HUMAN FACTORS SYMPOSIUM
IN MADRID, SPAIN, 28-30 NOVEMBER
Airbus continued the dialogue with its operators at this forum, discussing human factors aspects with practical and operational perspectives on:
• Flight operations (environmental, safety, pure ops e.g. procedures, philosophy, systems)
• Maintenance (safety, CRM, organization, procedures, manuals)
• Cabin operations (safety, CRM, organization, procedures, mass travel, medical aspects)
• Training (to flight operations, maintenance, cabin operations, to human factors)
• ATC (environmental, safety, pure operations e.g. procedures, philosophy, systems)

A300/A310 FAMILY TECHNICAL SYMPOSIUM
IN LISBON, PORTUGAL, 14-18 NOVEMBER
A landmark event occurred at this symposium, with the first formal presentation to operators of the Airbus initiatives to ensure Long Term Support of the A300/A310 Family. The objective of this initiative is to ensure equivalent levels of operator satisfaction for A300/A310 operators as for any other Airbus programme through to the last aircraft being in-service (up to year 2050). Clearly the enhanced support foreseen for the A380 will set the satisfaction benchmark, and for the A300/A310 Family other considerations that affect the level of service include the low rate of production (can affect spares availability) and the eventual closure of the final assembly line, which must be anticipated. The operators at the symposium expressed their view that their expectations for the future had been met (61%) or exceeded (39%) in this respect.

The symposium discussion otherwise covered various technical, maintenance and support issues and 100 participants from 36 operators were present, including all of the largest A300/A310 operators. 67% of the operator respondents considered the event very useful and 33% useful.

SPARES, SUPPLIERS & WARRANTY REGIONAL SYMPOSIUM
IN ATHENS, 13-16 FEBRUARY 2006
Following the Airbus Spares, Suppliers and Warranty symposium in Puerto Vallarta, Mexico for operators in the Americas, and in Sanya, China, for Chinese operators, it is now the turn of Europe and Africa. A Spares, Suppliers & Warranty regional symposium will be held in Athens, Greece, from the 13th to the 16th of February 2006 bringing together Airbus customers, operators and suppliers. Its objective is to review together strategic directions, operational support issues and current spares and warranty services. Operators will be given the opportunity to express their requirements and share their experience. Major suppliers will also have the opportunity to present their support and services strategy.

A330/A340 FAMILY TECHNICAL SYMPOSIUM
IN SUN CITY, SOUTH AFRICA, 28 MAY-2 JUNE 2006
Airbus is pleased to announce the date and location of the next A330/A340 Technical Symposium. The Symposium is the opportunity to review actual in-service experience with the A330/A340 Family of aircraft as well as to discuss subjects of more general technical interest.

A provisional agenda will be sent in February 2006.
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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Safeguards in Customer Services
An overview of Airbus safety initiatives
Michel Trémaud

Airbus cabin air quality
Still the best!
Claire Nurcombe

The European Aviation Safety Agency
A new regulatory authority for European aviation
Claude Schmitt

Engine noise reduction programme
Making aircraft engines better neighbours
Stephen Montgomery

A380
Airport ready
Thomas Burger
Thilo Sitp

Airbus Training Airport
A virtual airport for pilot training
Kheireddine Belguedj
Bernard Benetti

Countering jet fuel price increases
Guidance on fuel saving
Simon Weselby
Frédéric Desgeorge

Giants of the skies, past and present

Customer Services
Around the clock... Around the world
As an aircraft manufacturer, the prime duty of Airbus in terms of safety is two-fold:
• Ensure the continued airworthiness and operational safety of the Airbus fleet,
• Support Airbus operators in attaining and maintaining a safe and profitable operation.

The former represents the manufacturer’s regulatory obligation, as Airbus is the holder of a design and production operational approval. The latter reflects Airbus’s commitment, as a customer services organization, to operators of Airbus aircraft.

Since 2003, Airbus Customer Services has deployed a yearly portfolio of safety initiatives that address all aspects of Airbus’s internal core activities and all domains of an airline’s operation. This article provides an overview of this portfolio of safety initiatives to encourage operators and other actors to take full advantage of these safety enhancement opportunities.

Continued airworthiness and operational safety

Operators and Maintenance, Repair and Overhaul (MRO) organizations are required to report to their national authorities in-service occurrences defined by their country’s mandatory occurrence reporting (MOR) scheme. It is essential that such in-service occurrences are also reported to Airbus, documented, analysed and understood in order to prevent the recurrence of known types of events and the occurrence of potential events. Indeed, this prevention process includes both a reactive part and a proactive part.

For effective identification of events precursors (also referred to as weak signals), the proactive part also includes the analysis of observations made by operators in the frame of their flight operations monitoring programme (i.e. incidents and human factors reports, flight data analysis and line observations).

The operational, technical and human factors analysis of in-service experience feedback enables Airbus to continuously identify lessons-learned and implement safety enhancements in terms of Design, Operations (i.e. procedures) and Training.

Safety enhancement efforts address equally flight operations, cabin operations and maintenance. The lessons-learned derived from this process are blended with the conclusions and recommendations from industry working groups in order to develop and publish safety-awareness information in various media.

Attaining and maintaining safe and profitable operations

Support to operators in attaining and maintaining safe and profitable operations has been the charter of Airbus Customer Services since the entry-into-service of the first A380 aircraft back in 1975. However, the industry has greatly evolved and Airbus’ initial operators base of flag carriers has been enriched with charter operators and, more recently, low-cost carriers and corporate flight departments.

The leased-aircraft concept has been an enabler in this market evolution and has created a new Airbus Flight Operations Briefing Notes, an example of Airbus safety-awareness publications.
framework of relationships between Airbus, its customers (i.e. the leasing companies) and the aircraft operators. The traffic growth in fast-developing geo-economic regions has been an additional driver in the evolution of Airbus support to its aircraft operators.

Today, Airbus Customer Services offers a wide range of support and services to further enhance operating safety. This support is both direct (i.e., working with operators) and indirect (i.e., working with national civil aviation authorities, training organizations, MRO centres, international safety organizations...) and spans the following basic elements of a safe operation:

- Regulations,
- Regulatory oversight by national authorities,
- Operator's regulatory compliance and best practices: . General organization, . Flight operations organization (including flight operations monitoring process), Maintenance/engineering organization including maintenance best practices, spares provisioning and ground support equipment/tools,
- Company safety management system (SMS),
- Fleet upgrade and standardization,
- English proficiency training.

Safety awareness

Safety management is a mindset; safety readiness is a matter of awareness... being aware to be mentally prepared. Over the past years, Airbus Customer Services has developed a wide array of safety awareness publications on various media:

- 'Getting to Grips with' brochures that today cover 19 flight operations themes, including cabin safety,
- Videos and CDs.

To further ease the dissemination and understanding of complex subjects by all stakeholders, some of the above safety awareness publications have been translated into the Chinese and Russian languages.

Training and education

Maintaining the link with operators after their type qualification, in one of the Airbus Training centres, is an important element of Airbus’ safety awareness strategy. In 2004, Airbus created the concept of regional Airline Instructors Seminars to promote the continued exchange of teaching and safety information between Airbus instructors and airline instructors. The following is the regional coverage achieved by these seminars in 2004 and 2005, and planned for 2006:

- 2004: Taipei, Mumbai, Beijing,
- 2005: Miami, Moscow, Hanoi,
- 2006: Bangalore, Tunis, Beijing

plus locations to be selected in the Middle East, Asia and South America.

Acknowledging the requests of operators, the initial concept that focused on flight operations has been extended to maintenance from the last seminar in Hanoi.

The above set of safety initiatives are intended for the various users of Airbus products and their instructors, but would not be complete if Airbus were not involved upstream in the basic education and training of future Airbus pilots, flight attendants and maintenance mechanics. Therefore, cooperation programmes with state technical universities, flight academies and flying colleges have been developed in China and North America, while similar programmes are currently being developed in Russia, Ukraine, India, South Africa and Australia.

The objective of these programmes is to provide students and cadets with early exposure to modern technology systems and flight decks, by providing education and training organizations with:

- Technical documentation and safety awareness publications,
- Courseware,
- Training devices.

International safety cooperation

Airbus Customer Services is also further involved in the development of workshops and seminars that are deployed in the context of regional safety cooperation programmes funded or led by the European Union, the International Civil Aviation Organization (ICAO) and Airbus.

Airbus Safety Library home page hosted on the Airbus corporate website

E-Briefings, a new interactive safety awareness publication

Airbus Training centres in
1. Beijing
2. Hamburg
3. Miami
4. Toulouse
The scope of these workshops and seminars are defined to respond to regional needs and priorities. As described below, they address a large cross-section of themes identified as causal or contributing factors in incidents and accidents:

- **Company safety management**
  - Incident/accident prevention,
  - Safety Management System (SMS).

- **Flight operations**
  - Preventing Controlled Flight Into Terrain (CFIT),
  - Approach and Landing Accident Reduction (ALAR),
  - Flight operations safety awareness (CFIT, ALAR, runway incursions, altitude deviations/level busts, fire/smoke/fumes in cockpit/cabin, weather avoidance, ...),
  - Flight Operations Monitoring (FOM),
  - Understanding and use of the Minimum Equipment List (MEL).

- **Cabin operations**
  - Cabin safety (see brochure ‘getting to grips with Cabin Safety’ below).

- **Maintenance/Engineering**
  - Structural integrity/maintenance of aging aircraft structures,
  - Maintenance of electrical, wiring and interconnections,
  - Maintenance human factors.

Frequent flyers experience it regularly, flight attendants and cockpit crew complain about it, but up until now nothing was done about it - that smell coming from the exhausts of aircraft in front of you in the taxi queue waiting to take off. The major odour causing compounds in exhaust gases and fuels are from the family of compounds known as VOCs (volatile organic compounds) and they can really spoil that holiday feeling.

After carrying out air quality analyses (see FAST 20 December 1996 *Airbus Cabin Air Quality - Only the Best!*), and discovering that air quality was worst during ground phases due to the influence of external pollution, Airbus decided to concentrate on finding an answer to these complaints.
Current standards

Ozone Converters (OZC) have been standard equipment for aircraft for over 10 years and optional equipment for 20 since it was found necessary to introduce ozone removal capability after the first trans-Pacific flights in the mid-70’s. The OZC is installed as standard equipment on A330/A340 Family aircraft and the A380, and is increasingly being chosen as an option for the A320 Family. It was therefore decided to investigate the possibility of developing a new catalyst to remove both ozone and VOCs. Airbus suppliers rose to the challenge and developed a new catalyst to remove these odours, which could be combined with the existing ozone removing catalyst to minimize installation costs and weight impact.

The conversion principle

The VOCs entering the bled air supply via the engines may come from ground service vehicle exhausts or engine exhausts of other aircraft and mostly consist of hydrocarbons (HC) mixed with small amounts of other compounds, such as sulphur. Hydrocarbons are a class of compounds made up of hydrogen and carbon combined in molecular chains. These compounds are present in very small amounts, but due to the sensitivity of the human nose the cabin occupants can smell them, even down to levels of a couple of parts per trillion of the compound.

The catalyst coating is applied to a core within the converter’s body and oxidizes these odorous compounds, resulting in the formation of odourless water (H2O) and carbon dioxide (CO2) as reaction products (see figures below). Since VOCs are present in very low concentrations the amount of water and carbon dioxide created by the conversion process is small.

Test methods

To investigate the performance of the catalyst the VOC containing vapours from an aircraft fuel sample was passed over the catalyst. VOCs may come from many sources, however fuel vapour was selected to provide a realistic mix of contaminants that may be present in contaminated airport air.

In order to test the odour intensity and hedonic tone (the tone describes how pleasant the odour is), as well as the overall perceived air quality, test panels made up of members of the public were given questionnaires to rate how the air smelled upstream and downstream of the catalyst. The panelists had to rate how strong the odour was at different concentrations and temperatures, and also whether it smelt pleasant or not. After the overall air quality was judged by the panelists they were asked to judge whether they could smell fuel odours in the air sample.

In addition to this human ‘sniff’ testing, samples were taken for the GC-O analysis. For this the air sample is analysed by a GC-MS (gas chromatography - mass spectrometry) analyser with a modified off-take. A GC-MS analysis presents the full chemical spectrum of a sample, allowing the chemist to see which individual compounds are present. The GC-O analyser additionally allows the flavour chemist doing the analysis to see which individual compounds are present in the carbon chain.

Tapping points were installed upstream and downstream of the catalyst where air samples could be taken (see figure above).

In a quantitative analysis the iso-alkanes (a specialist term for compounds consisting of chains of carbon molecules) were measured and it could be clearly seen that the longer carbon chains present upstream of the catalyst were being broken down (see figure below). This proved that the catalyst was having an effect on the compounds within the vapour, however this type of analysis does not show whether the catalyst was effectively reducing odour.

While the chemistry may seem simple, the human nose is not and it was necessary to pursue some additional testing to make sure that the converter was not leading to more odorous by-products being produced. To do this human noses were used, as well as electronic analysers, in panel tests, and GC-O (gas chromatography - olfactometry) tests.

Percentage difference for iso-alkanes up/down-stream of the catalyst

* Cx is the number of carbon atoms present in the carbon chain.
identify the type of odour of the individual odorous compounds. The flavour chemist uses his or her trained nose to identify each odorous compound and give a description, such as ‘green’, ‘citrus’, or ‘fruity’ to it. These descriptions can then be compared to the known odorous characteristics of chemicals and the compounds that are causing the odour can be identified. A perceived air quality improvement of 80% and a significant reduction in the odour intensity was confirmed during the testing.

**Entry into service**

The new odour removing function is integrated into the existing ozone converter equipment, meaning minimal weight and maintenance impact for operators.

The combined converter has the same maintenance requirements as for the ozone converter and the two converters are fully interchangeable (although of course the odour removing function is lost if exchanged for a standard ozone converter).

The modification is optional for A320, A330/A340 families and the A380, although introduction as standard equipment for the A380 is planned. The combined Ozone VOC Converter (VOZC) will also be standard equipment for future Airbus programmes.

**Entry into service**

The formation of the European Aviation Safety Agency (EASA) was the result of a longstanding request from European industry, going back to 1969. EASA has now been in operation since October 2003, so this is an appropriate time to take both a global and closer look at this new institution, see how it is established and understand its role and actions in relation to Airbus products.

It all started in 1969, when aerospace industry leaders, conscious of the importance of international co-operation for future aeronautical programmes, prompted AECMA, then European trade association*, to submit a request to the main European aviation certification authorities, asking them to cooperate and adopt common airworthiness certification requirements.

**Conclusion**

Still the best!

Airbus is the first aircraft manufacturer to integrate this technology into their aircraft. The installation of the combined VOZC is available as an option for the A320 and A330/A340 families and the A380.

This technology will become standard equipment for future aircraft programmes. With the VOZC installed, and improved cabin air quality on ground for crew and passengers, airlines will soon be ‘smelling’ the benefits of Airbus’ dedication to innovation.
The authorities responded very positively and created in 1970 what would subsequently be called the Joint Aviation Authorities (JAA), developing harmonized technical requirements (the Joint Aviation Requirements - ‘JARs’) with the support and contribution of industry expertise.

European aviation safety requirements (no national differences or variants), and for a single set of binding rules suitable for EU member states, were required.

A number of solutions were explored and many milestones passed before the governments of the European Union (EU), in March 2000, finally instructed the European Commission to negotiate the establishment of a new EU agency that could provide the effective, recognized, single authority requested by the various stakeholders concerned with aviation safety regulation.

This process was finally completed with the adoption, on 15 July 2002, of the regulation ‘on common rules in the field of civil aviation and establishing a European Aviation Safety Agency’ (referred to as the ‘Basic Regulation’ in the following) by the EU Council and Parliament.*

The Basic Regulation and the European institutional context

Within the framework of existing EU treaties and institutions, the Basic Regulation is setting up the organization of Community competence for civil aircraft operations and is intended to ensure a high, uniform, level of safety of civil aviation in Europe. The regulation states that EASA, the European Aviation Safety Agency (EASA) and the European Commission are responsible for ensuring the effective, harmonized, single authority requested by the various stakeholders concerned with aviation safety regulation.

The objectives

The main objective of the Basic Regulation is to ensure a high, uniform, level of safety of civil aviation in Europe. Additional objectives, in line with general EU objectives and principles, have also been added, concerning environment protection, free circulation of products, services and persons, improved cost-efficiency, assistance to member states and promotion of European positions concerning aviation safety rules and standards.

The transfer of legal competence

Since 28 September 2003, legal competence and power have been transferred from member states to the EU for:

- Rules governing the airworthiness of aircraft and related products (type design, continued airworthiness, maintenanceorganizations and personnel)
- Compliance determination for aircraft product designs and issuance of relevant type certificates
- Verification of correct and uniform implementation of Basic Regulation and common rules by member states
- Certification specifications, acceptable means of compliance, acceptance of results of compliance verification
- A single European authority can issue, issue amendments to, withdraw, suspend or withdraw temporary approval, and publish the authority's decisions (including on the airworthiness of foreign aircraft and products).

The transfer of regulatory power

The legislative level (EU Council and Parliament), through the Basic Regulation, defines the scope of powers being transferred to the Community, adopts the essential requirements specifying the objectives to be met, allocates the executive tasks among the Community actors, and establishes the means of judical control. At the executive level, standards necessary for the implementation of the Basic Regulation may be adopted by either the European Commission (implementing rules) or by EASA (certification specifications, acceptable means of compliance). See ‘General scheme’.

The transfer of legal competence

The basic legislative framework in the field of civil aviation is submitted to the European Legislative process, and is included in the Basic Regulation.

EASA functions

EASA is in charge of drafting all future regulations relative to aviation safety (for adoption by EASA itself or for submission to European Commission or Parliament) and is responsible for compliance verification tasks associated with some of these regulations.

The agency is also responsible for the coordination of research on aviation safety and assists the European Commission on a number of aspects, including the
inspections to be conducted in the member states to check the uniform implementation of the regulations in Europe. Some of the tasks related to the implementation of regulations remain with National Aviation Administrations (NAAs), which requires a sharing of responsibilities between the agency and these administrations. A summary of what the agency will or will not do and the sharing of responsibilities is provided on pages 12 and 13.

The structure and organization of EASA

EASA is controlled by a management board, which comprises representatives from each of the 25 EU member states, from the European Commission and from observers (non EU member states having negotiated agreements with the EU). See EASA membership figure.

In accordance with the Basic Regulation, a consultative body composed of all professions concerned - the advisory board, has been established and is being consulted regularly by the management board prior to decisions affecting interested parties. The advisory board may also formulate positions, requests or proposals on its own initiative.

While recourse to the EU Court of Justice always remains possible in case of disagreement with an EASA decision, a board of appeal is established as a built-in appeal process, which provides for a faster resolution of disputes by independent experts.

The EASA executive director was recruited in September 2003 by the management board, which also endorsed the nominations of the four directors heading the agency's main functions (certification, rule-making, quality & standardization and administrative) on his proposal. EASA is currently pursuing a recruitment and staffing campaign for its four directorates, and it is expected that, after having reached a level of around 100 staff at the end of 2004, the agency will expand its resources to around 200 staff by the end of 2005. The agency's final level of staffing should be reached at the end of 2006 (assumed to be approximately 300 persons).

The EASA headquarters moved to Köln in Germany in November 2004 and the agency's organization and structure are summarized in the figure on the right.

Transition and relations between former JAA/NAAs system and EASA

EASA has taken over member States responsibility for issuing certificates for aeronautical products and organizations. This means that since 28 September 2003, any product design, any modification or repair to a product, any airworthiness directive affecting a product and any design organization approval or change thereof are now approved under the direct responsibility of the agency.

During the transition phase, until the agency has built up sufficient in-house resources and expertise to carry out these tasks entirely on its own, EASA will rely on the NAAs which will provide assistance to ensure the continuity of certification tasks during the establishment phase of EASA. EASA and the NAAs are accordingly negotiating contractual outsourcing arrangements for this purpose.

EASA has joined the JAA organization as a member and will represent EU member states in the JAA system, which is still developing operations and crew licensing rules (pending taking over of these aspects by EASA). JAA member states will accept EASA certifications and adopt the same requirements, to avoid any duplication or divergence. A contract between the two organizations also allows EASA to rely on the expertise and experience of the JAA central office for a number of regulatory tasks.

The funding of EASA

The Basic Regulation stipulates that EASA’s budget will be funded by resources provided by a contribution from the EU and by charges levied from applicants to cover the costs related to its certification and oversight tasks.

The EASA fees and charges system is the subject of a specific regulation, which has been adopted by the European Commission. In doing so, the Commission has been faced with the difficulty of evaluating the future workload involved for a number of tasks, and with the impossibility of making credible comparisons with the previous situation characterized by completely different cost recovery and charging systems in each of the member states (from free of charge to full cost recovery from applicants). An agreement has therefore been reached with the advisory board that the EASA fee structure and levels will be reconsidered annually during the first 4 years. This will be done against the results of a detailed analytical accounting system, to examine the balance between tasks and...
revenues, confirm or correct assumptions made, and adjust the level of charges for the following year.

The EASA fees and charges regulation entered into force on 1 June 2005 and transitional arrangements should be such that any double charging of applicants is avoided as EASA moves to the new charging system.

The new European regulatory context

To allow EASA to take over responsibility from 28 Sept 2003 for product airworthiness and environmental aspects, which includes both certification and maintenance (continuing airworthiness) aspects, the prior adoption of relevant implementing rules by the Commission was necessary: this was achieved with the adoption of Commission Regulations No. 1702/2003 and 2042/2003 (See figure below). Commission Regulation No. 1702/2003 provides, as an annex, the Part 21 implementing rule, dealing with the certification procedures for products, parts and appliances (type certificates covering airworthiness, noise and emission requirements, approval of parts and appliances, individual certificate of airworthiness, permits to fly, restricted certificates) as well as related organization approvals (design and production).

Similarly, Commission Regulation No. 2042/2003 provides, in several annexes, the implementing rules of Part M (continued airworthiness of individual aircraft), Part 145 (organizations involved in large and/or commercially operated aircraft), Part 66 (aircraft maintenance licence for staff allowed to issue certificates of release to service), and Part 147 (maintenance training organizations).

These new regulatory parts are essentially based on former equivalent JAA JARs and associated acceptable means of compliance and guidance material, with the exception of Part M (which has no former equivalent JAR, as these aspects were addressed by individual member states and not by JAA). While the same paragraph numbering system is retained, slightly different numbering is visible in the new parts, which contain not only the applicable technical requirements (Section A) but also the procedures to be applied by NAAs (Section B) in cases where they are in charge of implementing the relevant rules in their territory (examples of Parts 21 and 145 numbering compared to former JAR rules are shown above).

Each of the above-mentioned EC regulations also contains, for each of the relevant parts, the modalities by which former certificates and approvals, issued by NAAs in accordance with former JAA or national requirements and procedures, are automatically ‘grandfathered’ and transferred into EASA certificates and approvals.

For product certification requirements EASA has adopted the ‘Certifications Specifications’ (CS) composed of the applicable ‘airworthiness code’ (‘Book 1’, equivalent to former JAR section T) and ‘acceptable means of compliance’ (‘Book 2’, equivalent to former JAR sections 2 and 3). See figures above and right.

An important difference from the former JAA system is that member states may no more deviate from common rules, impose additional requirements, nor conclude arrangements with third countries.

Regulations in EASA context

The EASA Management Board has adopted general principles that will govern the agency activities concerning rulemaking and certification. For rulemaking activities, EASA is assisted by the Safety Standards Consultative Committee (SSCC, representatives of interested parties) and the Advisory Group of National Authorities (AGNA, representatives of NAAs) for the determination of rulemaking priorities and work programmes, and more generally the implementation of rulemaking activities. ‘DRAFTING groups’ may be called to prepare proposed texts, and in any case, a public consultation process is provided for before final decision by the Management Board.
process is to be followed (NPA: Notice of Proposed Amendment). Similarly, detailed certification procedures for both products and organizations have been prepared and published by the agency.

Finalization of transition and achievement of remaining EASA objectives

Naturally, industry is carefully watching the establishment phase of EASA and the transition from the former JAA/NAAs system, with particular attention paid to the necessity of maintaining the availability of the necessary authority expertise during and after this build-up phase. This requires careful management of a pool of sharable expertise, with appropriate sharing of this resource with national authorities, during the whole transition phase, until the agency is in a position to fulfil its responsibility and conduct all tasks with its own resources.

International relations, bilateral agreements

Interested parties have requested that every step of EASA establishment be carefully made so as not to disturb the validation of European certifications and approvals by foreign, non-European, authorities and the international exchange of aeronautical products and services. In particular, industry has insisted on the necessity for the European Community to conclude appropriate bilateral agreements with foreign countries, in particular with the USA. Negotiations are progressing between the European Commission, EASA and a number of foreign authorities, and working arrangements are already agreed with a number of them.

No significant difficulties have been noted so far in the international exchange of products and services, probably owing to the fact that it has generally been agreed that existing bilateral agreements will remain valid as long as necessary until replaced by new agreements with the EU/EASA.

Not long after the creation of the first regular air service between London and Paris, the residents of both cities started complaining about aircraft noise. The arrival of the jet age exacerbated the problem, Parisians and Londoners living under the flight paths took their cases to higher governmental bodies. The result was the introduction of operational restrictions and timeframes where aircraft could not land or take-off. These types of restrictions are still in place today, both in London and Paris, as well as most other airports around the world. The newer types of restrictions have become more complex, with different restrictions and landing fees enforced depending on the certified noise level of an aircraft.

Engine noise reduction programme
Making aircraft engines better neighbours

EASA - A NEW REGULATORY AUTHORITY FOR EUROPEAN AVIATION

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In line with the longstanding European industry principle of maintaining one level of safety for air transport throughout Europe, the establishment of EASA is considered by industry to be the logical final step to pursue the achievement reached by the former JAA system and transform it into a more coherent and efficient system, applying the principles of European Community treaties and accompanying the restructuring of the European aerospace industry.

Airbus and the whole European industry are placing great hopes in EASA, which they consider potentially to become the best aviation safety system for Europe and a model for the world, as well as an efficient partner of their future development.

Stephen Montgomery
Technical Manager
Engineering Centre of Competence Powerplant
Modern jets are much quieter than those first jet aircraft, thanks to increasing technology in both engine design, with higher by-pass ratios and better internal aerodynamics, combined with improved nacelle design, increased sound absorption and flow mixers.

Nevertheless, Airbus, in association with the major engine and nacelle manufacturers, constantly strives to reduce aircraft noise to meet the requirements of both the public and the environmental authorities.

An A322 or A317 aircraft to be certified after 2006, and not to current aircraft.

During initial discussion by the ICAO council (where Airbus was represented), it was clear to Airbus and CFM that Stage 4 would quickly become the reference standard by which all aircraft are measured. Therefore, even before the noise reduction target was known, Airbus and CFM launched initial design studies targeted to be introduced on the current A321 aircraft powered by CFM engines. This would allow reduction of A320 Family noise levels to whatever the Stage 4 noise requirements would be.

Airbus and CFM, along with nacelle manufacturer Goodrich Aerostructures Group (GAG), started investigating ways to reduce the noise signature of the engine. The particular concern was for the A321 aircraft at the highest MTOW (Maximum Take Off Weight), as the other members of the A320 Family already had a very good margin over Stage 3.

Nevertheless, it was clear that all modifications would have to be interchangeable across the entire Airbus A320 Family fleet to ensure part interchangeability and mix-ability was maintained.

Where to look?

Two major areas of improvements in acoustics were identified, these were both associated with the exhaust or jet noise of the engine.

The thrust reverser structure was acoustically treated along approximately half of its internal surface. It was clear that increasing this acoustic area would increase the acoustic sound absorption and hence decrease the overall measurable exhaust noise. The inner fixed structure was redesigned with increased acoustic area. In addition, the support struts and several fairings were also modified to include acoustic treatment. The result was an increase in the acoustic area of the thrust reverser by approximately 2 square meters (21.5 sq ft).

This increase would provide significant noise reduction, but would not be enough.

Next, the specialists turned their thoughts to the exhaust nozzle. The CFM engine nacelle has a separate flow short duct nacelle, which means that the bypass air and the jet (or core air) stay separated until right at the exhaust of the engine where the two flows meet. These two regions of air are moving at very different velocities, the core air being at much higher temperature and velocity than the bypass air. The resulting difference in energy causes shock waves, and shear, which result in noise. This is typically the highest noise source created by a modern high bypass jet engine.

If the core airflow is distorted and mixed into the bypass air there are less shock waves and hence the sound generated is reduced. However, distorting the flow of core air can have a significant affect on engine behaviour, especially for performance and fuel efficiency. Any modification in this area would have to be rigorously tested for effects on engine surge margin, Exhaust Gas Temperature (EGT) and Specific Fuel Consumption (SFC) amongst others.

Any distortion in this area therefore needs to be performed in a subtle manner. Studies on core chevron nozzles had shown good results from analysis, however model testing would be required to ensure the analytical results could be proven in the real world. The model tests could demonstrate the effects the chevrons would have on performance, but were subject to the usual scatter associated to model testing. The existing nozzle on the CFM56 engine is a two-piece construction made from high temperature resistant material. The idea was to utilize the current nozzle lines as much as possible to ensure a new chevron nozzle could be easily fitted onto existing engines, without modification of the actual engine hardware.

Chevron nozzle design challenges

Through model testing, it became apparent that the chevrons had a small but measurable effect on engine performance. This performance impact would have to be countered to ensure that the end result would be no difference in the operation of the aircraft, i.e. the operation of the engine and the basic engine reaction to control commands would not be different from the pre-chevron nozzle standard. The answer was to introduce a thrust compensator, which thanks to the CFM FADEC (Full Authority Digital Engine Control) simply required a software modification and a way of identifying to the aircraft when a chevron nozzle was fitted. This is currently done through a FADEC software change and a programmable engine data plug, which has push-pull pins allowing a discrete to be set on or off for the thrust compensator.

Additional verification from the MCDU (Multifunctional Control and Display Unit) allows programming on the aircraft side to tell the system a chevron nozzle is fitted, allowing a check between aircraft and engine to be made. This ensures that the thrust compensator logic is only applied when a chevron nozzle is fitted.

The result is full interchangeability and mix-ability of the chevron nozzle on A320 Family aircraft.

Another of the design challenges was durability. The introduction of the chevrons meant that there were now ‘petals’ of material in the hot air stream, which are subjected to high thermal stresses as well as high...
With the entry into service of the A380 less than a year away, preparations by the lead airlines and airports to receive the aircraft are in full swing. The coming months will see the culmination of many years of collaboration between Airbus and the airport community, all focused on ensuring a smooth entry into service.

To ensure that Airbus customers receive a reliable, mature aircraft with the capability to fit seamlessly into their existing ground operations environment, early engagement by the A380 operators has already started. The first airport check exercise was performed at Frankfurt Airport to perform the first of a series of airport check exercises, coincidentally 4 years to the day after the A340-600 visited to do the same before its entry into service. It was no coincidence however that the A380 arrived, was handled and departed using almost the same infrastructure, procedures and equipment that the A340 did four years earlier.

Many aspects of the A380 design have been driven by airport compatibility considerations, thus minimizing the amount of adaptation, and hence investment, required by the airports.

The test

During their development, the actual noise reductions resulting from the improvements could only be estimated. The flight effects, particularly for the chevron nozzle, could not be fully represented by model analysis. Therefore, the true result would come only from flying the aircraft in the correct configuration in front of the airworthiness authorities.

For a new certification of aircraft noise, there are certain weather conditions that must be adhered to. There is a narrow band of climatic conditions, which means flight testing can only be performed at certain times of the year, to be certain of catching these weather conditions.

A production A321 was used for acoustic certification flights at an airport specially selected for its ideal weather conditions, which increased the chances of having ‘good’ weather.

The flight test provided good results with the high weight A321 having an 11.2 EPNdB noise reduction compared to Stage 3, which is 1.2 EPNdB below the Stage 4 requirements.

To ensure that Airbus customers receive a reliable, mature aircraft with the capability to fit seamlessly into their existing ground operations environment, early dialogue with all stakeholders involved in airport operations was essential. This has been recognised on all Airbus aircraft programmes, and for the A380, the extensive consultation is now paying dividends. On 29 October, at 08:56, A380 MSN004 touched down at Frankfurt Airport to perform the first of a series of airport check exercises, coincidentally 4 years to the day after the A340-600 visited to do the same before its entry into service. It was no coincidence however that the A380 arrived, was handled and departed using almost the same infrastructure, procedures and equipment that the A340 did four years earlier.

Many aspects of the A380 design have been driven by airport compatibility considerations, thus minimizing the amount of adaptation, and hence investment, required by airports to accommodate the aircraft. The main aim of this design optimization was to ensure that the A380 could be handled in the most part like any other widebody aircraft. It was this capability that was validated by the tests at Frankfurt, which consisted of both an aisleway and landside element. The following describes, with figures from the tests, the process of handling the A380 and its similarities with other widebody aircraft.

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Conclusion

The Airbus and CFM view at the time was correct; Stage 4 has now become the reference standard to which all aircraft are measured. With the application of the noise reduction programme the A321 can join its A320 Family stable-mates in being the quietest aircraft in service today.

The noise reduction package is currently offered as the basic standard on all CFM powered Airbus A321 aircraft. It is also optional on all the other A320 Family aircraft.

Due to the easily distinguished profile of the chevron nozzle, those airlines operating aircraft with this modification package are easily identified as having associated lower noise characteristics and therefore being more environmentally friendly.

The acoustic benefits for the other A320 Family members will be less than for the A321, but would be able to be certified upon airline request - for airlines interested in achieving even more margin to Stage 4. This may be particularly interesting in the future if individual airports in highly populated city areas introduce penalties and landing surcharges based on noise levels even more stringent than Stage 4.
Airside compatibility

The airside element saw the aircraft arrive at a landing weight of 382 tonnes, just 4 tonnes below the maximum. It then taxied direct to stand E9 at terminal 2 where ground tests were carried out until 19:00, these are described in the following sections. The next day the aircraft departed at 09:34 at a take-off weight of 400 tonnes.

With a lower approach speed, better take-off, landing and climb performance than today’s largest aircraft, the A380 completed the airside elements of the check successfully, and performed in much the same way as any other widebody aircraft operating into Frankfurt that day. Similarly, due to better ground manoeuvrability and pavement loading than aircraft such as the A340-600 and B777-300ER, no problems were encountered during the taxi to the stand.

Landside compatibility

STANDS

The landside element started as the aircraft approached stand E9, shown on the left, one of eventually 18 A380 capable stands at the airport. With a mezzanine cockpit between its main and upper decks the A380 reference pilot eye height is 7.2m (23.6ft) but that of the 747-400 at 8.7m (28.5ft) and other widebodies at about 6m (19.7ft). This allows good forward visibility as well as compatibility with existing stand guidance systems, as was the case at Frankfurt.

At a width of 80m (262.5ft), stand E9 is an ICAO (International Civil Aviation Organization) Code F stand, capable of accommodating any aircraft up to a maximum wingspan of 80m. Many of the more than 60 airports that will see A380 operations by 2010 are taking advantage of the fact that Code F stands can have a MARS (Multi Aircraft Ramp uSage) capability. This capability allows two single-aisle aircraft to be parked in the same space as an A380. As terminal stands are used by many different sizes of aircraft during any given period, MARS stands allow airports to optimize gate usage and terminal efficiency. The A380 can also be accommodated at 65m (213.3ft) wide Code E stands if the size of aircraft on adjacent stands is limited to that of smaller widebodies.

RAMP OVERVIEW AND BRIDGE DOCKING

When the aircraft came to a stop and was chocked, the ground handling tests could begin. Several ramp scenarios were simulated, based around the standard layout with upper deck catering, shown on the right. Other equipment, not normally part of the normal round turn process was also tested as well as multiple pieces from different manufacturers. In total around 40 different pieces of GSE (Ground Support Equipment) were used, this compares to around 21 for a standard A380 round turn, a similar number to existing large aircraft.

The first process to take place was the positioning of the passenger boarding bridges. Stand E9 is equipped with two boarding bridges, with the second able to reach the 8m (26.2ft) door sill height of the upper deck. Although not an operational necessity, many airports are planning some form of upper deck access to enhance product differentiation and passenger service levels. Docking took place at main deck door M1L (main deck forward left door) followed by upper deck door U1L (upper deck forward left door), shown on the right. The main deck bridge was then moved to main deck door M2L. The docking process went smoothly with the desired clearances achieved, although the upper deck bridge canopy was not fully flush with the fuselage of the aircraft, a small case which a minor adjustment of the canopy rigging will solve.

Since MSN004 does not have a passenger cabin (it is equipped with a full flight test installation), boarding was restricted to the flight test crew. Full scale, timed, turn round tests including passenger boarding and cargo handling will be conducted during the route proving flights due to take place in mid 2006. These tests will validate that, due to its superior cabin architecture, the A380 will offer similar boarding and turn round times to existing aircraft using two main deck bridges.
**GROUND AND CABIN SERVICING – ONLY TWO NEW GSE PIECES REQUIRED FOR A380 SERVICING**

Following the successful docking of the bridges, the positioning and connection of the ground servicing equipment could commence. With main and lower deck doors as well as ground service connection points at the same height as those of existing large aircraft, the A380 is serviced using mostly existing ground servicing equipment and processes. Of the 21 pieces of equipment that are required to service the aircraft, 19 are standard widebody units, which can be found on any airport ramp today. As with any other aircraft, it is recommended to check the equipment manufacturers specification against the aircraft requirements to ensure compatibility of a certain piece of GSE. A380 requirements can be found in the Aircraft Characteristics for Airplane Planning (AC) document, available on the Airbus website (link at the end of this article).

The two A380 specific units are an upper deck catering vehicle, which allows direct access to the large upper deck galley in order to enhance catering times, and to the aircraft’s higher ramp weight, a more powerful tow tractor. These units are compatible with existing widebody aircraft, this being a clear requirement from the airlines and handlers that helped define them in regular Airbus organized working group meetings. They are available from several manufacturers, some of who provided vehicles for the Frankfurt tests.

**A380 CAPABLE TOW TRACTORS**

Carrying 555 passengers up to 8,000nm means that the A380 has a higher MTOW and consequently MRW (Maximum Take-Off Weight and Maximum Ramp Weight) than today’s largest aircraft. Although this extra weight does not result in higher pavement loading than existing widebody aircraft (the A380 has more wheels to spread its weight) it does necessitate heavier and more powerful tow tractors. This is especially the case if push back at MRW and under low traction conditions is to be achieved.

Both conventional (towbar) and towbarless A380 capable tractors are available from several manufacturers. The requirements for these vehicles have been defined in Airbus organized working groups in which airlines, GSE manufacturers and ground handlers were involved. Today eight manufacturers are offering A380 capable tractors with several already in service.

Conventional A380 capable units weigh around 70 tonnes and have engines with around 300hp, which allow them to handle the A380 at MRW and under poor surface friction conditions. At weights below MRW and/or with good surface friction, it is also possible to use existing widebody tractor units. As for all other aircraft, the A380 requires its own dedicated towbar.

Existing towbarless tractors cannot handle the A380 due to its larger nose wheel size; therefore new models have been defined and are today available from five manufacturers. These new designs were again defined during the working group meetings. Due to the direct interface between these tractors and the aircraft nose landing gear these units need to be qualified prior to being used on the A380 on a regular basis. The towbarless tractor qualification procedure is a standard practice today for all Airbus and other manufacturers aircraft and ensures that the pushback and towing manoeuvres will not adversely affect the nose landing gear life cycle.

**CONCLUSION**

The fact that nine vehicle manufacturers have announced the availability of prototype vehicles before entry into service (three of which were tested at Frankfurt) is again testament to the cooperation between Airbus, the airlines, catering, and vehicle manufacturers. The upper deck catering working group, organized by Airbus, was successfully concluded in the summer of 2005 after eight meetings. During these meetings different concepts were analysed and basic functional requirements were defined. IATA has also developed a dedicated Airport Handling Manual standard (926) in its 2005 issue. A new ISO standard on upper deck catering vehicles is also under development.

The Frankfurt airport check exercise represented the culmination of many years of cooperation between Airbus and the airport community on the design of the A380. It also signalled the readiness of airports to accept the aircraft using mainly existing infrastructure and equipment, thus validating a design goal set from the start of the programme. In the coming months Airbus contact with the ground handling community will continue in conjunction with customer airlines through a more general ground handling working group. This will ensure that all relevant information is passed to those who will shortly be regularly servicing the aircraft. The route proving campaign will then be the final validation of the airport optimized design of the A380, providing Airbus, customer airlines, airports and ground handlers with the knowledge and experience to ensure a smooth entry into service.
The ability to offer a wider range of experience, such as ‘black hole’ approaches, or airports in line with a pilot’s future operating environment in different parts of the world is the ideal for pilot familiarization, but is not feasible in this situation. Considering these issues, and with a vision of what an ideal system should be like, Airbus training has developed and introduced an innovative tool for pilot training. This is the Airbus Training Airport - a virtual airport that is used in the MFTD (Maintenance/Flight Training Device) and in the Full Flight Simulator for the new Airbus Pilot Transition (APT) courses. Its objective is to provide functionalities to enable pilot training on most types of approaches, runways, signboards and ground markings etc that they will encounter worldwide.

This article describes the six steps it took to achieve the Airbus Training Airport: airport site, platform, terminal buildings and facilities, charts, FMGS (Flight Management Guidance System) database and visual scene.

Airport site
The airport position is: 46 24.4N/004 01.3E. The reason for this choice is the presence of a flying school that has available runway and radio aids. In addition, it is close to the centre of France, thus it is possible to fly a one-hour leg to the major airports of the neighbourhood.

Platform
The platform was designed to provide the functionalities to train pilots on most of the types of runways, signboards, ground markings and so on. To achieve this, it was designed according to the airport on the selected site. However, this did not offer all the possibilities needed, so it was necessary to add a new runway at 90° to the existing one to allow particular circling approaches, which necessitated diverting the course of the river Loire!

Fortunately, as this is a virtual airport and consequently a virtual river diversion the residents of the new river course did not get wet!

For performance limitations: GPWS (Ground Proximity Warning System) training and ILS (Instrument Landing System) approaches with a 4° glide slope a hill was introduced in line with the new runway. Urban areas were also included for noise abatement restrictions.

The design of taxiways and ground markings was done with experts from the French Civil Aviation Authorities in compliance with ICAO (International Civil Aviation Organization) annex 14 as well as French regulations. Particular attention was paid to ground markings due to the taxi training recommended by the FAA (Federal Aviation Administration) in Advisory Circular 120-74.

The platform has three runways of different lengths and widths and an additional one under construction. All have several approach lighting systems (PAPI, APAPI, VASI). A LDIN (Lead-in Light System) approach is also available with a final turn over water as a lake was added to enable this.

The platform will be available in 2007 in Jeppesen ANS (Airport Navigation System). In addition, the software makes it possible to reproduce airport traffic moving on the ground so training exercises, in particular with low visibility, are achievable. One of the most difficult parts of a flight in some congested airports is the taxi from the gate to the holding point and from the runway to the gate. This is significantly eased when the airport is equipped with the SMGCS (Surface Movement Guidance Control System) and the airport also has this possibility.

ABBREVIATIONS
PAPI: Precision Approach Path Indicator
APAPI: Abbreviated Precision Approach Path Indicator
VASI: Visual Approach Slope Indicator
LDIN: Lead-in Light System
Terinal buildings and facilities

The airport has a main central terminal building and two side satellites. Each is devoted to an aircraft size: the north satellite for the A380, the central terminal for the A330/A340 and A300 families and the south satellite for the A320 Family. Three different aircraft guidance systems are implemented at the gates. The airport has two control towers, a freight terminal, a maintenance hangar and several parking positions on the tarmac. A fire station is included, as well as some administration buildings. The service roads and antennas of radio aids are also shown on the visual scene.

FMGS database

The STARs (Standard Terminal Arrival Routes), SIDs (Standard Instrument Departures), and instrument approaches listed in the pilot documentation are included in the FMGS (Flight Management and Guidance System) database and coded according to ARINC (Aeronautical Radio, Inc) 424 norms. The database is then translated by another software into data to be processed by the simulator image generator. The airport is available for a number of visual systems of different manufacturers.

Visual scene

For training tools like flight training devices or full flight simulators the visual scene is of paramount importance, as its level of reliability and visual quality has a direct impact on the level of training.

The design of the airport visual scene started with a two-dimensional model drawing followed by building from this a three-dimensional model using appropriate software. The model data was then translated by another software into data to be processed by the simulator image generator. The airport is available for a number of visual systems of different manufacturers.

The airport was designed by ENAC (Ecole Nationale de l’Aviation Civile), which is the French aviation academy. With the airport it is possible to practise ILS approaches, CAT I, CAT II and CAT III with a 3° glide slope and also a 4° glide slope on different orientations of the same runway.

Non-precision approaches like VOR, DME, ADF, localiser back course and even VDF (Voice Directional Finder) are also possible.

The basic issue of the charts is in AIP (Aeronautical Information Publications) format converted to Jeppesen format and it will be available in LIDO Flight Nav format as well. These formats are alternative versions of the charts available for airports (see examples and list on the left).

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Particular attention was paid to details to obtain high definition of the close environment of the airport.

Pilots in some regions of the world may have to land at night with only the runway lights as a reference, which is a so-called ‘black hole approach’. Such an approach can be simulated with the airport by switching off all the lighting of the environment of the visual scene except the lights of the landing runway.

Conclusion

This was achieved by day, as well as by night, in all kinds of weather conditions such as nice weather, fog and snow. When the runway is wet or contaminated with ice, snow, or slush, the visual scene reflects the runway surface and degraded braking action is reproduced.

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Countering jet fuel price increases
Guidance on fuel saving

In the last two years the average cost of jet fuel has doubled as shown in the report on the right, while competition in the airline industry is intense. Consequently, more and more airlines are looking to optimize their fuel consumption as a means of minimizing overall costs.

The mechanisms for maximising fuel economy are well understood as being aerodynamically clean aircraft, well maintained engines and good flight planning and procedures.

This article highlights existing Airbus ‘Getting to grips with’ publications where information on optimizing fuel consumption can be found and identifies some additional areas for consideration.

getting to grips with fuel economy
ISSUE 3 - JULY 2004

This examines the influence of flight operations on fuel conservation and provides recommendations to enhance fuel economy. It covers maximization of range for a given payload, the decrease of fuel uplift from high fuel cost airports and introduces the concept of cost index (see ‘Getting to Grips with the cost index’ on the right).

Also, it systematically reviews fuel conservation relative to ground and flight performance, including centre of gravity position, excess weight, flight planning, auxiliary power unit operations, taxiing, climb, step climb, cruise, descent, holding and approach.

getting to grips with the cost index
ISSUE 2 - MAY 1998

In addition to navigation functions, the Flight Management Computer (FMC) carries out real-time performance optimization aimed at providing best economics, not simply in terms of fuel consumption, but rather in terms of direct operating costs. This is achieved using the cost index concept that helps fuel and time-related costs to be balanced.

Airbus has recently launched a new software tool called AirSavings. It is designed to provide a dynamic determination of the cost index under a wide variety of operational criteria so that it can be accurately tailored to the specifics of an airline’s operation on a particular route.

None of the information contained in the ‘getting to grips’ publications is intended to replace procedures or recommendations contained in the Flight Crew Operating Manual (FCOM), but rather to highlight the areas where maintenance, operations and flight crews can contribute significantly to fuel savings.

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This examines the influence of aerodynamic deterioration on operational costs. During an aircraft’s life deterioration is likely to occur and drag can increase by up to 2% within five years. This in turn can result in a significant fuel consumption increase. However, this cost has to be traded against the cost of maintenance to establish when it is cost-effective to carry out corrective measures.

Cost-benefit analyses are a practical way to approach this and Airbus has carried out numerous performance audits in cooperation with airlines. Consequently this can help operators determine corrective actions that are financially beneficial despite the short-term maintenance costs.

This addresses three different aspects of aircraft performance:
• Physical aspect: Reminders on flight mechanics, aerodynamics, altimetry, influence of external parameters on aircraft performance, flight optimization concepts, etc.
• Regulatory aspect: Description of the main JAR and FAR certification and operating rules, leading to the establishment of limitations.
• Operational aspect: Description of operational methods, aircraft computer logics, operational procedures, pilot’s actions, etc.

This provides guidelines for aircraft performance monitoring based on feedback obtained from many operators and on Airbus’ knowledge of its aircraft. It has five objectives:
• Introduce performance monitoring, presenting the different analysis methods and tools.
• How to deal with the amount of data required, the most common ways to get data routinely recorded are described via a quick overview of the available aircraft systems.
• Guidelines on the way to process the data using one of the Airbus aircraft performance-monitoring tools, namely the APM programme.
• Assessing data coming from regular cruise performance analysis.
• Airbus recommendations on how to use the results of analysis in daily aircraft operations.

In addition to the ‘getting to grips with’ publications an airline has many other routes available for minimizing fuel expenditure, including:
• Minimising dispatches under MEL (Minimum Equipment List) conditions that include requirements for additional fuel reserves, or where fuel burn is increased.
  Example: dispatch with wing anti-ice valve failed in open position may increase fuel consumption by up to 6% depending on aircraft.
• Implementing an engine health monitoring system
  Example: engine component defects may increase fuel consumption while remaining operational and engine health monitoring can highlight such increases.
• Working closely with the engine shop to establish an optimized refurbishment workscope that provides the best compromise between cost, reliability and performance restoration.
• Developing an engine water wash schedule
  Over time, dirt accumulation on the compressor airfoils reduces engine compressor efficiency. Engine core water washes are recommended to remove this. Contamination levels depend on the aircraft’s operation and environment, so wash frequency must be optimized by each operator. Periodic engine water washes also have a positive effect on the exhaust gas temperature margin and consequently on engine life.
• Trading passenger comfort or service against weight (carrying newspapers, magazines, blankets, reducing potable water carried, etc.).

Airbus has previously published a wide range of information and recommendations for the optimization of both aircraft performance and fuel economy. These publications remain as valid today as when they were published (with the exception of certain economic conditions). The breadth of these recommendations illustrate that an airline wishing to minimize its fuel bill will be best served by adopting a holistic or airline-wide approach and not making fuel economy the responsibility of any single entity in the organization.

Airbus also recognizes the increasing importance of fuel efficiency to its customers so further support will become available during the course of 2006.
Giants of the skies, past and present

A ‘giant of the skies’, a seven seater Fokker D378 of Aero Lloyd, lands at Hamburg Fuhlsbüttel airport in Germany in 1926 – the same year Germany’s main airport Frankfurt opened.

Almost 80 years later, on 29 October 2005, another ‘giant of the skies’ landed at Frankfurt airport and is shown docked. This is the 555 seater Airbus A380 - how things have changed, not only for aircraft but airports too!
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Customer Support Centres
Training centres
Spares centres / Regional warehouses
Resident Customer Support Managers (RCSM)

RCSM location Country
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Ajaccio France
Alger Algeria
Al-Manamah Bahrain
Amman Jordan
Amsterdam Netherlands
Auckland New Zealand
Baku Azerbaijan
Bandar Seri Begawan Brunei
Bangalore India
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Dhaka Bangladesh
Doha Qatar
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Fort Lauderdale United States of America
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Jinan China
Johannesburg South Africa
Karachi Pakistan
Kita-Kyushu Japan
Kuala Lumpur Malaysia
Kuwait City Kuwait
Lanzhou China
Lamaca Cyprus
Lisbon Portugal

RCSM location Country
London United Kingdom
Louisville United States of America
Luton United Kingdom
Macau S.A.R. China
Madrid Spain
Manchester United Kingdom
Manila Philippines
Mauritius Mauritius
Memphis United States of America
Mexico City Mexico
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Quito Ecuador
Rome Italy
San'a Yemen
San Francisco United States of America
San Salvador El Salvador
Santiago Chile
Sao Paulo Brazil
Seoul South Korea
Shanghai China
Sharjah United Arab Emirates
Shenyang China
Shenzhen China
Singapore Singapore
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