains.

INTERNET: in the future it could be possible to use a handheld computer in the same way as a PalmPilot or SMS text messages on mobile phones, allowing encrypted emails with extra information to be sent and received when required.

Chip data

The data transponder chip, called RFID, was researched and developed by Fraunhofer Institute for factory operation and automation and eConnective AG, both situated in Magdeburg, Germany.

Originally, Fraunhofer approached Airbus Material Support and studied the logistics of the tooling supply chain. The chip type was chosen, a data model was created and the software for the handheld computer and PC database was programmed.

The chip and bar code systems have many characteristics in common – both allow immediate identification and use the same type of handheld, wireless technology to read the data. However, the two systems complement rather than compete with each other and the chip system is not designed to replace bar codes.

Chips vs. bar codes

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Recognising the need and the importance of upgrading in-service aircraft for customers, Airbus decided to launch a new business unit within Customer Services, called Upgrade Services, to respond to growing customer expectations on quality, lead-time and price.

Upgrade Services brings together a team of approximately 250 people, who were already involved throughout the company in activities to provide optional and chargeable retrofit solutions for in-service aircraft.

It delivers a wide range of services from relatively simple technical aircraft modifications, to full cabin and system upgrades, including embodiment, for Airbus passenger, freight and corporate aircraft. Wherever possible existing solutions are applied, which is generally quicker and less expensive. However, if necessary fully customised solutions may also be applied, at competitive rates.

Although, all the technical publications, documentation and competencies to provide retrofit solutions for Airbus aircraft are readily available, Airbus is clearly not the only company in the market who can offer the Upgrade Services its customers need. Even if Airbus, as the original equipment manufacturer (OEM), is expected to provide aircraft upgrades, it has to prove for every case its competitiveness and reliability in the global upgrade market.

Upgrade Services has the unique advantage of being part of the OEM and having access to all Airbus resources and competencies necessary to develop and manufacture aircraft. This provides it with a full scope of information on all Airbus aircraft delivered, including the customised options, even after delivery, due to the Airbus configuration follow-up system.

When developing solutions for its customers, Airbus can investigate the vast majority of upgrade solutions provided to its customers in the past, or in the case of new subjects, we can simply base the upgrade solution on the new development performed for current production aircraft: harmonisation or standardisation of fleets is therefore a standard activity.

But even in the case of highly customised and non-standard requests, all Airbus core competencies in Design, Engineering and Manufacturing can be involved, to provide an appropriate solution.

The new Upgrade Services business unit has been launched by Airbus to help customers to project and increase the residual value of their fleets. It delivers a wide range of services from simple technical aircraft modifications to full cabin and system upgrades for Airbus passenger, cargo and corporate aircraft. Embodiment of the upgrades will be performed exclusively by third party organisations.
Airbus organised a series of special A340-600 passenger flights called the “First passengers’ programme” to demonstrate the aircraft operational capability in an airline environment, prior to Type Certification and delivery to the first customer, mid 2002.

The first series of 15 flights/100 flight hours, including eight long flights, with sectors as long as 15 hours, took place in November 2001. More than 2000 passengers were transported. Based on the results of these flights, and in line with prior expectations, a number of modifications of cabin systems (hardware and software) were defined and implemented.

A second series of 25 flight hours/450 passengers in March 2002 confirmed the improvements, and was followed by the route proving flights in April 2002 (25 flights of seven long range flights and 18 short-medium flights, 150 hours) when the aircraft was operated by Lufthansa and Virgin.

These flights were part of the programme of “Certification and Maturity at Entry-Into-Service”, the objective of which is to ensure high reliability from the beginning of airline service. They were operated with MSN376, the third A340-600 aircraft, which made its first flight on 24 September 2001.

The first passengers, prior to the ELF series, were in fact dummies installed in the cabin seats, each generating a heat load equivalent to one passenger. They were used from the second flight to start the air conditioning system tests before passengers were allowed to board.

Before passenger flights, toilet reliability was tested with simulators installed on the toilet seats and generating a “wastefluid” and flushing according to a programmed automatic sequence.

Aircraft

This aircraft has a unique cabin layout with several combinations of seats, galleys and storage areas designed to thoroughly test the cabin in very demanding in-service conditions.
Further objectives were the collection of crew and passenger comments on cabin design and systems during long duration flights (ergonomic, perception, ... of system use as well as a series of questions to determine the in-service performance of the numerous offers: video on demand, flight information system, telephone, games and in-flight camera views. The latter includes a camera mounted near the top of the tail-fin offering views of the aircraft, an almost spiritual feel at sunrise.

These flights were as representative of standard commercial flights as possible, including the check-in and security formalities, with the exception that several passengers had portable test equipment and were walking through the cabin, microphone in hand. Something they would not be allowed to do in a commercial flight.

Airbus also used these flights to gain a better understanding of the aeromedical aspects of long range travel. A Telemedicine station was installed on-board and more than 300 medical files were created and transmitted using the SATCOM. This was a great opportunity for the medical experts to assess the operational constraints of in-flight medical care.
e-mails via their own laptop computers or consult websites. During one flight 25 users were connected to the service, 537 e-mails were sent and 562 e-mails received.

Innovative passenger services were proposed such as Cabin Information Network System (CINS):
- e-mail (same functions as on grounds);
- on-board internet (cached web, a selection of favorite web sites with content updated on the ground via gate/link);
- business services (the contents of Tenzing Now was updated every 15 minutes during the flight).

All functions were available from a laptop either connected to an in-seat plug (all seats equipped with RJ11 plugs) or wireless (portable terminals can be used all along the cabin thanks to antennas installed in the cabin floor).

The availability of a fully furnished aircraft early in the flight test programme allowed an unprecedented level of testing of the full cabin in real life conditions. The lessons learnt from this experience, combined with the other flight test data and the existing in-service data from other aircraft types, gives early operators the high level of confidence that the A340-600 will be a mature product and popular at Entry-Into-Service.

Passenger feedback has, in large measure, validated the work undertaken by the cabin design team and underlines the importance of working closely with customers. The initiatives launched for the A340-600 will be adapted to the yet more challenging ultra-long range A340-500, and have spawned an even greater consultative process for the A380.
ON THE A330/A340 FAMILY THE SYSTEM OF NO BREAK POWER TRANSFER (NBPT) AVOIDS THE BREAK IN ELECTRICAL SUPPLY WHEN CONNECTING OR DISCONNECTING THE VARIOUS POWER SOURCES.

THIS ARTICLE PROVIDES A DESCRIPTION OF THE PRINCIPLES OF THE NBPT FUNCTION.

A330/A340 Electrical generation
No Break Power Transfer

Electrical power can be supplied to an aircraft’s AC bus bar from a variety of sources: from the Integrated Drive Generators (IDG) on the engines, the generator on the Auxiliary Power Unit (APU), or externally, from the Ground Power Unit (GPU). On previous aircraft, when transferring from one power source to the other there is a momentary break in supply. Momentarily blank screens in the cockpit during engine start and cabin lights switching off then on are the most visible signs of break power transfers.
System description & function

The electrical generation system has several generating channels ensuring segregation in the electrical distribution system and redundancy in case of generator failure. Generators are capable of taking over the loads from other electrical channels following a chain of priorities that are managed by the Electrical Contactor Management System (ECMS).

An electrical transfer without a break requires that the two power sources are momentarily connected in parallel, i.e., they are connected simultaneously to the same bus bar.

Voltage, phase and frequency have to be synchronized within the required time window.

With AC power sources, the frequency, phase and voltage have to be synchronized before the paralleling, and it is the purpose of the NBPT function to perform this synchronization.

### Controls

**GRAPHIC TEXT:**

1. One generator supplies both channels. On request for connection of the 2nd generator, power supply of the associated bus is removed for a few milliseconds.
2. Upon synchronization, power sources are paralleled during a few milliseconds.
3. Paralleling is then stopped. Power sources supply their own channels.

**NBPT operating principles**

**Synchroisng and Paralleling**

An NBPT is achieved by synchronizing the voltage, phase and frequency of the power source already supplying an AC bus bar with the power source to be connected to this bus bar. Upon synchronization the generators are momentarily connected in parallel on the electrical network for a few milliseconds, then the original supplier is switched off.

An NBPT cannot be achieved between external power A and B since the GPCU has no control of the GPU parameters. Also during NBPT involving a GPU, other generators have to be synchronized to the GPU parameters.

**NBPT with IDGs**

Before NBPT between two IDGs, their associated GCU tunes the frequency of the generators to a Frequency Reference Unit (FRU) provided by the GPCU. When the synchronization is achieved a signal is sent to the ECMU by the GCUs to allow the two generators to operate in parallel for some milliseconds.

**NBPT with the auxiliary generator**

Contrary to the IDG, the auxiliary generator has no frequency regulation device. The frequency of this generator depends directly on the rotation speed of the Auxiliary Power Unit (APU). Thus before NBPT between a GPU and the APU generator, the Electronic Control Box (ECB) tunes the rotation speed of the APU to synchronize the auxiliary generator to the GPU frequency.

**Diagram:**

- Before NBPT between an IDG and a GPU, the parameters of the IDG are synchronized to the external power unit parameters.
- Before NBPT with an IDG, the parameters of the IDG are synchronized to the auxiliary generator parameters.
The NBPT function has been designed in order to be available on the ground during the aircraft standard operating procedures. Outside these procedures Break Power Transfers are observed. Airframe systems have been designed to sustain break power transfers of 200 milliseconds and so, no system failure should result from a power transfer with break. The reasons for having conventional break power transfers are provided hereafter.

If for any reason the system is not able to perform the synchronisation within the required time window a BPT is performed and no failure message is recorded in that case. There are several system behaviours that could affect the stability of parameters and so the ability of the system to keep the generators synchronized:

- Ground power unit providing fluctuating parameters.
- IDG with worn piston and block bores.
- Electrical load variations at the time of the transfer (e.g. flight controls or cargo door operation).
- High oil viscosity in cold weather conditions.
- Simultaneous start or shut down of engines.
- Fluctuating Engine & APU rotation speed...

As a consequence the NBPT function cannot be available in 100% of the electrical transfers. If the rate of BPTs remains within acceptable limits and no failure message is recorded there is no peculiar investigation required.

Conventional transfers

If for any reason the NBPT function is not available a conventional electrical transfer (with break) lasting less than 200 milliseconds is performed.

The NBPT function has been designed in order to be operative on the ground during the Standard Operating Procedures (SOP) described in the Flight Crew Operating Manual (FCOM). Outside these procedures or in flight the system performs conventional electrical transfers with a momentary break.
Every engineering organisation bases itself on its knowledge. So why are there Knowledge Based Engineering (KBE) teams active throughout the Airbus partnership?

This article investigates the KBE arena and, through examples, to show why Airbus is a world leader in this technology.
What is Knowledge Based Engineering?

**KBE METHODOLOGY**

Although there are many definitions, a simplification is to say that engineering processes and rules are captured, coded in to the computer, and run so that results can be generated more accurately and faster. They are generally unique applications, tailored to the engineer’s needs, which focus around the process, and not the data generation. This is illustrated in the MOKA (Methodology Of Knowledge Acquisition) cycle as shown.

**Two main streams**

**KNOWLEDGE ACQUISITION & STRUCTURING**

We have all been doing this for years, both in terms of handbook development, design guides, stressing manuals and technical reports. However as the technical age advances so the electronic archiving and retrieval of information becomes more advanced. Also, we all know how difficult it can be to find information on the internet.

When we find it, how do we know it is knowledge applicable to our context?

For example: I do an on-line search for ‘bonded lap joint’. I get 3297 hits. I put this into context by searching for ‘bonded lap joints analysis on single shear high temperature’. I get 6 hits. How do I know, on my trading edge panel, which ‘pocket of knowledge’ to use? Frankly I am more confused now than before.

The knowledge presented to me needs to be approved and verified for my particular application.

Simply ‘information mining’ or ‘cognitive search engines’ don’t help, without the approval of knowledge and the appropriate structuring of it, MOKA gives us a framework for this. So we have at least one methodology for our structuring. However, what about the acquisition???

**Knowledge Acquisition**

Put three bonded joint experts in a room and ask them to state how to design my bonded joint. I get three processes; rule sets and, possibly, results. How do I get consensus? Well this requires advanced interviewing, data analysis and negotiation techniques to be applied to my group of experts. However there are technologies and techniques out there that have demonstrated an ability to rapidly develop consensus and so acquire and approve knowledge in the most efficient way. This includes methodologies in which the interviewer is trained how to talk with multiple experts, harvest their knowledge and get them to agree a single knowledge base.

So, I have my knowledge, I have approved and structured it, so what? Well I now have KNOWLEDGE, not INFORMATION. I have it in a form readily utilised by either PEOPLE (written or INFORMAL) or MACHINE (electronic or FORMAL). I have the basis for building my applications.

**APPLICATION & EXPLOITATION**

This is where the ‘intellectual’ and the ‘practical’ come together – exploiting knowledge in an efficient way for our core business of aircraft engineering. By accelerating elements of the engineering process great economic or lead time advantages can be realised over current practices. More importantly, if done well, the applications can be used from aircraft programme to programme, realising the savings over and over.

Two examples

**CABIN CONFIGURATION**

A customer can discuss the seating layout, galley configuration and interior details in Toulouse using one suite of applications, geared to give the customer an instant representation of their choices. This is forwarded electronically to the Final Assembly Line (FAL) where another, integrated suite of KBE applications is used to engineer the cabin.

**WING TRAILING EDGE**

On the A380 programme the Trailing Edge team are utilising KBE in the engineering of the trailing edge fixed structural assembly. This application suite has the potential to integrate the structures design, sizing, analysis, routing, machining and tooling disciplines in a way never previously anticipated.

All of these modules can be integrated to help in both the product definition and detailing phases. It delivers benefit due to the large number of similar components and due to the fact that a fuller suite of disciplines can be engineered together in one environment.

Conclusion

The building of Knowledge Based Engineering applications has been happening across the Airbus partnership for more than 12 years in many forms, ranging from cabin applications, knowledge wing structure and systems engineering to tooling and numerically controlled production. However, what characteristics them all is their ability to automate the mundane, secure quality, securing static and dynamic processes, and integrating in a concurrent environment engineers from across engineering and manufacturing. Various levels on benefits have been claimed, from minor to major, but the most recognised is the philosophical shift from focusing on data generation (e.g. CAD), to engineering process, with data being simply the output. It all boils down to helping our prize winning engineers to focus on the engineering, together.

Are we alone?

Almost every major engineering organisation has invested in this technology, including aerospace and automotive organisations.

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Customer support

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TECHNICAL, SPARES, TRAINING
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Flight Operations Monitoring

part 2

FOM has been around for a very long time. There is nothing as accurate as MK3 eyeballs, especially six pairs of them, to measure deviation from normal operations and provide multiple analyses of the situation. Each crew member was ideally placed to identify possible risks and launch corrective action to improve safety.

Undoubtedly, a large crew can provide greater insight working in the fresh air of the total flight operation environment.
The Airbus A340, 4 engines 4 long haul.

The Airbus A340 is the only modern 4-engined, long-haul aircraft in service today. So unlike its twin-engined competitors it can fly the most direct routes, no matter how far from civilisation. Flying up to 18 hours non-stop, the A340 takes you a lot further, yet makes long haul seem a great deal shorter. Airbus. Setting the standards.