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Abstract

The Boeing 787 Dreamliner program brings together dozens of global partners involving a multitude of countries to design and build major components of the airplane.

1. Introduction

Boeing created a new business model to manage the schedule, cost and staffing needs of the international partnership that would create the 787 Dreamliner. Teams devoted to writing initial contracts, ensuring export and import requirements were followed, coordinating process and tool decisions and protecting individual company's proprietary data focused on providing oversight to the complex support network that accompanied the design and build teams. Life Cycle Product Teams, formed to provide focus on specific functional areas of the airplane, consist of leaders from each of the these functions: Engineering, Manufacturing, Business and Supplier Management. Global build teams drove innovations in tooling and long distance part delivery, culminating in many advances including the redesign of the 747 model into the Dreamlifter, an airplane with the ability to transport entire 787 fuselage sections to enable a shorter final assembly flow.

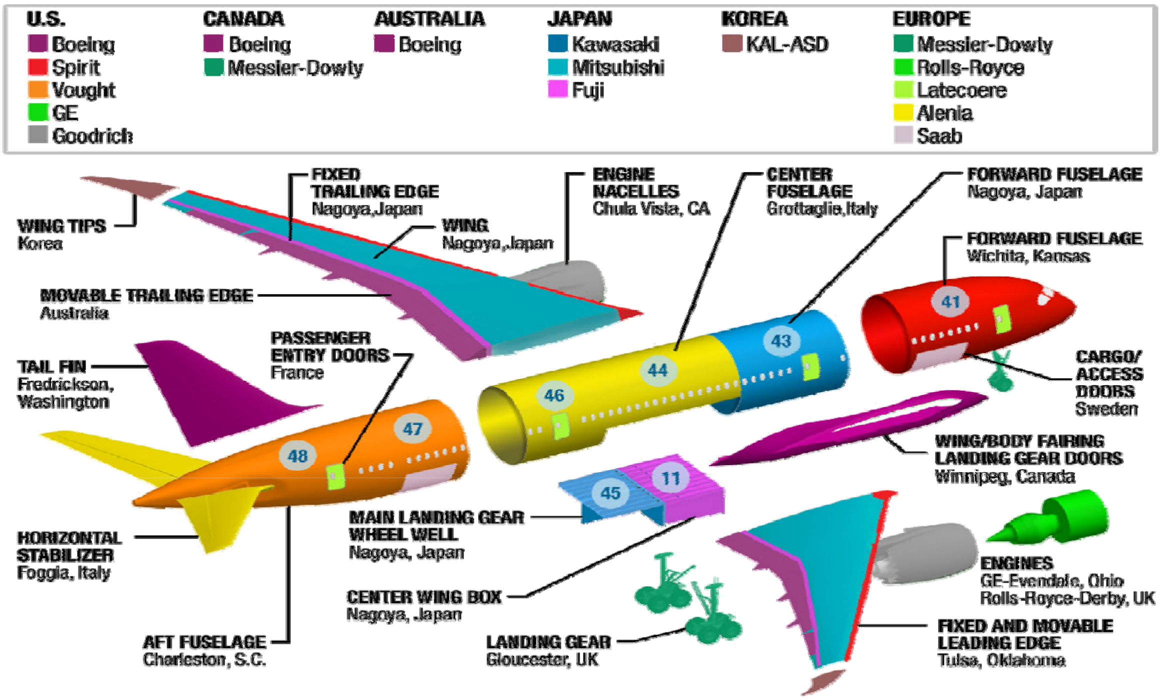

Fig. 1. Cooperation Between Global Partners

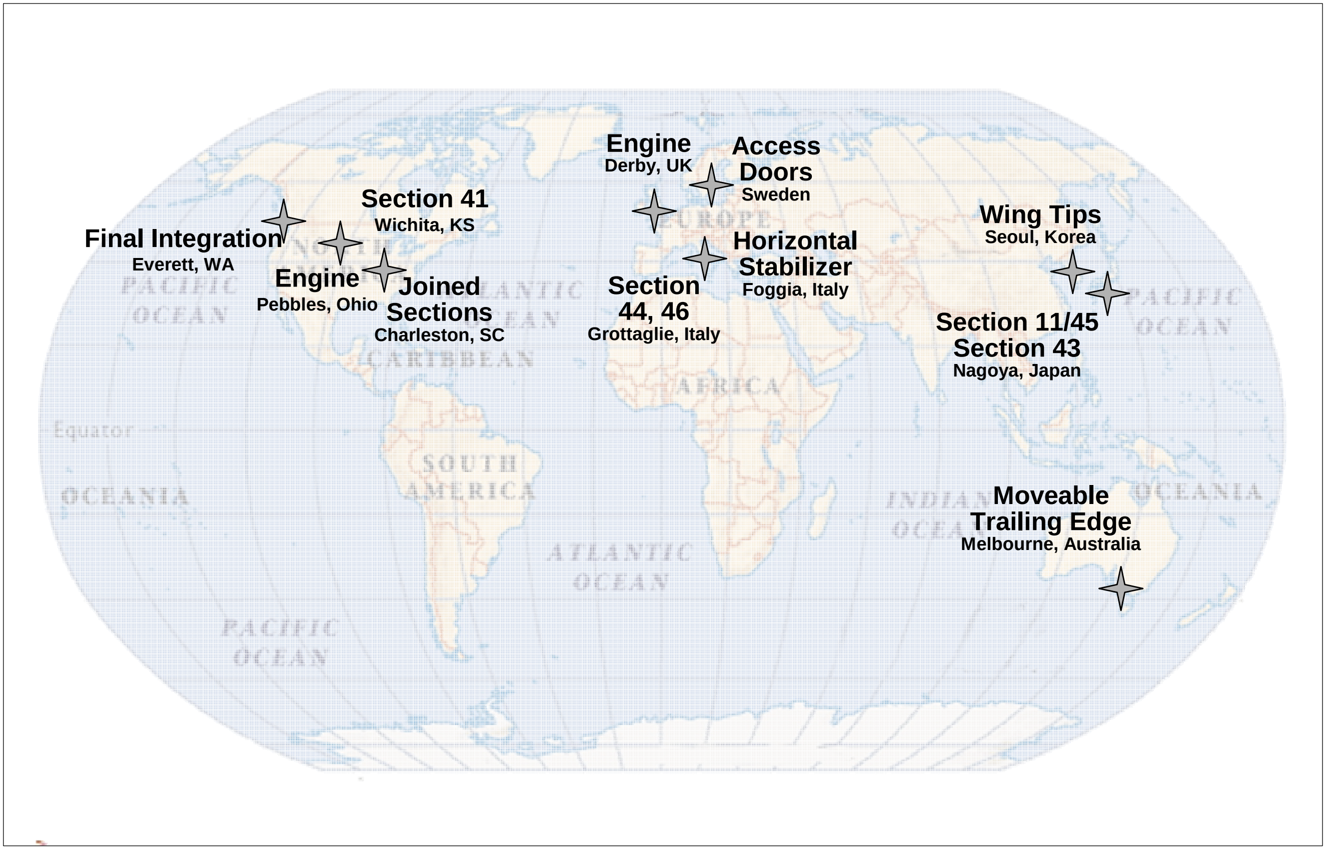

Fig. 2. Partners Across the Globe Are Bringing the 787 Together

2. Expanding the Technical Horizon

The 787 Dreamliner program is comprised of teams that are making critical design decisions in the fields of loads, airframe structure, systems and performance. In addition to building parts for the 787, the global team of partners also participated in the design phase of the airplane. This was a new experience for structural partners, though systems providers have worked in this model for some time. This encouraged an environment of international knowledge transfer, providing every partner the opportunity to increase their skill base. Advances in composite material construction provided new opportunities for manufacturing large sections, such as the fuselage, in a single barrel, and in the areas of testing and repair. The 787 team pioneered the large-scale use of composite material for primary structure by understanding not only the properties of strength and durability, but also its response to lightning, vibration and stress. Because composites don't fatigue or corrode and because they are more damage resistant, the inspection intervals for the 787 – how often major inspections must be completed – can be spread out over more time. One of the biggest drivers in maintenance costs is the labor hours expended to keep an aircraft flying. When compared to its metallic counterparts, the 787 will require less maintenance less often.

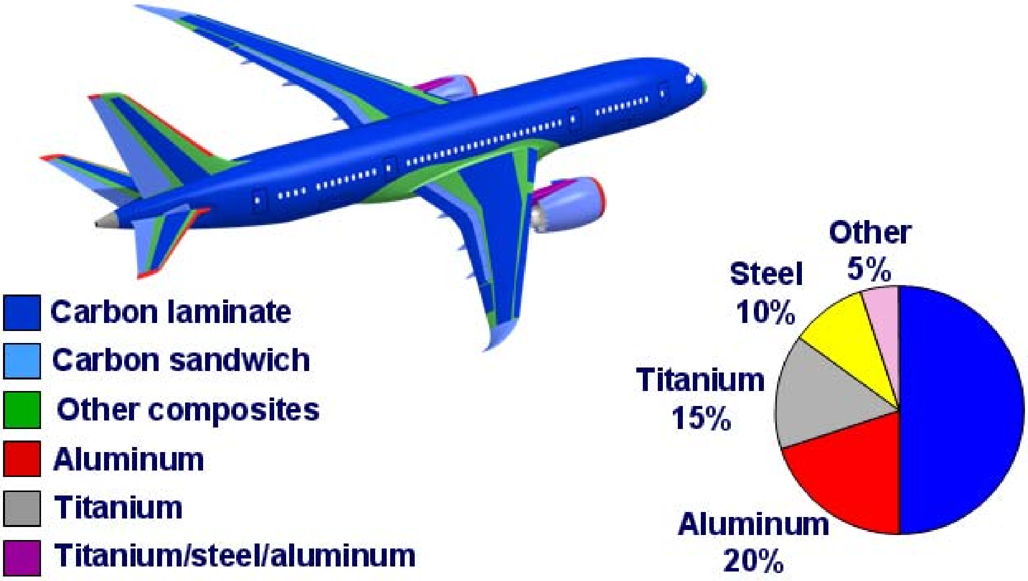

Fig 3. Building on the Future

2.1 Key Technologies

In addition to the expanded use of composites, there are three other key technologies that contribute to the 787's 20 percent fuel advantage.

2.1.1 Engines contribute about eight percent of the improvement

Airlines can choose either Rolls-Royce or General Electric engines for the 787. Both companies have created new engines for the airplane to achieve improved performance.

The engines achieve their performance by featuring a higher bypass-ratio and a no-bleed air systems architecture in addition to advances proprietary to each design. The overall effect is a more efficient power plant.

In addition to improvements in the engine design, the 787 features improvements in the nacelles that help reduce noise and improve performance. These improvements include low-noise chevrons and laminar flow.

Finally, the 787 is the first commercial jetliner that can be outfitted with either version of the engine throughout its lifetime. This ability to more easily switch engine types allows the 787 to be a more flexible asset, giving financiers additional confidence in the long-term value of the airplane.

2.1.2 Aerodynamics contributes about three percent

Boeing has a unique set of computational tools and industry expertise enabling the company to improve airplane performance through advanced technology optimization. These advances have been verified through extensive wind tunnel testing conducted in global facilities. The results of these tests validated the accuracy of the computational fluid dynamics design tools as well as verifying the 787's high-speed and high-lift design.

2.1.3. Systems contribute three percent

In addition to making the engines more efficient, the removal of the bleed-air system provides weight saving to the overall airplane systems. The electric systems replacing the bleed-air system are more efficient and robust and easier to maintain.

Among the systems that are now electric instead of relying on pneumatics – or bleed air – are the air conditioning system, engine start, wing ice protection system, and hydraulic pumps.

The 787 is also the first commercial jetliner to use a common core open systems architecture. In addition to being a more efficient method of distributing data throughout the airplane, this open architecture allows for continued upgrades in technologies. This is especially important because the composite materials onboard the 787 will enable it to have a considerably longer service life.

By using advanced predictive sensing, the airplane systems can report on their own health and maintenance needs, allowing airlines to schedule their maintenance activities instead of being surprised, and reducing delays at the gate for maintenance.

2.2 Interior Enhancements for Passengers and Crew

The interior of the 787 has been designed to be as innovative as the structure and systems of the airplane. Passengers and crew will notice that they feel better after a long flight onboard the 787.

2.2.1 Making flying fun again

The 787 incorporates a wide array of improvements to enhance the comfort of passengers. These improvements include: larger windows, cleaner air, higher humidity, improved lighting, bigger stowage bins and wide seats and aisles. Also, advances in flight controls allow the 787 to sense and respond to turbulence, creating a smoother ride.

2.2.2 Better for crews too

In addition to the same enhancements introduced for passengers, the 787 flight deck has been designed to provide pilots tools to more easily and efficiently operate the 787 Dreamliner. Its new, larger display screens provide twice the display area as the popular 777. Dual electronic flight bags (EFBs) and dual head up displays (HUDs) are standard on the airplane. And while the look is all-new, from an operation standpoint, there is very little difference with the 777, allowing 777 pilots to

Fig 4. Flight Deck

be fully trained for 787 operations in only five days. It's just one more way that Boeing is offering value to its customers.

Flight control laws are the computational codes that determine the handling and response characteristics of the airplane. Boeing has created an environment that is highly similar to the characteristics of the 777 and offers some new features for more efficient handling of the loads that occur during flight.

Initial flight tests of the 787 flight controls were completed using a concept validation and risk-reduction testbed, a 777-200ER leased from American Airlines for 10 months. By loading software on board this airplane, the team was able to test and validate the enhanced 787 flight-control system before it is flight tested on the real aircraft.

With these tests, Boeing was able to identify issues with initial versions of the 787 flight-control software and work through solutions well in advance of the 787's first flight.

2.3 Standard and flexible

More than on any other commercial jetliner, Boeing has embraced the concept of standardization on the 787. By reducing the number of optional features, and making high value features such as dual HUD standard, the company is creating a more-standard airplane that can easily move between different airlines.

This offers significant advantages to leasing companies and makes the airplane more financeable. Keeping production consistent and ensuring suppliers that their products will be on board the airplane, Boeing is helping to control costs. The company has learned along with the industry that a high-degree of customization in an airplane can lead to difficulties in the long run.

While the airplane is significantly more common in its systems and structures, airlines are still given ample opportunity to customize the interiors to create brand identity with its customers. By balancing commonality with flexibility, Boeing has created an airplane that meets the needs of its customers.

3. Building on the Future

The 787 is now entering into its recurring production phase. Major decisions regarding build rates, workforce stabilization and design improvement will impact every global partner and their subsidiaries.

3.1 Global collaboration

Boeing evaluated the capabilities and capacities of many potential partners very early in the development of the 787. A core group of premier aerospace companies were selected to help design and build the 787.

Early in the development phase, partner engineers worked at Boeing locations to jointly develop the technologies required for the airplane. Upon completion of these activities, most of the partner engineers returned home to work on teams that finalized the designs and build instructions.

Around the globe, partners built new facilities dedicated to the 787. More than three million square feet of new factory space was created in Japan, Italy and the United States. Work on the program also takes place in Canada, Russia, the U.K, France, Germany, Mexico, Korea and Australia, among other locations.

The ability to coordinate and manage the work of these diverse suppliers is key to the success of the program.

3.2 Airplane #1 in Production

The company's confidence in the 787 and the decisions it has made for the program are strongly validated by the market. The interest in buying the airplane has been even stronger than expected. Fifty-eight customers have ordered nearly 900 airplanes, making the 787 the fastest selling new commercial jetliner in history.

Fig 5: Airplane #1 In Production

The 787 has brought together a world-class, and worldwide, team of commercial aviation partners dedicated to the entire life-cycle of the Dreamliner, from sales to servicing, and is truly an airplane that defines international cooperation.

