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to the Right
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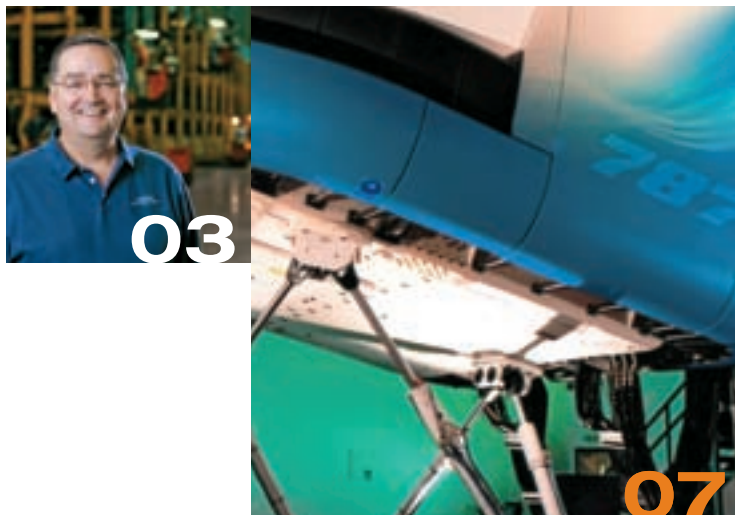
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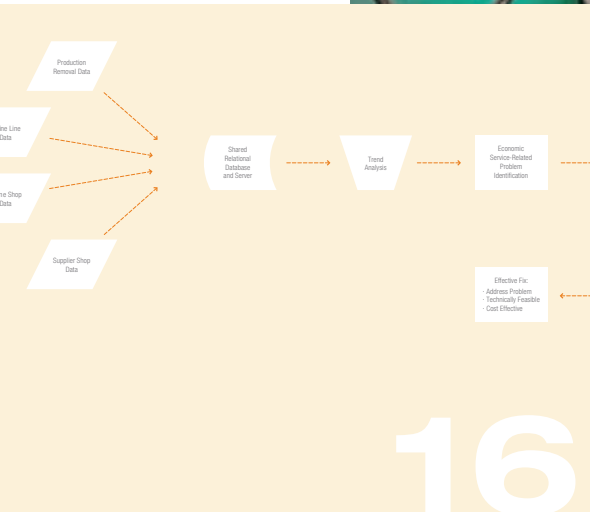
AERO

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Boeing continually communicates with operators through such vehicles as technical meetings, service letters, and service bulletins. This assists operators in addressing regulatory requirements and Air Transport Association specifications.

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Getting the Right Part to the Right Place at the Right Time



MARK OWEN
Vice President
Material Management
Boeing Commercial Aviation Services

Mark Owen at the Boeing Spares Distribution Center in Seattle.

During the past several weeks, I've had the opportunity to present the Material Management Lean Vision and Implementation Plan to more than 50 airline customers at a variety of meetings and a symposium. Contrary to what many think, the objective of Lean is not to support our customers with less but, instead, to reduce internal Boeing cycle times in order to speed the effectiveness of the support we provide our customers. It is meant to – better than ever before – provide the right parts to the customer as quickly and efficiently as possible.

I can honestly say that after two years of focus on Lean, our Material Management organization is fully engaged. Customers are seeing us respond with answers more quickly. They are receiving more regular updates when we're still working the

problem. The Air Transport Association Industry Standard Metrics, which we use to track our progress, are showing that for airplanes on ground (AOGs), we have a part available to ship in four hours or less almost 80 percent of the time —



We continue to refine our operations based on customer feedback. Specifically, each year, we invite 15 to 18 airline customers to what has become an annual meeting called the Material Management Customer Council.

up from only about 40 percent of the time a year ago. Our schedule performance for non-AOGs has also been improving.

However, we realize that we have a significant way to go. Some common themes from customers that I've received include:

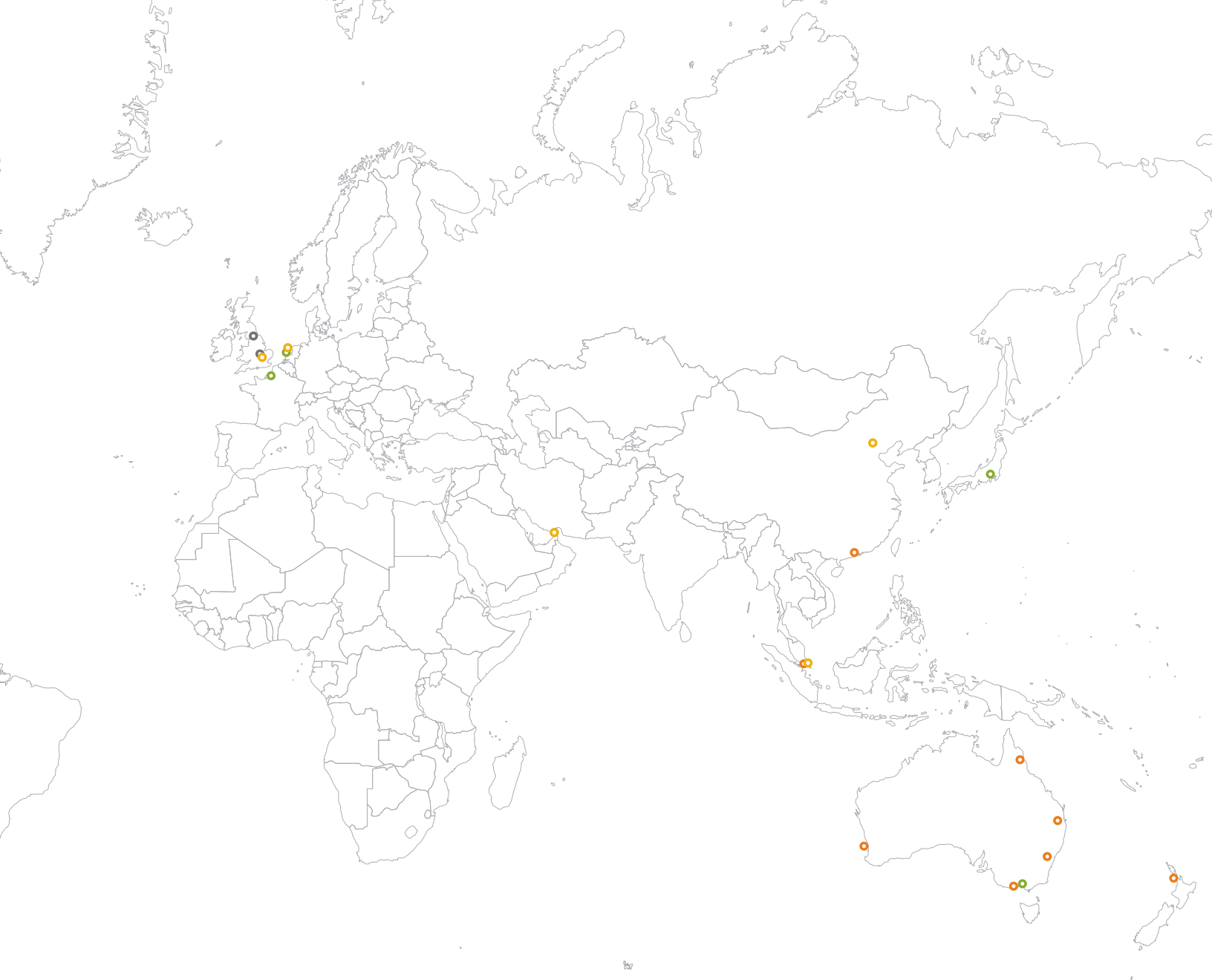
- We need to publish more reliable lead times.
- We need to do a better job of supporting all types of in- and out-of-production parts.
- We need to do a better job of supporting our customers with small fleets.
- There is a desire for more data — more on key performance associated with service bulletins, management control parts, and price escalation.

We continue to refine our operations based on customer feedback. Specifically, each year we invite 15 to 18 airline customers to what has become an annual meeting called the Material

Management Customer Council. During our last meeting at the end of August (our third annual), we captured a specific set of action items that we will work, track, and report back to the Customer Council on a regular basis. Without a doubt, this feedback will help us identify gaps and make our organization more efficient, so we can meet our goal of being No. 1 in customer support.

In order to meet your needs, feedback is imperative. I welcome your comments and questions. Please feel free to contact me directly at MaterialManagement@boeing.com.

MARK OWEN
VICE PRESIDENT, MATERIAL MANAGEMENT
BOEING COMMERCIAL AVIATION SERVICES



Boeing operates the aviation industry's most comprehensive spare-parts sales and distribution network, maintaining the inventory for about 500,000 different types of parts to support the worldwide fleet.

- Distribution centers
- Component repair centers
- Continental DataGraphics offices (subsidiary)
- Avial offices (subsidiary)

787 Training for Pilots and Mechanics

By Capt. Al Nader, Director, 787 Training;
Jeff Haber, Manager, 787 Maintenance Training;
and Don Reiter, Manager, 787 Flight Training



ADVANCED TRAINING
TECHNIQUES RESULT IN
SHORTER, MORE
EFFICIENT TRAINING
FOOTPRINTS.

Believing that the new digital technology of the 787 Dreamliner required a digital training solution to maximize training effectiveness and value to customers, Boeing has developed an all-digital, Internet-based teaching system for flight and maintenance training, along with training tools that connect real-time to a virtual airplane and airplane systems. The use of personal desktop computers, interactive computer-based training, three-dimensional images, and desktop simulation make it possible to do much more efficient training. Modern flight training devices and simulators combine with these tools, digital delivery, and currency based on fleet commonality to offer significantly shorter courses than on previous Boeing training programs. These new training programs are available at subsidiary Alteon's global network of 787 training locations.

In much the same way that training moved from viewfoils on the 747, 757, and 767 to electronic training for the Next-Generation 737 and the 777, the training system and new simulation devices for the 787 use technology to take learning to the next level.

But the 787 training program is more than just a training program. A strategic decision was made to build an electronic performance support system rather than a traditional training program. It is designed to be an integrated electronic environment that's available to, and easily accessible by, each trainee and structured to provide immediate, individualized access to a full range of information, from flight and maintenance technical

documents to airplane troubleshooting and systems information. These programs are offered through Alteon, Boeing's training subsidiary.

This article describes Boeing's development of a new training program from the ground up that takes advantage of and complements the 787's design and technology, e-enabled and digital technology, and respect for the environment. It also outlines the guiding principles behind 787 flight and maintenance training. All training programs detailed in this article are subject to regulatory agency approval and may be modified during the approval process before they can be used to train airline pilots and mechanics.

Technological advances in the airplane inspired similar technological advances in training. This approach puts the trainee as close to the actual airplane as possible.

TRAINING TECHNOLOGY INSPIRED
BY THE AIRPLANE

The new 787 training system reflects many of the advanced technologies in the 787 Dreamliner itself. This approach puts the trainee — whether in flight training or maintenance training — as close to the actual airplane as possible. The effectiveness of this approach means shorter, more efficient training footprints. For example, a 777 pilot can complete 787 flight differences training in five days with no full-flight simulator, and the maintenance training Line and Base Course is 50 percent shorter than the 777 course. Distance learning options reduce time at the training center and prepare students for formal training.

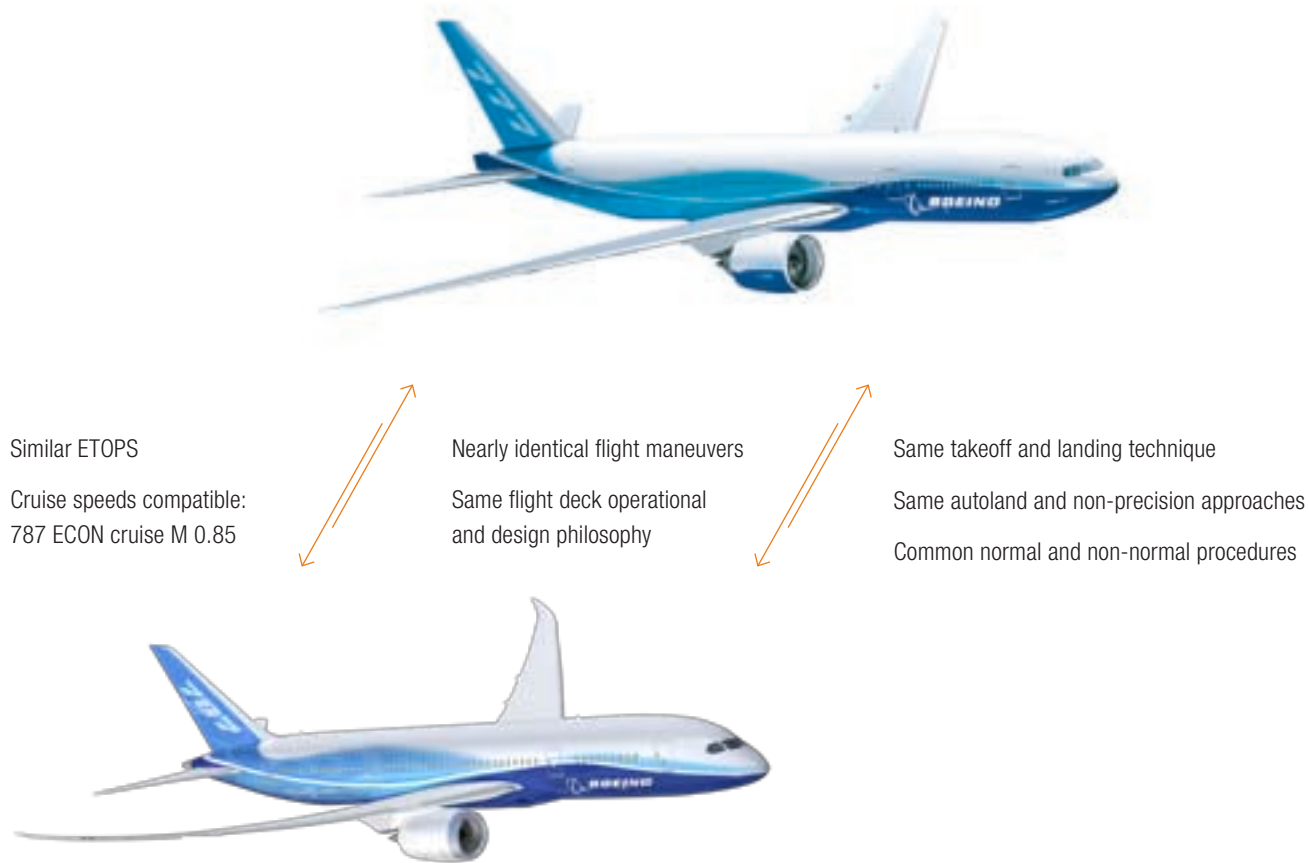
Simulation-based training. One of the objectives of the new training system is to replicate the airplane — not just the flight deck — and bring real, performance-based information to pilots and mechanics. This led to the use of real-time simulation in the maintenance training environment that allows practice on the same tools in the classroom that the mechanics actually use in the field on the airplane.

It also inspired the use of flat panel, touch-screen trainers that have simulated functionality, as well as real hardware where tactile feel is important. These simulators can be used to train pilots on all aspects of operation, including the new heads-up display and electronic flight bag features of the 787 without the need for costly fixed-base simulators.

HIGH DEGREE OF PROCEDURAL COMMONALITY BETWEEN 777 AND 787

Figure 1

The high degree of commonality between the 777 and 787 means it will take as few as five days of training for 777 pilots to qualify as 787 pilots.



E-enabled and digital technology.

Technological advances in the airplane inspired similar technological advances in training. For instance, the airplane is e-enabled and so is training, including training delivered just in time at the point of use. The development work in progress targets a Web-managed, distance-learning capability that brings training to the trainee in a paperless training environment. Enhanced technical data for flight training will include linkable features in the Flight Crew Operating Manual and Flight Crew Training Manual. The system also provides training that familiarizes mechanics with the 787's real-time, current airplane performance support data that is accessed through the Web portal MyBoeingFleet.com.

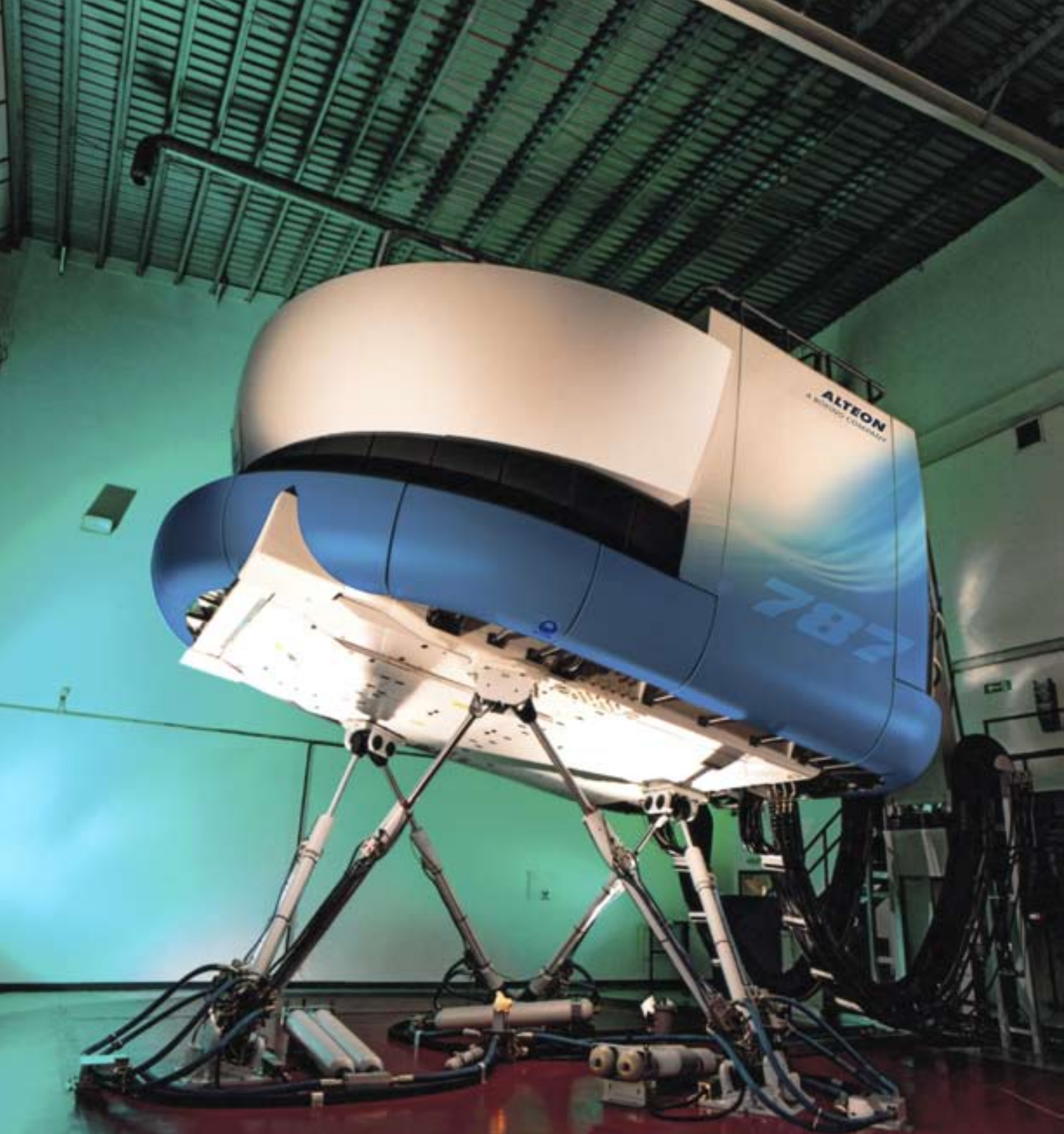
Respect for the environment. An e-enabled airplane supports a more environmentally progressive training solution. Distance learning enables more training to be conducted locally. Digital Web-managed training, training support products, and the use of tablet personal computers for note-taking eliminate the need for paper along with the attendant production waste, transportation, distribution, storage, and revisions.

FLIGHT TRAINING

The philosophy behind the 787 flight training program is to leverage airplane commonality with the 777 and other Boeing models, enable students to achieve a high degree of proficiency, and continue to build on the success of the Shortened Transition

and Rating (STAR) courses. The STAR courses reduce the transition time for pilots current on other Boeing models by eliminating tasks and objectives that are common between those models and the 787. In keeping with the concept of training technology inspired by the airplane itself, 787 flight training incorporates modern simulation tools, Web-managed academics, and performance support data to provide an effective training environment that mirrors the actual airplane. Training is available through Alteon, Boeing's training subsidiary, at a global network of 787 training centers.

Commonality. The 787 is designed to be operationally common with the existing Boeing fleet, with the highest commonality with the 777 (see fig. 1). For instance, even though it may look



787 FULL-FLIGHT SIMULATOR

Figure 2

The 787 full-flight simulator is a Level D device with six degrees of freedom; wide day, night, and dusk visuals; and selectable customer options. It includes dual heads-up displays and electronic flight bags and a brief/debrief station. The line-oriented simulation training verifies proficiency in normal procedures. The simulator is

designed to train pilots to become proficient in visual maneuvers, instrument landing system (ILS) and non-ILS approaches, and missed approaches using integrated approach navigation, non-normal procedures with emphasis on those affecting handling characteristics, and wind shear and rejected takeoff training.

different, the 787 flight deck operates just like the flight deck on a 777. As a result, it takes as few as five days of training for 777 pilots to qualify as 787 pilots. The pilot pool for operators of 777/787 mixed fleets is the same, and 787 pilots will spend less time training and more time flying.

The commonality extends to other Boeing airplanes as well. For example, Boeing is developing other short courses, such as a course from the 767 to 787, which could be as short as eight days. (As a comparison, it would take more than 21 days to train these pilots to fly a non-Boeing airplane.)

Proficiency. 787 pilot training is based on a complete, detailed task analysis of pilot actions required to fly the airplane. These tasks define the pilot knowledge, skills, and crew resource management abilities necessary to perform those actions. Systems instruction is reinforced with hands-on

training. Pilot training courses meet the regulatory requirements of the U.S. Federal Aviation Administration and the European Aviation Safety Agency. Courses are approved for Federal Aviation Regulations Part 142 and Joint Aviation Requirements-Flight Crew Licensing (Type Rating Training Organization). Course lengths may be adjusted based on the pilot's experience and English language ability, and can vary based on individual operator circumstances and requirements.

Shortened transition and rating.

STAR courses allow pilots with experience on different Boeing models to train together, giving both the airlines and their pilots more flexibility.

As a comparison, courses to train pilots on non-Boeing models require that the pilots have identical backgrounds and career paths to train together. This requirement forces airlines to send the crews through more costly full-transition training.

A global network of 787 training centers. Alteon will have nine full 787 training suites around the globe to support the growing number of 787 operators. Having 787 training centers closer to customers' home base reduces operators' training-related costs, such as crew downtime.

The locations include two in the United States, and one each in China, England, India, Japan, and Singapore, with two locations yet to be announced. Each training suite includes a full-flight simulator (see fig. 2), a flight training device (see fig. 3), desktop simulator-based training, maintenance training tools, and a door trainer. Most of these Alteon-designated 787 centers will be ready for training in advance of the first airplane delivery.

787 launch customer ANA (All Nippon Airways), as well as Northwest Airlines and Shanghai Airlines, are home to three of the Alteon training centers that include 787 training suites and sophisticated maintenance training classrooms.



787 FLIGHT TRAINING DEVICE

Figure 3

The 787 flight training device provides flight crews with the same flight management and control systems as the full-flight simulator, making it ideal for instrument familiarization and reinforcing knowledge of airplane systems. It develops proficiency in all normal procedures, simple non-normal procedures, the flight management system, autoflight operations, and display operations, including electronic flight bags and heads-up displays. It also enables flight crews to become familiar with complex non-normal procedures.

Flight Training Courses and Services

Boeing 787 Flight Training offers a number of options designed to match the experience and needs of a wide variety of students. Below is a list of offerings.

Full Transition Training

20 days

Shortened Transition and Rating (STAR) Training

13 days

777 to 787 Differences Training

5 days

Airplane Training*

Route and Line Training (Initial Operating Experience)*

Instructor Pilot Training*

Dispatcher Training

5 days

Performance Engineer Training (Generic)*

787 Emergency Exits/Doors Training

1 day

Flight Attendant Transition Training

2 days

* The number of days varies depending on the airline and regulatory requirements.

Note: Course lengths listed are targets and may change subject to task analysis/course design, validation, regulatory approval, and airplane design changes.

Rather than having to use a standard training program, operators who purchase the 787 Dreamliner can select from a variety of training resources.

Distance learning. Distance-learning training options enable students to complete portions of the computer-based training segment of a selected course at their home station prior to arriving at the training center. Individually paced, highly interactive computer-based training is available for all airplane systems and can be customized to major airplane options, including engine type, displays format, and units (pounds or kilograms). The courseware is managed through Alteon's online Learning Management System.

Training flexibility. Rather than having to use a standard training program, operators who purchase the 787 Dreamliner can select from a variety of training resources. Each customer receives "training points" that may be redeemed (until two

years after its last airplane is delivered) for a choice of Alteon training services (see "Flight Training Courses and Services"). This allows airlines to customize training packages to meet their unique training requirements.

MAINTENANCE TRAINING

The maintenance training program for the 787 leverages and integrates with the data support program of the airplane data support program. The emphasis is on performance support with the fundamental premise of the training program being to help airlines use the electronic data tools quickly, efficiently, and with confidence. Specific features of the program include:

MAINTENANCE PERFORMANCE TOOLBOX

Figure 4

The Boeing Maintenance Performance Toolbox is an electronic performance support system designed to provide assistance in learning and performing tasks.



Simulation of the work environment.

This new training approach maximizes the use of actual airplane maintenance data in the classroom environment. Students practice using a laptop computer to troubleshoot real-world scenarios. Because the laptop is the main troubleshooting tool on the 787, the classroom practice exactly replicates the actual work environment. The primary interface for 787 support data is the Maintenance Performance Toolbox (see "Maintenance Performance Toolbox," *AERO* first-quarter 2007), which accesses maintenance procedures, fault isolation procedures, parts information, and other maintenance data in electronic form on a laptop computer (see fig. 4). At the conclusion of the training program, 787 maintenance training

students are able to effectively use the Toolbox to troubleshoot and solve maintenance issues.

Performance-based. 787 maintenance training focuses on better job performance rather than on system knowledge. Though system knowledge is necessary for effective performance, it is more important for the training program to have a solid foundation of learning objectives and base the training on measuring how effectively the students can accomplish the objectives.

The training program integrates the classroom and the airplane operational environment. This involves two distinct elements. First, the classroom environment is student-centric, not instructor-centric. The majority of activities involves higher-level learning in which the students analyze and

evaluate real-world problems and then solve those problems to a specific level of proficiency. Second, student evaluation goes beyond multiple-choice tests. Evaluation focuses on a higher level of knowledge, with an emphasis on comprehension, application, and analysis of information.

Web-based. Portions of the course, such as a pre-course assessment, are available any time, any place via the Web through the Alteon learning management system. In addition, maintenance and training data are available through MyBoeingFleet (see fig. 5). The key element is to make the information easy to access and compatible with the connectivity required to access other 787 support data.

The Three Pillars of 787 Maintenance Training

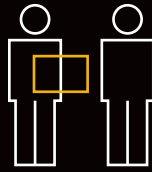
1



Foundation Training

includes an initial assessment of a student's level of knowledge and a subsequent "prescription" of training materials to prepare the student for classroom (i.e., formal) training. This ensures the student's understanding of certain system concepts (such as central maintenance computer or engine indicating and crew alerting system messages) before the formal classroom training begins. The foundation training is delivered on a digital video disk (DVD) or via the Internet. Alteon's learning management system monitors the results of a student's assessment test, determines training modules that must be taken, and monitors completion of these modules.

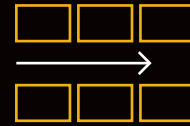
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Formal Training

is the classroom portion of the training. The training includes instructor-led sessions, student-paced computer-based training, and a series of troubleshooting exercises that are line maintenance scenarios. Assessments, including exams and other methods of evaluation, are given throughout the training to measure student achievement of the objectives and to assess student performance using the electronic troubleshooting and data support tools, such as the Maintenance Performance Toolbox. The students' proficiency in obtaining data is also monitored to ensure they are using the Toolbox efficiently. This provides an assessment of how well students will perform required tasks when they return to their jobs.

3



Future Training

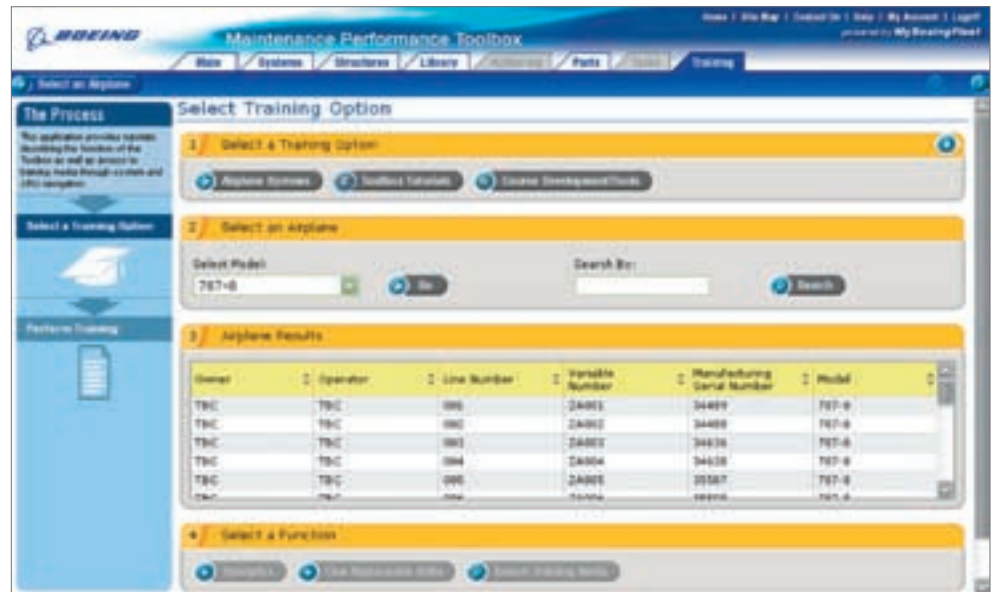
is the ability to access maintenance support data to provide just-in-time training at the point of use for 787 maintenance personnel. All maintenance support data used for training is accessible by the airlines' mechanics and engineers at any time. Boeing also will research future training opportunities to assist the airlines (i.e., creating training for a new change to the airplane).

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**ONLINE TRAINING
 ANY TIME, ANY PLACE**

Figure 5

787 maintenance and training data are available through MyBoeingFleet.com, a secure Web portal that is available to Boeing airplane owners; operators; maintenance, repair, and overhaul shops; and other third parties.



787 maintenance training focuses on better job performance rather than on system knowledge.

Just in time at the point of use. By using electronic tools in the classroom, the training directly carries over to the work environment. This facilitates the mechanics' ability to review maintenance support media when and where actual maintenance occurs.

Shorter, relevant courses. By reducing the amount of instruction that is standup, direct, and knowledge-based (rather than performance-based) and focusing on using electronic performance support tools, the courses achieve their objectives in much less time.

SUMMARY

The goal of the Boeing 787 Dreamliner flight and maintenance training is to provide a digital training experience for students, along with real-time, current support data that can be accessed by pilots and mechanics for recurrent training in the field and for online troubleshooting by the mechanic.

The new support data available on the 787, along with access via the Web portal MyBoeingFleet.com, allows for more efficient, high-quality training, and distance learning via the Internet, following formal training.

For more information, please contact Capt. Al Nader at alfred.h.nader@boeing.com or Kelli Whaley at kelli.whaley@alteontraining.com. **A**

In-Service Data Program Helps Boeing Design, Build, and Support Airplanes

By John Kneuer
Team Leader, In-Service Data Program

The Boeing In-Service Data Program (ISDP) allows airlines and suppliers to securely share fleetwide reliability data with other ISDP members. The program allows Boeing to better support member airlines by using airline data to locate and resolve issues specific to each operator. Additionally, the ISDP enables Boeing to improve the entire fleet by closely analyzing issues such as early component removals.

ISDP began in 1994 as a way to gather in-service data for the Boeing 777 airplane after its initial delivery in May 1995. The ISDP-collected data helped verify the reliability of the new airplane's systems and components. What began as a standalone Boeing database expanded into a shared system with the realization that this data would also be extremely valuable to suppliers and 777 airlines. Today, ISDP covers all Boeing airplane models.

This article provides an overview of the ISDP, explains how the program works, describes how Boeing uses ISDP data to support both individual airlines and the fleet in general, and outlines the overall benefits of the program.

OVERVIEW OF ISDP

ISDP was designed to gain insights into the performance and maintenance requirements of the 777 as it went into service. The concept was to electronically exchange airplane maintenance data, including component removal, repair, and shop teardown data that each company collected, and place it into a common database for all the participating companies to access and share.

After its initial implementation on the 777 program, operators, suppliers, and Boeing recognized the value of extending the ISDP to other airplane models and increasing the number of participating members (see fig. 1). Now more than 50 airlines and more than 30 suppliers participate in ISDP, providing data on all Boeing models. The program is available at no charge to all participating airlines and suppliers.

ISDP provides access to data only to authorized users within each member company. Each must sign a proprietary information agreement prior to participating in the program and accessing data. Each participating company has separate secure network access to the data and agrees to use the data for reliability purposes only. Views of data are tailored to the account type or actual user. Suppliers cannot view other suppliers' components. Airlines can view all other airline and supplier member data.

HOW ISDP WORKS

All of the companies participating in the ISDP gather similar airplane, component, and system reliability data (see fig. 2). A "Data Dictionary" containing standardized record layouts for each data subject enables data

MORE THAN
50 AIRLINES
AND MORE THAN
30 SUPPLIERS
PARTICIPATE
IN ISDP.

PERCENTAGE OF BOEING FLEET IN ISDP

Figure 1



from the different companies to be exchanged and stored in a common format in the database.

Each month, suppliers and airlines send raw data for each pertinent data subject to Boeing for processing. Boeing then screens the suppliers' and airlines' files for errors, places the processed data into an NCR Corporation Teradata enterprise data warehouse at Boeing, and stores it in a relational database.

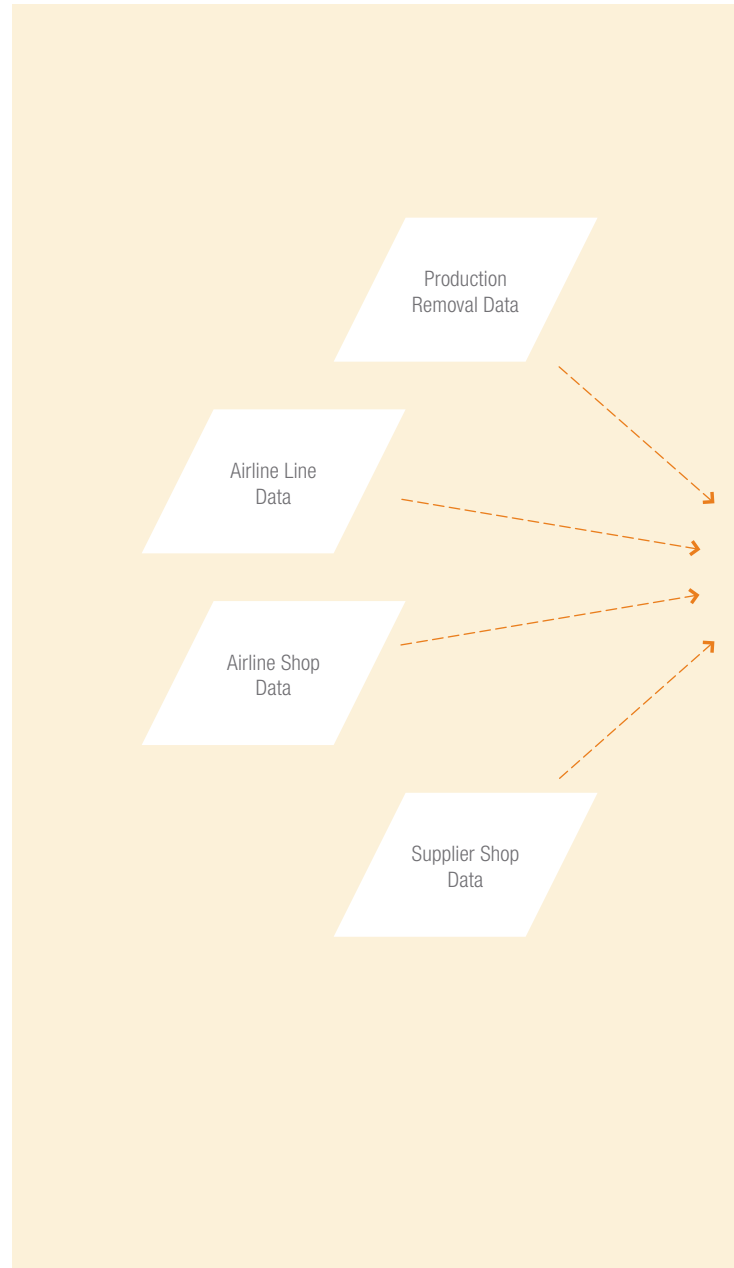
ISDP's Data Dictionary, which defines data exchange record layout and data element definitions, was used as the baseline by the Air Transport Association (ATA) in the creation of a new SPEC2000 chapter: Chapter 11, Reliability Data Collection/Exchange Standard. Chapter 11 of the SPEC2000 e-business system is the industry standard for reliability data collection and exchange using an extensible markup language (XML) format.

Access to the processed data is provided through the Web portal MyBoeingFleet.com, using a Boeing-developed Web-based data extraction and reporting tool called Fleet Reliability Statistics, and BI Query, an enterprise-strength query and reporting application from Open Text Corporation. The data can also be accessed using any software that has an open database connectivity interface compatible with Teradata.

Standard reports are available for management visibility and trend analyses. These reports — which can be accessed by operators through MyBoeingFleet.com and by suppliers through the Web portal Boeing Partners Network — contain monthly flight hours and landings, schedule interruptions, line maintenance action rates, removal rates, failure rates, shop findings, component rejection rates, and other data, all of which are critical in monitoring the reliability performance of the airplane fleet (see fig. 3).

In addition to line maintenance data, ISDP is now able to collect base maintenance records, such as scheduled maintenance and service bulletin

How ISDP component removal data improves the reliability of in-service airplanes



DATA PROVIDED BY AIRLINES	DATA PROVIDED BY SUPPLIERS
Aircraft hours and landings Aircraft events (Schedule interruptions) Logbook Line replaceable unit removals Scheduled maintenance Service bulletin Shop findings (component repair)	Shop findings from: <ul style="list-style-type: none"> ■ Airline-returned components ■ Boeing factory- and receiving-rejected components ■ Components returned for modification

ISDP DATA PROVIDED BY AIRLINES AND SUPPLIERS

Figure 2

ISDP DATA-DRIVEN PROCESS

Figure 3

ISDP allows cost, trend, root-cause, and other analyses to be performed using the same data resource.

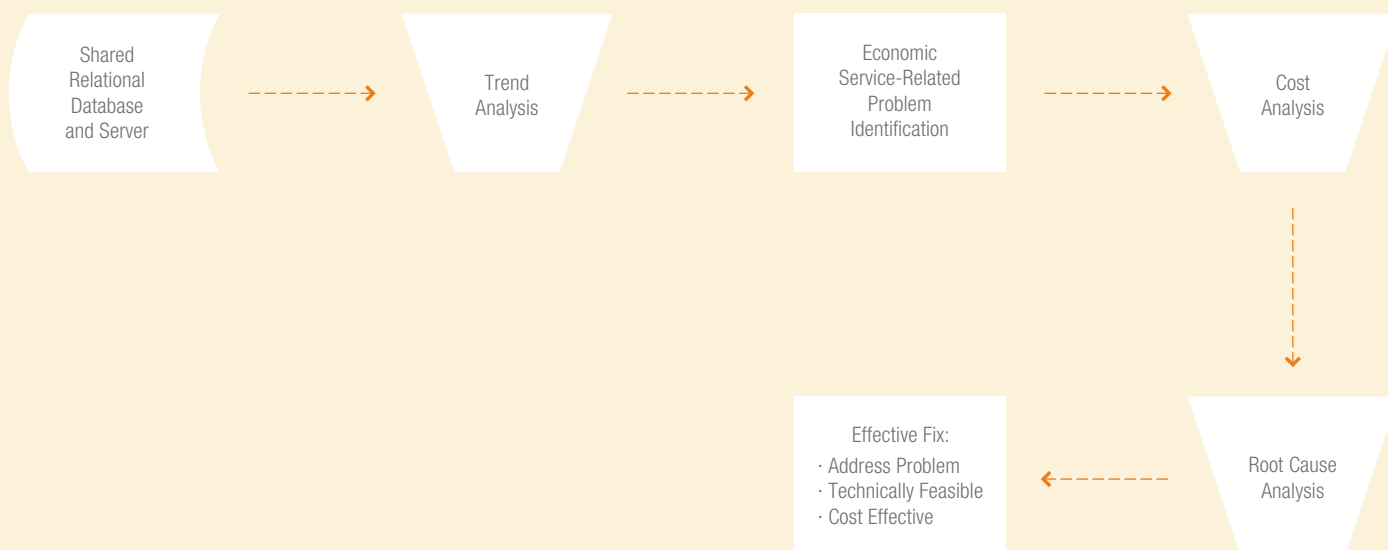
ISDP can identify potential reliability improvement areas by highlighting unusually high component removal rates.

For example, an excerpt of ISDP component removal data for a one-year period showed that an integrated drive generator (IDG) had 76 removals. This could be an indication of poor maintenance practice, extreme operational conditions, poor troubleshooting, or poor component or system reliability.

Shop findings showed that the IDG had a 100 percent justified removal rate (i.e., no no-fault-found [NFF] findings), indicating the problem was with the component itself.

The data excerpted also showed that later configurations of the IDG had low removal rates. The latest reconfiguration of the IDG had 11 removals with no NFFs.

Given this information, one recommendation to operators for improving IDG performance was to upgrade to a newer part configuration. Another option was for operators to make improvements (as outlined in the Component Maintenance Manual) to the IDG currently being used to bring it up to the level of the newest configuration.



Prior to ISDP, most airlines provided only flight hour and schedule interruption data, which limited the support Boeing could provide. The additional logbook and removal data provided through participation in this program allows more complete support for member airlines and the entire fleet.

incorporation. This additional data will provide complete visibility to all aspects of maintenance activities and enable Boeing engineers to become more proactive. For example, Boeing maintenance program engineers are planning to use this comprehensive data to optimize the scheduled maintenance requirements for the Boeing fleet. This would enhance safety and reliability of commercial airplanes, improve airplane availability, and achieve maintenance cost efficiencies.

Prior to ISDP, most airlines provided only flight hour and schedule interruption data, which limited the support Boeing could provide. The additional logbook and removal data provided through participation in this program allows more complete support for member airlines and the entire fleet.

HOW BOEING USES THE ISDP DATABASE

Boeing uses the ISDP database in two major ways:

- *Trend monitoring* to track routine airplane performance using these parameters: flight hours and landings, component removals and failures, component NFFs, airplane schedule reliability, and maintenance action rates. The processed data is also used to understand, in greater detail, what is driving the high-level trend data. For instance, if there is a change in the mean time between unscheduled removal for a particular component, the user can find out why by accessing data for that specific component as illustrated in figure 3.
- *New airplane development*, including system improvements and requirement setting. For example, ISDP fault analysis information has helped Boeing design the new 787 Dreamliner by providing historical data about various components. ISDP data was also instrumental in creating technical performance measurements for schedule reliability and maintenance costs allocations for the 787.

Boeing uses the database to perform analyses as well. For quality assurance, Boeing uses the data to compare factory functional test results with actual in-service removal and failure results. Boeing also uses the database to understand airline and airplane in-service performance as well as spares allocations.

BENEFITS OF ISDP

The ISDP enables Boeing and airlines to:

- Determine whether specific problems are unique.
- Assess whether a mean time between unit replacement is normal.
- Compare NFF rate among airlines.
- Compare repair and removal data to determine which modification has a better payback.
- Perform contingency planning for failures that might occur in the future.
- Efficiently review the same data by multiple parties.
- Develop benchmarks for operations.

ISDP data is used to identify component problems, enabling Boeing to be more proactive with suppliers and engineering groups to solve these problems, instead of driving corrective action following airline feedback.

ISDP component removal data is provided to Boeing production quality teams monthly. This data helps these groups prioritize their investigations for early component removals in the factory, improving overall delivery quality.

ISDP can also be used in a self-service manner to compare specific component removals by an airline to the entire fleet, allowing the airline to investigate the cause.

SUMMARY

The Boeing In-Service Data Program allows Boeing to better support member airlines by using airline data to locate and resolve issues specific to each operator as well as fleetwide issues. It also enables airlines to securely share fleetwide reliability data with other member airlines. The program is available to any airline or supplier with a need for reliability information. Data is available for all Boeing airplane models.

For more information, please contact John Kneuer at john.a.kneuer@boeing.com. [A](#)

How to join ISDP

1 Sign the proprietary information agreement.

To become an ISDP member, an airline must first sign a proprietary information agreement controlling the use of other members' data in the system, which can be obtained by contacting John Kneuer at john.a.kneuer@boeing.com.

2 Complete computing access and account paperwork.

Boeing provides operators with computing access and account forms that need to be completed to allow access to the data file transfer application (Data Upload Service) and to the database via the data extraction tool.

3 Map airline data to ATA SPEC2000 Chapter 11.

Identify where the data fields in the ATA SPEC2000 Chapter 11 standard are located in the airline maintenance database to ensure that all required fields are available.

4 Create test data file.

Create an extended markup language (XML) formatted test data file for each data subject according to the ATA SPEC2000 Chapter 11 standard and submit the file to Boeing for testing.

5 Resubmit a corrected file, if necessary.

After validation testing, make any necessary corrections to the file according to Boeing's feedback and resubmit the file to Boeing.

6 Obtain reporting tool access.

After all test data files pass validation, the airline begins providing monthly data files and Boeing provides access to the data via the Fleet Reliability Statistics tool on MyBoeingFleet.com.



WITHOUT A REGULATOR, A NITROGEN SOURCE CAN CAUSE A WHEEL TO EXPLODE, MAKING THE WHEEL, WHEEL TIE BOLTS, OR THE TIRE DEADLY PROJECTILES.

Wheel/Tire Pressurization: Simple Precautions Can Save Lives

By Chris Dubuque
Senior Engineer, Landing Gear Systems

In the last 20 years, a number of severe injuries – including several incidents of dismemberment and three fatalities – occurred during the inflation of nose wheel/tire assemblies on airplanes. Over-pressurization can cause an explosion that fractures the wheel during tire inflation, ejecting fragments at a high velocity. Typically, an unregulated nitrogen supply is responsible for the explosion. Virtually every accident involving nose wheel/tire inflation can be prevented by consistently following simple precautions.

WHEEL DAMAGE DUE TO OVERINFLATION

Figure 1

A maintenance worker was fatally injured in 2006 during inflation of a 737 nose wheel/tire assembly with an unregulated nitrogen pressure source that allowed the wheel to be exposed to the full pressure inside the nitrogen bottle. In this case, the nitrogen bottle was reported to be at 3,000 psi while the service pressure for the wheel was 166 psi.

Inflating a commercial airplane's tires is a routine task that occurs without problems thousands of times each day. Yet this job can turn deadly if standard safety precautions are not followed.

This article provides information to operators and maintenance, repair, and overhaul (MRO) shops to help prevent injury or death when maintenance personnel are inflating a wheel/tire assembly.

CAUSES OF WHEEL/TIRE ASSEMBLY EXPLOSIONS

Airplane wheel/tire assemblies are inflated to high pressures, often in excess of 200 pounds per square inch (psi). Because the pressure in a nitrogen bottle

or tire-servicing cart can be as high as 3,000 psi, connecting the nitrogen source directly to the wheel without a regulator subjects the wheel to sudden high pressure that can exceed the design limits for the wheel, the wheel tie bolts, or the tire. Consequently, the wheel, the wheel tie bolts, or the tire can explode and become projectiles (see fig. 1), causing severe injuries, dismemberment, or death.

In most of the reported cases of related injuries, the wheel/tire assembly that exploded was a nose wheel on a smaller-configuration airplane such as a 737 or DC-9. These tires present a greater risk because their smaller size means they reach dangerous pressures faster than the tires on main landing gear.



TIRE INFLATION TOOL

Figure 2

A tire inflation tool such as this adds another level of protection that can help prevent over-pressurization of the wheel/tire.

TIRE INFLATION PRECAUTIONS

Whenever an airplane tire is being serviced, three layers of protection are normally in place to protect maintenance workers from wheel fracture:

- A pressure regulator on the nitrogen supply.
- A pressure relief valve on the tire inflation tool.
- An overinflation pressure relief (OPR) valve installed in the wheel.

Pressure regulator on the nitrogen supply. Maintenance personnel should never attempt to inflate a wheel/tire assembly in any maintenance or shop location without a regulator between the pressure source — such as a tire-servicing bottle or cart — and the inflation valve on the wheels. It is *essential* that operators ensure regulated nitrogen sources are correctly used.

Boeing also recommends operators have back-up protection (such as additional regulation or pressure-relief devices) installed in *all* high-pressure nitrogen sources in case the primary regulator is not adjusted correctly or fails to properly regulate. Procedures for inflating the wheel/tire assembly when it is installed on the airplane are located in Chapter 12 of the Airplane Maintenance Manual (AMM).

Pressure relief valve on tire inflation tools. Because many inflation valves on airplane wheels are similar to automotive valve designs, automotive tools are frequently used for airplane wheels. However, many Boeing AMMs specify a tool for tire inflation that incorporates a pressure relief device designed to release at a pressure slightly higher than the tire service pressure, providing an additional layer of protection if the

nitrogen source is inadvertently at high pressure (see fig. 2).

OPR valve installed in the wheel. The risk of explosion increases greatly on wheels that are not equipped with an OPR valve. An OPR valve is a device similar to that shown in figure 3. It is included in many wheel assemblies to limit the pressure in the wheel/tire assembly. If the pressure in the wheel exceeds a predetermined value, a disk in the OPR valve will rupture, allowing the gas to escape while reducing the pressure in the wheel before it can fracture. After the disk ruptures, the gas in the wheel exits through the OPR valve. The valve is designed so that when the disk ruptures, the gas will exit from the wheel faster than it can be supplied from the pressure source.



OPR VALVE

Figure 3

An OPR valve should be installed on every wheel assembly. It provides a valuable layer of protection that can help prevent wheel/tire explosions that result from introducing an excess of pressure to the airplane tire.



Certain older wheels do not include this valve. As a result, Boeing recommends the following retrofits:

DC-9/MD-80 operators: Boeing recommends retrofitting an OPR valve into all nose wheels per McDonnell Douglas Air Operator Letter 9-2274, "Nose Landing Gear Wheel Assembly Failure," dated July 21, 1992.

737-100/-200 operators: Boeing recommends retrofitting the OPR valve into all nose wheels per Honeywell Service Bulletin 2601045-32-002, "Modification of the 737-100/-200 Nose Wheel Assembly P/N 2601045-2 Into Assembly P/N 2601045-3, for Installation of a Safety Relief Valve," dated August 31, 2000.



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PORTABLE NITROGEN CART

Figure 4

Portable nitrogen carts that are used to service both high- and low-pressure equipment should have hose and fitting sizes that are different between the high- and low-pressure sides. The high- and low-pressure sides also should be clearly marked.

Boeing recommends that operators and MROs train shop and maintenance personnel about the hazards associated with inflating wheel/tire assemblies.

USING PORTABLE NITROGEN CARTS

Portable nitrogen carts (see fig. 4) are often used to service high-pressure equipment (such as accumulators) as well as low-pressure equipment (such as tires). To accommodate this range of equipment, nitrogen carts are typically equipped with both a high-pressure regulator and a low-pressure regulator.

It is essential that operators ensure the hose and fitting sizes are different between the high- and low-pressure sides so that the high-pressure side cannot inadvertently be used on a low-pressure device. The high- and low-pressure sides also should be clearly marked.

INSPECTING WHEEL TIE BOLTS, NUTS, AND WASHERS

Because worn or damaged wheel tie bolts, nuts, or washers can cause (or contribute to) a dangerous wheel fracture, it is essential that operators and MROs place proper emphasis on inspection and replacement of this hardware. Each wheel Component Maintenance Manual (CMM) or overhaul manual provides specific inspection and rejection criteria for wheel tie bolts, nuts, and washers.

THE IMPORTANCE OF ONGOING TRAINING

Boeing recommends that operators and MROs train shop and maintenance personnel about the hazards associated with inflating wheel/tire assemblies. Boeing also recommends that operators and MROs place extra emphasis on wheel tie bolt, nut, and washer maintenance because this hardware can cause (or contribute to) dangerous wheel fracture.

SUMMARY

In the past 20 years, several accidents have occurred during tire servicing in which the wheel exploded because of over-pressurization, causing dismemberment or death to service personnel or damage to equipment. It is essential that tire-servicing equipment be equipped with a regulator to prevent tires from being subjected to excessive pressures that can result in an explosion. In addition, strict adherence to established procedures in the AMM and CMM will help ensure the safety of maintenance personnel during tire servicing. For more information, please contact Chris Dubuque at christopher.v.dubuque@boeing.com. **A**

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