The Boeing 777

1988 Boeing is the world's largest manufacturer of civil airliners, and America's biggest exporter, but is facing growing competition from Airbus, its European rival. In 1987 Airbus announced two new medium to long range wide body 300 seat jets, the A330 and A340, to replace aging Douglas DC-10 and Lockheed Tristar aircraft. Boeing has an obvious gap in its range in this bracket, between its 767 and 747 models. Airlines are approached with various ideas about expanding and stretching the 767, but they say they want a full wide body fuselage which the 767 cannot provide, as well as better operating economics and much greater flexibility in cabin layout.

1989 The decision is made to develop an entirely new aircraft, to be known as the 777. This will be a huge commitment - Boeing's first major civil aircraft programme for over ten years. It will also be a huge risk. For an aircraft the size of the 777 manufacturers have to invest billions of dollars in new product development that typically lasts five to six years, and then sell over 300 aircraft (at hundreds of millions of dollars a unit) to break even. The scale of losses suffered by Lockheed on the Tri-Star programme shows how high the stakes are. However, Boeing predicts a $260 billion global market for wide body jets smaller than the 747 over the period 1991 to 2005. Philip Condit, a Boeing veteran of 24 years, is put in charge of the programme. Airlines are canvassed about their requirements.

1990 - 1994 The 777 programme is formally launched in October 1990 with an order from United Airlines to buy 34 777-200 aircraft. The 777 management team consists of five vice-presidents reporting to Phil Condit - all men with 25-30 years at Boeing. Boeing recognises that to compete with Airbus it will have to excel in two areas where Airbus has an edge - advanced technology and lean production methods. At the time company is cash rich so can develop the new aircraft partly from its own resources, and through risk sharing with sub-contractors. A major innovation in the project is the direct involvement of customers in the design, starting before the official launch. Eight airlines send full time representatives to Boeing's headquarters in Seattle. The 'Working Together' initiative enables airline people to talk to design engineers directly rather than through service engineers (their usual interface with Boeing). 300 significant design innovations are based on customer requests, from making it easier to replace passenger reading light bulbs to better separation of hydraulic hoses and electrical wiring. A common 747/777 cockpit layout allows pilots to fly both aircraft.

New technology includes fly-by-wire controls, a 'glass cockpit' (without mechanical dials), 10% of the structure made of composites and an advanced new wing. This wing is designed to be able to lift future stretched versions of the 777 without modification. Many of the technologies had been developed for the 7J7 project (which was cancelled), saving time and cost. The engine suppliers (Pratt & Whitney, General Electric and Rolls-Royce) all produce up-rated engines to power the new airliner.

In common with most aircraft programmes, the 777 involves a large number of sub-contractors, the biggest of whom have a direct investment in the programme and hence share the risk of commercial failure. Sub-contractors are spread all over the world, and the biggest concentration is in Japan, where Fuji, Kawasaki and Mitsubishi together produce 20% of the value of the airframe. 250 Japanese engineers work in Seattle before returning home to begin production. Japan is an important target market and in return for participation in the programme Boeing secured orders for 46 777 jets.

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The 777 is the first Boeing airliner to be designed entirely on computers. CATIA 3-D software (from Dassault and IBM) is used to create virtual models rather than 2-D drawings, so that the fit of every one of 132,000 parts can be checked to see whether it interferes with others. 3-D design enables most physical mock-ups to be dispensed with. 2,200 computer terminals are distributed throughout the design teams, including sub-contractors. Despite the advantages, this early generation 3-D system is far from perfect. Boeing needs 60% more engineers than with 2-D methods, and response times can run into minutes because of the limited computer power available. Getting designers to think in 3-D is a major challenge, requiring much more training than anticipated.

The development project is organised into thirty integrated project teams focused on major sections of the aircraft (e.g. wing leading edge), supported by 230 design-build teams (DBTs) of up to 40 people working at a component and sub-assembly level. All teams are cross-functional, so that engineering, manufacturing, materials, customer support, finance and quality assurance people work together to solve problems. The DBTs operate as semi-autonomous mini-companies, with the power to spend budgets and make contracts. There is a huge emphasis on team work throughout the programme, moving away from traditional narrow views of what people are expected to do. The team culture is popular but not universally accepted. Some people are reluctant to share mistakes, and managers worry about losing authority.

Phil Condit encourages an open culture in what traditionally has been a very hierarchical status-conscious company. Regular briefings enable anyone to share ideas or complaints. In particular, manufacturing staff are encouraged to raise concerns early, to save time and money in the assembly process. This openness causes concern among senior Boeing executives that key information might easily leak to competitors.

The 777 makes its first flight on 14 June 1994, followed by an extensive flight test programme. Series production of the aircraft begins with 118 orders confirmed at in excess of $100 million each. A goal of the DBT approach has been to reduce change, error and rework in the factory by 50%. In fact it falls by between 60% and 90% depending on the part of the aircraft. More team work in development has led to better morale and involvement among assembly staff (called 'machinists' at Boeing).

According to Business Week the total development cost of the 777 was $12 billion ($6 billion has been suggested as the original budget). 10,000 employees were involved at the peak of the project.

1995 The 777 enters service with United Airlines in June. Thanks to the involvement of airlines in the design, industry reaction is very positive, and it earns high praise from passengers. The 777-300 is launched which is 10m longer than the 777-200 and can carry 20% more passengers. It flies in 1998.

The full 777 programme approach is not instituted throughout Boeing. Maintaining it on 777 required frequent training, plus continuous monitoring and reinforcement. Cross functional teams are used in only one contemporary programme, and in a modified form. Gradually the additional cost burden of 3-D design falls, as hardware becomes more powerful and cheaper, and pumping huge amounts of data rapidly between globally dispersed partners becomes feasible.

Senior 777 figures go on to executive positions in Boeing and take aspects of the 777 culture with them.

Today As of December 2018 Boeing has secured orders for almost 2,000 777s and delivered 1,582. Production runs at between 4 and 5 a month. The 777 is regarded as Boeing's most profitable airliner. 1,816 examples of the Airbus A330/340 family have been delivered to airlines although the current order book is smaller than Boeing's.

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