**Building the Boeing 787**

Executives at the Boeing Corporation, America's largest exporter, like to say that building a large commercial jet aircraft like the 747 or 787 involves bringing together more than a million parts in flying formation. Forty-five years ago, when the early models of Boeing's venerable 737 and 747 jets were rolling off the company's Seattle area production lines, foreign suppliers accounted for only 5 percent of those parts on average. Boeing was vertically integrated and manufactured many of the major components that went into the planes. The largest parts produced by outside suppliers were the jet engines, where two of the three suppliers were American companies. The lone foreign engine manufacturer was the British company Rolls-Royce.

Fast-forward to the modern era, and things look very different. In the case of its latest aircraft, the super efficient 787 Dreamliner, 50 outside suppliers spread around the world account for 65 percent of the value of the aircraft. Italian firm Alenia Aeronautica makes the center fuselage and horizontal stabilizer. Kawasaki of Japan makes part of the forward fuselage and the fixed trailing edge of the wing. French firm Messier-Dowty makes the aircraft's landing gear. German firm Diehl Luftahrt Elektronik supplies the main cabin lighting. Sweden's Saab Aerostructures makes the access doors. Japanese company Jamco makes parts for the lavatories, flight deck interiors, and galleys. Mitsubishi Heavy Industries of Japan makes the wings. KAA of Korea makes the wing tips. And so on.

Why the change? One reason is that 80 percent of Boeing's customers are foreign airlines, and to sell into those nations, it often helps to be giving business to those nations. The trend started in 1974 when Mitsubishi of Japan was given contracts to produce inboard wing flaps for the 747. The Japanese reciprocated by placing big orders for Boeing jets. A second rationale was to disperse component part production to those suppliers who are the best in the world at their particular activity. Over the years, for example, Mitsubishi has acquired considerable expertise in the manufacture of wings, so it was logical for Boeing to use Mitsubishi to make the wings for the 787. Similarly, the 787 is the first commercial jet aircraft to be made almost entirely out of carbon fiber, so Boeing tapped Japan's Toray Industries, a world-class expert in sturdy but light carbon-fiber composites, to supply materials for the fuselage. A third reason for the extensive outsourcing on the 787 was that Boeing wanted to unburden itself of some of the risks and costs associated with developing production facilities for the 787. By outsourcing, it pushed some of those risks and costs onto suppliers, who had to undertake major investments in capacity to ramp up to produce for the 787.

So what did Boeing retain for itself? Engineering design, marketing and sales, and final assembly are done at its Everett plant north of Seattle, all activities where Boeing maintains it is the best in the world. Of major component parts, Boeing made only the tail fin and wing to body fairing (which attaches the wings to the fuselage of the plane). Everything else was outsourced.

As the 787 moved through development in the 2000s, however, it became clear that Boeing had pushed the outsourcing paradigm too far. Coordinating a globally dispersed production system this extensive turned out to be very challenging. Parts turned up late, some parts didn't “snap together” the way Boeing had envisioned, and several suppliers ran into engineering problems that slowed down the entire production process. As a consequence, the date for delivery of the first jet was pushed back more than four years, and Boeing had to take millions of dollars in penalties for late deliveries. The problems at one supplier, Vought Aircraft in North Carolina, were so severe that Boeing ultimately agreed to acquire the company and bring its production in-house. Vought was co-owned by Alenia of Italy and made parts of the main fuselage.

There are now signs that Boeing is rethinking some of its global outsourcing policy. For its next jet, a new version of its popular wide-bodied 777 jet, the 777X, which will use the same carbon-fiber technology as the 787, Boeing will bring wing production back in-house. Mitsubishi and Kawasaki of Japan produce much of the wing structure for the 787, and for the original version of the 777. However, recently Japan's airlines have been placing large orders with Airbus, breaking with their traditional allegiance to Boeing. This seems to have given Boeing an opening to bring wing production back in-house. Boeing executives also note that Boeing has lost much of its expertise in wing production over the last 20 years due to outsourcing, and bringing it back in-house for new carbon-fiber wings might enable Boeing to regain these important core skills and strengthen the company's competitive position.

Sources: K. Epstein and J. Crown, “Globalization Bites Boeing,” *Bloomberg Businessweek,* March 12, 2008; H. Mallick, “Out of Control Outsourcing Ruined Boeing's Beautiful Dreamliner,” *The Star,* February 25, 2013; P. Kavilanz, “Dreamliner: Where in the World Its Parts Come From,” *CNN Money,* January 18, 2013; S. Dubois, “Boeing's Dreamliner Mess: Simply Inevitable?,” *CNN Money,* January 22, 2013; A. Scott and T. Kelly, “Boeing's Loss of a $9.5 Billion Deal Could Bring Jobs Back to the U.S.,” *Business Insider,* October 14, 2013.

**Who Makes the Apple iPhone?**

In its early days, Apple usually didn't look beyond its own backyard to manufacture its devices. A few years after Apple started to make the Macintosh computer back in 1983, the late Steve Jobs bragged that it was “a machine that was made in America.” As late as the early 2000s, Apple still manufactured many of its computers at the company's iMac plant in Elk Grove, California. Jobs often said that he was as proud of Apple's manufacturing plants as he was of the devices themselves.

By 2004, however, Apple had largely turned to foreign manufacturing. The shift to offshore manufacturing reached its peak with the iconic iPhone, which Apple first introduced in 2007. All iPhones contain hundreds of parts, an estimated 90 percent of which are manufactured abroad. Advanced semiconductors come from Germany and Taiwan, memory from Korea and Japan, display panels and circuitry from Korea and Taiwan, chip sets from Europe, and rare metals from Africa and Asia. Apple's major subcontractor, the Taiwanese multinational firm Foxconn, performs final assembly in China.

Apple still employs some 43,000 people in the United States, and it has kept important activities at home, including product design, software engineering, and marketing. Furthermore, Apple claims that its business supports another 254,000 jobs in the United States in engineering, manufacturing, and transportation. For example, the glass for the iPhone is manufactured at Corning's U.S. plants in Kentucky and New York. But an additional 700,000 people are involved in the engineering, building, and final assembly of its products *outside* the United States, and most of them work at subcontractors like Foxconn.

When explaining its decision to assemble the iPhone in China, Apple cites a number of factors. While it is true that labor costs are much lower in China, Apple executives point out that labor costs account for only a very small proportion of the total value of its products and are not the main driver of location decisions. Far more important, according to Apple, is the ability of its Chinese subcontractors to respond very quickly to requests from Apple to scale production up and down. In a famous illustration of this capability, back in 2007 Jobs demanded that a glass screen replace the plastic screen on his prototype iPhone. He didn't like the look and feel of plastic screens, which at the time were standard in the industry, nor did he like the way they scratched easily. This last-minute change in the design of the iPhone put Apple's market introduction date at risk. Apple had selected Corning to manufacture large panes of strengthened glass, but finding a manufacturer that could cut those panes into millions of iPhone screens wasn't easy. Then a bid arrived from a Chinese factory. When the Apple team visited the factory, they found that the plant's owners were already constructing a new wing to cut the glass and installing equipment. “This is in case you give us the contract,” the manager said. The plant also had a warehouse full of glass samples for Apple, and a team of engineers available to work with Apple. It had built onsite dormitories so that the factory could run three shifts seven days a week in order to meet Apple's demanding production schedule. The Chinese company got the bid.

Another critical advantage of China for Apple was that it was much easier to hire engineers there. Apple calculated that about 8,700 industrial engineers were needed to oversee and guide the 200,000 assembly-line workers involved in manufacturing the iPhone. The company had estimated that it would take as long as nine months to find that many engineers in the United States. In China it took 15 days.

Also important is the clustering together of factories in China. Many of the factories providing components for the iPhone are located close to Foxconn's assembly plant. As one executive noted, “The entire supply chain is in China. You need a thousand rubber gaskets? That's the factory next door. You need a million screws? That factory is a block away. You need a screw made a little bit differently? That will take three hours.”

All this being said, there are drawbacks to outsourcing to China. Several of Apple's subcontractors have been targeted for their poor working conditions. Criticisms include low pay of line workers, long hours, mandatory overtime for little or no additional pay, and poor safety records. Some former Apple executives say that there is an unresolved tension within the company; executives want to improve working conditions within the factories of subcontractors such as Foxconn, but that dedication falters when it conflicts with crucial supplier relationships or the fast delivery of new products.

Sources: Gu Huini, “Human Costs Are Built into iPad in China,” *The New York Times,* January 26, 2012; C. Duhigg and K. Bradsher, “How U.S. Lost Out on iPhone Work,” *The New York Times,* January 22, 2012; “Apple Takes Credit for Over Half a Million U.S. Jobs,” *Apple Intelligence,* March 2, 2012, <http://9to5mac.com/2012/03/02/apple-takes-credit-for-514000-u-s-jobs/#more-142766>.

**Ethical Issues at Apple**

In mid-2006, news reports surfaced suggesting there were systematic labor abuses at a factory in China that makes the iPhone and iPod for Apple, Inc. According to the reports, workers at Hongfujin Precision Industry were paid as little as $50 a month to work 15-hour shifts making Apple products. There were also reports of forced overtime and poor living conditions for the workers, many of them young women who had migrated from the countryside to work at the plant and lived in company-owned dormitories.

The 2006 articles were the work of two Chinese journalists, Wang You and Weng Bao, employed by *China Business News,* a state-run newspaper. The target of the reports, Hongfujin Precision Industry, was reportedly China's largest export manufacturer with overseas sales totaling $14.5 billion. Hongfujin is owned by Foxconn, a large Taiwanese conglomerate, whose customers (in addition to Apple) include Intel, Dell, and Sony Corporation. The Hongfujin factory is a small city in its own right, with clinics, recreational facilities, buses, and 13 restaurants that serve the 200,000 employees.

Upon hearing the news, Apple management responded quickly, pledging to audit the operations to make sure Hongfujin was complying with Apple's code on labor standards for subcontractors. Managers at Hongfujin took a somewhat different tack; they filed a defamation suit against the two journalists, suing them for $3.8 million in a local court, which promptly froze the journalists’ personal assets pending a trial. Clearly, the management of Hongfujin was trying to send a message to the journalist community—criticism would be costly. The suit sent a chill through the Chinese journalist community because Chinese courts have shown a tendency to favor powerful, locally based companies in legal proceedings.

Within six weeks, Apple had completed its audit. The company's report suggested that although workers had not been forced to work overtime and were earning at least the local minimum wage, many had worked more than the 60 hours a week allowed for by Apple, and their housing was substandard. Under pressure from Apple, management at Hongfujin agreed to bring practices in line with Apple's code, committing to building new housing for employees and limiting work to 60 hours a week.

However, Hongfujin did not immediately withdraw the defamation suit. In an unusually bold move in a country where censorship is still common, *China Business News* gave its unconditional backing to Wang and Weng. The Shanghai-based news organization issued a statement arguing that what the two journalists did “was not a violation of any rules, laws, or journalistic ethics.” The Paris-based Reporters Without Borders also took up the case of Wang and Weng, writing a letter to Apple's then CEO, the late Steve Jobs, stating, “We believe that all Wang and Weng did was to report the facts and we condemn Foxconn's reaction. We therefore ask you to intercede on behalf of these two journalists so that their assets are unfrozen and the lawsuit is dropped.”

Once again, Apple moved quickly, pressuring Foxconn behind the scenes to drop the suit. Foxconn agreed to do so and issued a “face-saving” statement saying the two sides had agreed to end the dispute after apologizing to each other “for the disturbances brought to both of them by the lawsuit.” The experience shed a harsh light on labor conditions in China. At the same time, the response of the Chinese media, and *China Business News* in particular, point toward the emergence of some journalistic freedoms in a nation that has historically seen news organizations as a mouthpiece for the state.

More recent news may indicate new ethical concerns at Apple's production facilities in China. In a 2014 story by BBC News, Apple is again the center of issues related to workers’ hours, ID cards, housing arrangements, work meetings, and juvenile workers at its Pegatron facilities on the outskirts of Shanghai. Apple disagreed strongly with the portray of the Pegatron factory's working conditions, and stated in the BBC News article that “We are aware of no other company doing as much as Apple to ensure fair and safe working conditions.”

Sources: R. Bilton, “Apple Failing to Protect Chinese Factory Workers,” *BBC News*, December 18, 2014; E. Kurtenbach, “The Foreign Factory Factor,” *Seattle Times,* August 31, 2006, pp. C1, C3; Elaine Kurtenbach, “Apple Says It's Trying to Resolve Dispute over Labor Conditions at Chinese iPod Factory,” *Associated Press Financial Wire,* August 30, 2006; “Chinese iPod Supplier Pulls Suit,” *Associated Press Financial Wire,* September 3, 2006.