Chapter 11
Application: Mitigating New Product Development Risks—The Case of the Boeing 787 Dreamliner

Abstract Besides those outsourcing-related risks presented in Chapter 10, there are various supply chain risks arising from new product development. In this chapter, we illustrate these new product development risks by using the case of the Boeing 787 Dreamliner to present how Boeing managed these risks . More importantly, we highlight key lessons for manufacturers to consider when designing supply chains for new products.

11.1 Introduction

In Chapter 10, we presented eight outsourcing-related risks as well as different ways to mitigate these risks. In this chapter, we examine various supply chain risks arising from the specific context of new product development in the case of the Boeing 787 Dreamliner. Specifically, we shall (a) analyze Boeing's rationale for developing the 787's supply chain that was a break from past practice, (b) describe Boeing's challenges for managing this supply chain, and (c) highlight key lessons for manufacturers to consider when designing supply chains for new products.[1]

Boeing decided to develop its latest aircraft—the 787 Dreamliner—to stimulate revenue growth and raise its profile in the commercial aircraft industry. With the 787 Dreamliner, Boeing developed not only a revolutionary aircraft, but also an unconventional supply chain to reduce development cost and time drastically. However, despite significant management effort and capital investment, Boeing experienced delays in its schedule for the maiden flight and for delivery to customers.

Since the US government deregulated air travel in 1977, more airlines entered the market causing fierce price competition. As airfares continued to decline, the total number of US passengers rose from approximately 240 million in 1977 to 679 million in 2008. Since then, traffic has grown significantly in other parts of the world. At the same time, US commercial aircraft manufacturers faced major

[1] Joshua Zimmerman contributed significantly to this chapter.

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competition from Europe. After losing market share in the late 1990s to Airbus (owned by EADS, based in Europe), Boeing was under pressure to decide between two basic competitive strategies: reduce the production costs (and the selling prices) of existing types of aircraft or developing a new aircraft that could create more value for its customers.

In 2003, Boeing decided to focus on the latter approach of creating value to its customers (airlines) by developing an innovative aircraft: the 787 Dreamliner. (We use the terms "787 Dreamliner", "787", and Dreamliner" interchangeably.) First, Boeing's value creation strategy for the passengers was to improve their travel experience through redesign of the aircraft and offer significant improvements in comfort as a means for differentiating from competitors, mainly Airbus. For instance, relative to other aircrafts, over 50 percent of the primary structure of the 787 aircraft (including the fuselage and wing) is made of composite materials (c.f., Hawk (2005)). As opposed to the traditional material (aluminum) used in airplane manufacturing, the composite material allows for increased humidity and pressure to be maintained in the passenger cabin offering substantial improvement to the flying experience. Also, light-weight composite materials enable the Dreamliner to take long-haul flights, enabling airlines to offer non-stop flights between distant pairs of cities without layovers, as preferred by most international travelers (c.f., Hucko (2007)). Table 11.1 and Fig. 11.1 compare the 787 aircraft with other popular aircrafts from Boeing itself and the other new airplane for long-haul from Airbus, the A380.

Table 11.1 Comparison of select Boeing (737, 747, 787) and Airbus aircraft (A380-800)

Airline Family	Max Range (nautical miles)	Max Capacity (passengers)	Empty Weight (lbs)	Cruising Speed (mph)	Strategy
737-800	3,000	189	91,000	514	Direct flights to multiple cities
747-8	8,000	467	410,000	570	Hub to hub
787-9	8,500	330	254,000	561	Direct flights to multiple cities
A380-800	8,200	525	610,000	561	Hub to hub

Second, Boeing's value-creation strategy for its customers (the airlines) was to improve efficiency by using midsize airplanes to provide big-jet-type flying ranges while flying at approximately the same speed (Mach 0.85). The resulting efficiency would allow airlines to offer economical non-stop flights to and from more and smaller cities. In addition, with a capacity between 210 and 330 passengers and a range of up to 8,500 nautical miles, the 787 Dreamliner is expected to use 20% less fuel than existing airplanes of similar size. The cost per seat-mile is therefore expected to be 10% lower than for any other aircraft. Also, unlike the traditional

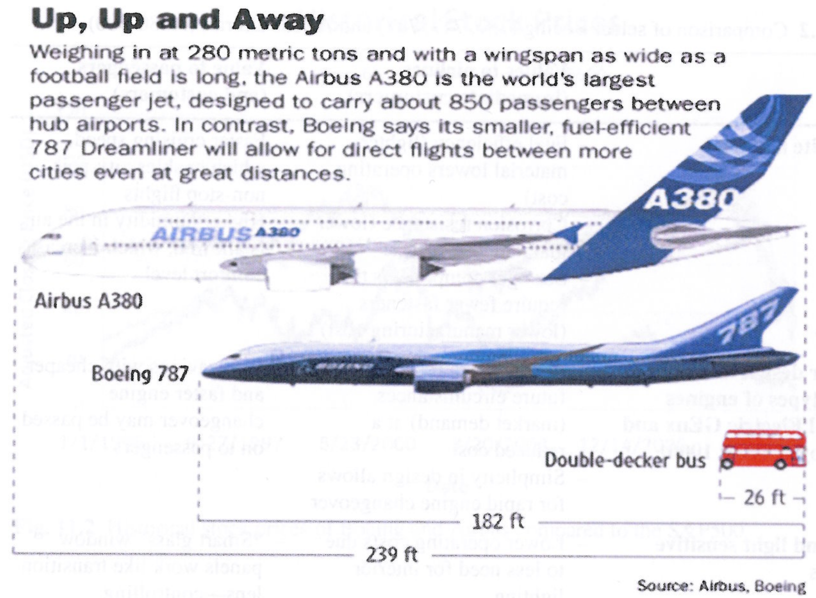

Fig. 11.1 Dreamliner and A380 size comparison

aluminum fuselages that tend to rust and to experience metal fatigue, 787's fuselages are based on the composite materials, which reduce airlines' maintenance and replacement costs (c.f., Murray (2007)). Table 11.2 provides a summary of the Dreamliner's benefits for both the airlines and their passengers.

Due to the unique value that the 787 provides to the airlines and their passengers, the number of orders exceeded expectations. The Dreamliner is the fastest-selling plane in aviation history with carriers attracted to its new largely composite design and innovative next-generation jet engines that will allow the wide-bodied plane to fly further on less fuel. The Dreamliner program has been considered a model endeavor combining novel technology and production strategies. As of November 16, 2008, Boeing (www.boeing.com) had received orders from 7 airlines that accounted for 895 Dreamliners. The overwhelming response from the airline industry to Boeing's 787 forced Airbus to quickly redesign its competitive wide-bodied jet, the A350, to make it even wider, which was later re-released as the A350XWB for "extra wide body"[2]. Boeing is currently the second largest global aircraft manufacturer (behind Airbus) in terms of revenue and deliveries (though having received more orders than Airbus), the second-largest aerospace and defense contractor in the world (behind Lockheed Martin), and the single largest U.S. exporter (with nearly $29 billion of exports in 2009). Sales for the fiscal year ending in March 2011 amounted to $64 billion with net income of $4.46 billion.

Besides airlines, the stock market also responded favorably when Boeing launched its "game-changing" 787 Dreamliner program in 2003. Between 2003

[2] c.f., Wallace (2006 a and b).

Table 11.2 Comparison of select Boeing (737, 747, 787) and Airbus aircraft (A380-800)

Feature	Values to airlines (immediate customers)	Value to passengers (end customers)
Composite material	– Fuel efficiency (lighter material lowers operating cost) – Corrosion resistance (lower maintenance cost) – Stronger components that require fewer fasteners (lower manufacturing cost)	– Faster cruising speed, which enables city-pair non-stop flights – Higher humidity in the air is allowed, which increases comfort level
Modular design that allows for two types of engines (General Electric GEnx and Rolls-Royce Trent 1000)	– Flexibility to respond to future circumstances (market demand) at a reduced cost – Simplicity in design allows for rapid engine changeover	– Cost savings with cheaper and faster engine changeover may be passed on to passengers
Large and light sensitive windows	– Lower operating costs due to less need for interior lighting	– "Smart glass" window panels work like transition lens—controlling the amount of light automatically—decreasing glare and increasing comfort and convenience
Redesigned chevron engine nozzle (serrated edges)	– Reduction in community noise levels	– Reduction in interior cabin decibel level
Easy preventive maintenance	– Boeing provides service so planes are in operation for longer periods of time	– Fewer delays due to mechanical problems

and 2007, Boeing's stock price increased from around $30 to slightly over $100 (Fig. 11.2). Since then however, Boeing has had to announce a series of delays beginning in late 2007 to which the market has reacted negatively (Fig. 11.2). The negative market response is expected as publicity of Boeing's supply chain issues become increasingly evident. As shown in Fig. 11.2, Airbus shared a similar fate after announcing a series of delays for the delivery of its A380 aircraft in early 2006 (c.f., Raman et al., 2008). Despite significant capital investment and management effort, Boeing has continued to face delays its schedule for plane delivery to customers as of this writing although the maiden flight of the Dreamliner finally took place in December 2009 and Boeing began pilot training for the first customer, All Nippon Airways (ANA) in April 2011. This motivates us to examine the underlying causes of Boeing's challenges in managing 787's delivery schedule.

We first examine Boeing's rationale for the 787's unconventional supply chain and then present our analysis of the underlying risks associated with its supply chain. In subsequent sections of this chapter, we describe Boeing's risk mitigation strategies to expedite its development and production process. Then we draw some

Fig. 11.2 Historical stock prices of Boeing and Airbus compared to the S&P500

lessons for other manufacturers to consider when designing their supply chains for new product development.

11.2 The 787 Dreamliner's Unconventional Supply Chain

To reduce development time for the 787 from the typical six to four years and the development cost from $10 billion to $6 billion, Boeing decided to develop and produce the Dreamliner by using a new and unconventional supply chain in the aircraft manufacturing industry. The 787's supply chain was envisioned to keep manufacturing and assembly costs low, while spreading the financial risks of development to Boeing's suppliers. Unlike the 737's supply chain that requires Boeing to play the traditional role of a key manufacturer who assembles different parts and subsystems produced by thousands of suppliers (Fig. 11.3), the 787's supply chain is based on a tiered structure that would allow Boeing to foster strategic partnerships with approximately 50 tier-1 strategic partners. These strategic partners serve as "integrators" who assemble different parts and subsystems produced by tier-2 suppliers (Fig. 11.4). The 787 supply chain depicted in Fig. 11.4 resembles Toyota's supply chain that has enabled Toyota to develop new cars with shorter development cycle time and lower development cost than its competitors (c.f., Tang (1999)). Table 11.3 highlights the key differences between the supply chain for the older 737 and that of the new 787. For instance, under the 787's supply chain structure, tier-1 strategic partners are responsible for delivering complete sections of the aircraft to Boeing to allow allow Boeing to assemble these complete sections in three days at its plant located in Everett, Washington (Fig. 11.5).

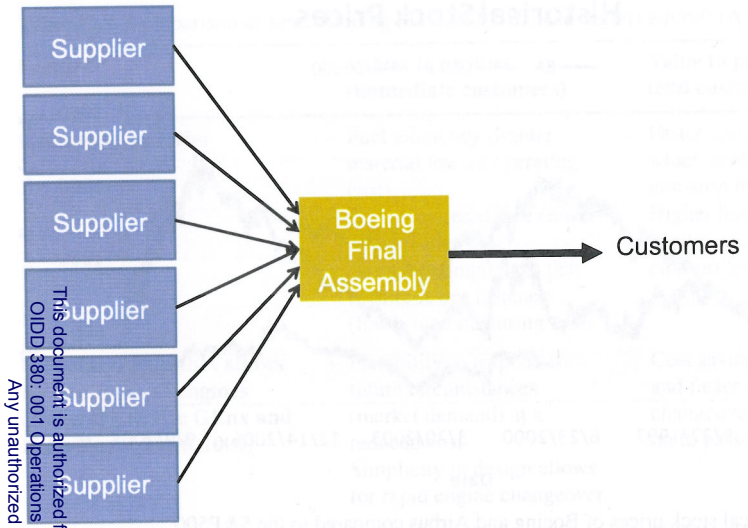

Fig. 11.3 Traditional supply chain for airplane manufacturing

We now explain the rationale behind the 787's supply chain as highlighted in Table 11.3.

Outsource More

By outsourcing 70% of the development and production activities under the 787 program, Boeing sought to shorten the development time and development cost by leveraging suppliers' ability of developing different parts in parallel. As Boeing

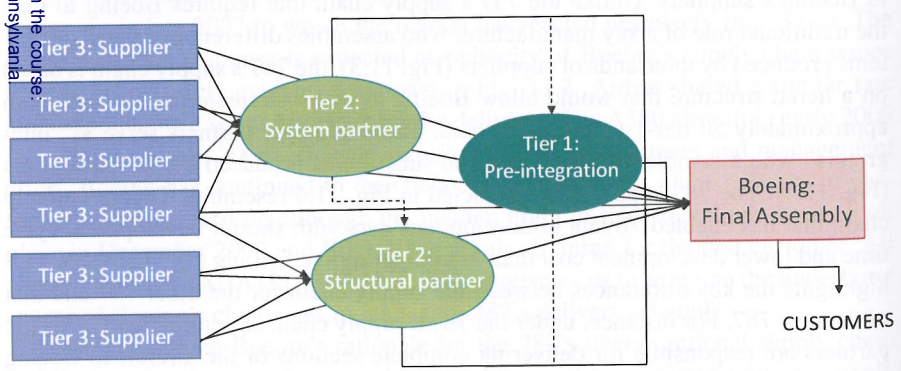

Fig. 11.4 Redesigned supply chain for the Dreamliner program. (Adapted from Steve Georgevitch, Supply Chain Management, Boeing Integrated Defense Systems.)

Table 11.3 Dreamliner features with benefits for airlines and passengers

Component	737 program	787 program
Sourcing strategy	Outsource 35-50%	**Outsourced 70%**
Supplier relationship	Traditional supplier relationship (purely contract based)	**Strategic partners with tier-1 suppliers**
Supplier responsibilities	Developed and produced *parts* for Boeing	**Developed and produced entire *sections* for Boeing**
Number of suppliers	Thousands suppliers supplying directly	**Approximately 50 tier-1 strategic partners**
Supply contracts	Fixed price contracts with delay penalty	**Risk sharing contracts**
Assembly operations	30 days for Boeing to perform final assembly	**3 day assembly of complete sections**

Source: Seattle Post-Intelligencer, Seattle

outsourced more, communication and coordination between Boeing and its suppliers became critical for managing the progress of the 787 development program. To facilitate the coordination and collaboration among suppliers and Boeing, Boeing implemented the Exostar Supply Chain Systems powered by E2Open software that is intended to gain supply chain visibility, improve control and integration of critical business processes, and reduce development time and cost. For example, when delivery problems arise with tier-2 suppliers, Exostar would alert the affected tier-1 partner. Then, if the situation is not resolved appropriately, Exostar would alert Boe-

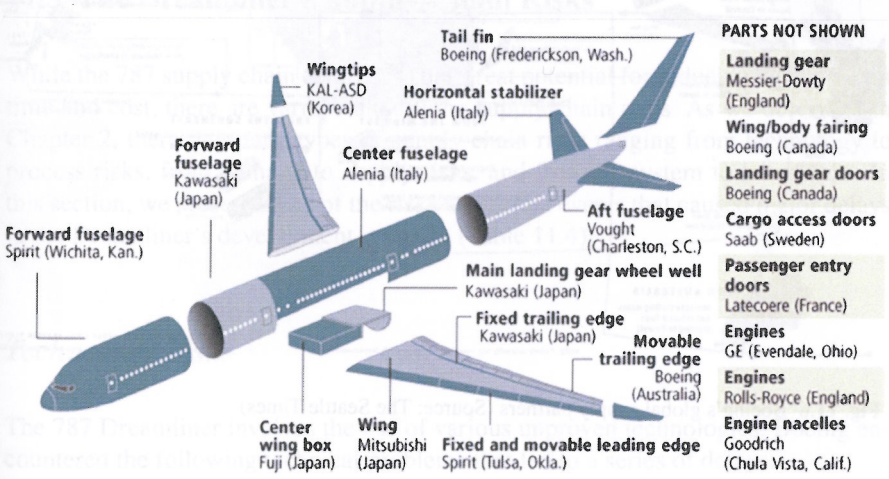

Fig. 11.5 Dreamliner subassembly plan (Source: Seattle Post-Intelligencer, Seattle)

ing so that Boeing has the option of intervening directly to address the issue (c.f., Manufacturing Business Technology, 2007).

Reduce Direct Supply Base, Delegate More, and Focus More

To reduce development time and cost for the Dreamliner, Boeing fostered strategic partnerships with approximately 50 tier-1 suppliers to design and build entire sections of the plane and ship them to Boeing. By reducing its direct supply base from thousands for the 737 to only 50 or so for the new 787, Boeing could focus more of its attention and resources on working with tier-1 suppliers (pre-integration stages) rather than with raw material procurement and early component subassembly. (Dyer and Ouchi, 1993, discuss the benefits of reducing the direct supply base as used by Toyota to develop new cars faster and cheaper than GM in the automotive industry.) The rationale behind this shift is to empower its strategic suppliers to develop and produce different sections in parallel so as to reduce the development time. Also, by shifting more assembly operations to its strategic partners located in different countries, there are potential savings in development costs as well (Fig. 11.6).

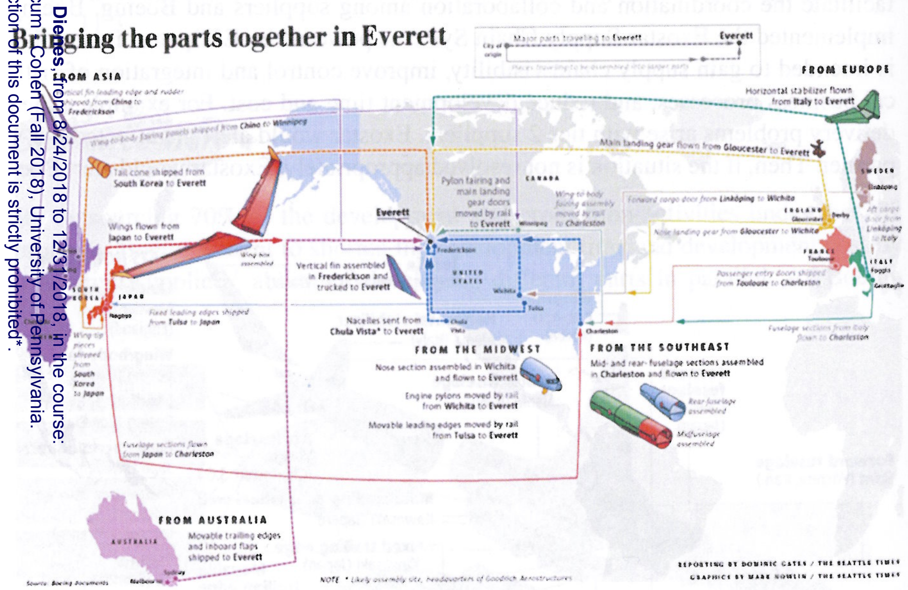

Fig. 11.6 Boeing's global supply partners (Source: The Seattle Times)

Reduce Financial Risks

Under the 787 program, Boeing instituted a new "risk sharing" contract under which no strategic supplier receives the payment for the development cost until Boeing delivers its first 787 to its launch customer, ANA airlines. This contract payment term was intended to provide incentives for strategic partners to collaborate and coordinate their development effort. While this contract imposes certain financial risks for Boeing's strategic suppliers if delivery deadlines are missed, they are incentivized by being allowed to own their intellectual property, which can then be licensed to other companies in the future. Another incentive for the strategic partners to accept this payment term is because it allows them to increase their revenues (and potential profits) by taking up the development and production of the entire section of the plane instead of a small part of the plane.

Reduce Assembly Time Without Incurring Additional Costs

Decentralizing the manufacturing process would allow Boeing to outsource non-critical processes. The intention is to reduce the capital investment for the 787 development program. Also, under the 787 supply chain, Boeing would need only three days to assemble complete sections of the Dreamliner at its plant. Relative to the 737 supply chain, this drastic reduction in cycle time would in turn increase Boeing production capacity without incurring additional investments.

11.3 The Dreamliner's Supply Chain Risks

While the 787 supply chain (Fig. 11.4) has great potential for reducing development time and cost, there are various underlying supply chain risks. As we described in Chapter 2, there are many types of supply chain risks ranging from technology to process risks, from demand to supply risks, and from IT system to labor risks. In this section, we present some of the risks and actual events that caused major delays in the Dreamliner's development program (Table 11.4).

Technology Risks

The 787 Dreamliner involves the use of various unproven technologies. Boeing encountered the following technical problems that led to a series of delays.

- ***Composite Fuselage Safety Issues:*** The Dreamliner contains 50% composite material (carbon fiber reinforced plastic), 15% aluminum and 12% titanium. The

Table 11.4 Dreamliner features with benefits for airlines and passengers

Risk Factor	Potential risk caused by the 787 supply chain	Risk consequence: what happened at Boeing?
Technology	Infeasibility of material in flight tests, which is untested on this scale	Invisibility of development issues with tier-1 suppliers' partners resulting in major delays
Supply	Tier-1 suppliers outsource development tasks to tier-2 partners, which may not have technical know-how	Lack of knowledge about supplier selection by tier-1 partner, delay in development and manufacturing work
Process	Over reliance on tier-1 partners to coordinate their development tasks with their suppliers further down the supply chain	Need for increased coordination of supplier's activities required "traveled work" by Boeing personnel
Management	Inexperienced management team without supply chain expertise	Management failure, need for reorganization at highest levels
Labor	Union dissatisfaction with Boeing's decision to outsource more	Union strike causing work stoppage
Demand (Customer)	Publicity of problems may cause problems with airline and passenger perceptions of Boeing	Delivery delays may cause financial penalties and cancellation of orders

Source: Seattle Post-Intelligencer, Seattle

composite material has never been used on this scale and there was a perceived risk creating an airplane with this mixture of materials is not feasible. Also, lightning strikes are a safety concern for wings made out of this composite material because the lightning bolt could potentially travel through wing-skin fasteners (c.f., Wallace (2006)).

- ***Engine Interchangeability Issues:*** One of the key benefits of the 787's modular design concept was to allow airlines to use engines from two different makers (Rolls-Royce and GE) interchangeably. However, due to recent technical difficulties and parts incompatibility, it takes 15 days to change engines from one model to the other instead of the originally intended 24 hours (c.f., Leeham (2005)).
- ***Weight Issues:*** As of May 2009, Norris (2009) reported that the first 787s have 8%, or 2.2 metric tons of excess weight over that in the original design. Analysts are predicting that the heavier planes will have a 15% reduction in range. This reduction in range negates some of the advantages that the Dreamliner was supposed to provide.
- ***Computer Network Security Issues:*** The current configuration of electronics on the Dreamliner puts passenger electronic entertainment on the same computer network as the flight control system. This raises a security concern for terrorist attacks (c.f., Zetter and Kim (2008)).

Supply Risks

Boeing is relying on its tier-1 global strategic partners to develop and build entire sections of the Dreamliner based on unproven technology. Any break in the supply chain can cause significant delays of the overall production. In early September 2007, Boeing announced a delay in the planned first flight of the Dreamliner citing ongoing challenges including parts shortages and remaining software and systems integration activities. Although the Exostar computer system is an efficient tool to manage the information flow within the supply chain, it is only useful if accurate and timely information is provided by different suppliers. First, after realizing insufficient in-house system integration capability, one of the tier-1 suppliers, Vought, hired Advanced Integration Technology (AIT) as a tier-2 supplier to serve as a system integrator without informing Boeing. AIT is supposed to coordinate with other tier-2 and tier-3 suppliers for Vought (c.f., Tang (2007)). Second, due to cultural differences, some tier-2 or tier-3 suppliers did not always enter accurate and timely information into the Exostar system. Consequently, various tier-1 suppliers and Boeing were not aware of the technical problems (such as parts shortages) or delay problems in a timely fashion. These two problems undermined the benefits sought from Exostar.

Process Risks

The design of the supply chain for the 787 is a likely cause of the delays because delivery depends on the synchronized Just-In-Time deliveries of all major sections from Boeing's tier-1 strategic partners: if the delivery of any section is late, the delivery schedule of the entire aircraft is delayed as a consequence. Also, under the risk-sharing contract, none of the strategic partners will get paid until the first completed plane is certified for commercial flight. As strategic partners recognize they may be penalized if they were to complete their tasks before other suppliers, the risk-sharing contract payment may actually tempt these strategic partners to work slower, which undermines the original intent of the risk-sharing contract (c.f., Kwon et al., 2010).

Management Risks

Given the unconventional supply chain for the Dreamliner, it was essential for Boeing to assemble a leadership team that included members with proven supply chain management experience of having prevented and anticipated certain risks as well as having developed contingency plans to mitigate the impact of different types of risks. However, Boeing's original leadership team for the 787 program did not include members with expertise on supply chain risk management. Without the requisite skills to manage an unconventional supply chain, Boeing was undertaking a huge risk in uncharted territory.

Labor Risks

As Boeing increased its outsourcing effort, Boeing workers became concerned about their job security. Their concerns resulted in a strike by more than 25,000 Boeing employees in December 2008. The effects of the worker strike were also felt by Boeing's strategic partners. For example, Spirit Aerosystems, a manufacturer of fuselage parts for the 787, could not deliver parts as a direct result of the strike.

Demand Risks

As Boeing announced a series of delays, some customers lost their confidence in Boeing's aircraft development capability and began canceling orders for the Dreamliner or migrating toward leasing contracts instead of purchasing the airplane outright. As of May 2009, 58 orders for the Dreamliner had been canceled by four different airlines and by August 2010 more orders had been cancelled than booked for that year.

11.4 What Boeing Did to Mitigate Risk

We now present Boeing's reactive response for reducing the negative impact of these problems and for avoiding further delays (Table 11.5).

Mitigating Technology Risks through Redesign

To improve the safety of its composite fuselage, Boeing is redesigning its fuselage by using additional material to strengthen the wing structure; however, this additional material would increase the aircraft's overall weight. Boeing management has continued to assure its customers that it would work diligently to reduce the weight of the final version of the plane. Regarding the time it takes to change engines from one model to the other, Boeing is redesigning its installation process with the hope of reducing changeover time. Finally, to ensure that the computer network is secure, a proper design is required that allows for the separation of the navigation computer systems from the passenger electronic entertainment system.

Table 11.5 Boeing's reactive risk mitigation strategies

Risk Factor	Reactive Risk mitigation strategy
Technology	Modify design
Supply	Purchase company at the bottleneck stage (Vought Aircraft Industries)
Process	Boeing personnel perform "traveled work" to solve issues with underperforming partners
Management	Reorganization of top management—replaced program manager with supply chain expert
Labor	Concessions to labor unions—increased pay and decreased outsourcing
Demand (Customer)	Boeing to pay penalties for delivery delays, public relations campaign to reassure customers

Mitigating Supply Risks

Attempting to regain control of the delayed program, Boeing purchased one of its tier-1 strategic partners—a unit of Vought Aircraft Industries—that was known to be the weakest link of Boeing's 787 supply chain (c.f., Ray (2008)). This acquisition would provide Boeing direct control of this unit as well as over the tier-2 suppliers for the fuselage development. As a result of continued production delays, some of Boeing's suppliers were facing massive profit losses, which in turn put completion of the entire Dreamliner program at risk. To mitigate this risk, Boeing paid its tier-1 strategic partner, Spirit Aerosystems, approximately $125 million in 2008 to ensure that this partner continued its vital operations (c.f., Reuters (2008)).

Mitigating Process Risks

With suppliers being unable to meet production deadlines, Boeing decided to send key personnel to supplier sites across the globe to understand and address production issues in person. However, reducing supply risks this way created its own risks

as personnel were pulled from responsibilities on-site at Boeing to address supply and manufacturing issues at the sites of their outsourced partners. The strategy of relying on suppliers for subassembly proved to be too risky for Boeing in certain circumstances and resulted in Boeing having to perform the work themselves. This "traveled work" to sites such as Finmeccanica SpA's Alenia unit and Carlyle Group's Vought Aircraft Industries Inc. has been a substantial headache for Boeing. Ultimately, Boeing had to redesign the entire aircraft subassembly process (c.f., Gunsalus (2008)).

Mitigating Management Risks

To restore customers' confidence about Boeing's aircraft development capability and to reduce the possibility of further delays, Boeing recognized the need to bring in someone with a proven record of supply chain management expertise. In response, the original 787 program director, Mike Bair (with marketing expertise), was replaced by Patrick Shanahan with expertise in supply chain management. In his new role, Shanahan is now responsible for coordination of all activities for Boeing's major plane families which includes the Dreamliner. Moreover, Boeing changed its top leadership by replacing its Interim CEO, James Bell, with Jim McNerney in 2008.

Mitigating Labor Risks

To bring about an end to the strike after two months of shutdown, Boeing made concessions that would give workers a 15 percent wage boost over four years. On the key issue of job security, which had been the major impediment to reaching an agreement, Boeing agreed to limit the amount of work that outside vendors can perform. Therefore, Boeing's concept of outsourcing a significant amount of work to global partners was put to risk and production costs may eventually rise. In response to the wage increases and limits in outsourcing promised by Boeing, the machinists union conceded to withdraw charges filed with the Department of Labor regarding allegations of unfair bargaining practices at Boeing (c.f., Gates (2008)).

Mitigating Demand (Customer) Risks

As customers began to cancel their 787 orders and as the company's capability of developing the 787 was in question, Boeing has developed the following mitigation strategies. First, as a way to compensate its customers' potential loss due to the late deliveries of their orders, Boeing is supplying replacement aircrafts (new 737 or

747) to various concerned airlines such as Virgin Atlantic (c.f., Lunsford (2007) and Crown (2008))). Second, to restore Boeing's public image, Boeing has improved its communication by sharing its progress updates on its webpage. Finally, Boeing is conducting a publicity campaign to promote the superior technology of the planes and the overall value that the airplane will offer to airlines and passengers (c.f., Crown (2008)).

11.5 What Might Boeing Have Done Differently to Mitigate Risk

With the benefit of hindsight, we can point out certain risk mitigation strategies that Boeing could have used at the outset of the program to better manage potential risks proactively (Table 11.6). These may be useful lessons for other manufacturers seeking to redesign their supply chains for new products.

Table 11.6 Alternative strategies for mitigating program risks

Risk Factor	Proactive actions	Risk affect
Supply chain visibility	Use IT to ensure transparency of entire supply chain	Avoided or reduced
Strategic partner selection and relationship	Proper vetting of all strategic partners to determine their capability of completing tasks	Reduced
Process	Develop better risk sharing opportunities and incentives for strategic partners	Reduced
Management	Establish proper working team with expertise in supply chain logistics	Avoided
Labor	Outreach and communication with union heads to discuss sourcing strategies	Avoided
Demand (Customer)	Treat customers as partners and better communicate the potential for missing delivery deadlines	Avoided or reduced

Source: Seattle Post-Intelligencer, Seattle

Improve Supply Chain Visibility

As described earlier in this chapter, Boeing's supply risk was caused in part by the lack of supply chain visibility. Without accurate and timely information about the supply chain structure and the development progress at each supplier's site, the value of Exostar in terms of providing status updates was compromised significantly. To improve information accuracy, Boeing should have insisted on having all strategic partners and suppliers provide all information imbedded in the supply chain relationships instead of relying on alerts generated from the program only when they were directly affected. Also, Boeing should have provided incentives for all suppliers to use Exostar to communicate accurate information in a timely manner.

Improve Strategic Supplier Section Process and Relationships

Had more effort been spent on evaluating each supplier's technical capability and supply chain management expertise for developing and manufacturing a particular section of the Dreamliner, Boeing could have selected more capable tier-1 strategic suppliers. Doing so would have enabled Boeing to avoid or reduce potential delays caused by tier-1 suppliers with inadequate experience. Also, Boeing should have insisted on participating in the tier-1 partner's vetting process of tier-2 (or tier-3) suppliers. The additional effort of properly vetting key suppliers would certainly enhance communication and coordination and reduce the risks of potential delays, which would in turn reduce the development time and cost (c.f., Lunsford (2007)).

Modify the Risk-Sharing Contract

As we noted already, under Boeing's risk-sharing contract, individual tier-1 strategic partners would not get paid until they had all completed their sections and the first plane was actually certified. While this payment term was intended to reduce Boeing's financial risk, it did not provide proper incentives for tier-1 suppliers to complete their tasks early. When some strategic partners did not develop their respective sections according to the schedule, the entire development schedule was pushed back and Boeing was hit with millions of dollars in penalties that it had to pay out to its customers (c.f., West (2007)). To properly align the incentives among all strategic partners, Boeing should have structured the contracts with reward (penalty) for on-time (late) delivery (c.f., Kwon et al., 2009).

Proactive Management Team

Having the right people for the job at the outset of the program would have helped Boeing better avoid and anticipate the risks associated with its novel supply chain structure. Also, identifying the sources of potential problems and having the right person (or team) in place would mitigate many of the risks, and allow Boeing to respond more quickly and effectively when problems were realized. Had Boeing appointed appropriate persons (including someone like Patrick Shananhan with proven supply chain management expertise) to serve on the original leadership team, Boeing could have avoided and anticipated various types of supply chain risks. Boeing could have reached out to experts in other industries who have managed complex supply chains similar to that of 787 supply chain. For example, Toyota has successfully managed its tiered supply chain that resembles the 787 supply chain. Also, such a leadership team would have the expertise and authority to respond to delays more effectively.

Proactive Labor Relationship Management

Dissatisfaction among Boeing's machinists was caused by Boeing's strategy to increase its outsourced operations to external suppliers. Had the union's general disapproval of Boeing's outsourcing strategy been taken into account, Boeing may not have decided to outsource 70% of its tasks. Even if this outsourcing strategy was justified financially, Boeing could have managed its labor relationship proactively by discussing the strategy, by offering job assurances, and by obtaining buy-in from unions. This proactive labor relationship management would have created a more mutually beneficial partnership, which could have avoided the labor strikes.

Proactive Customer Relationship Management

Recognizing the risks associated with innovative product development, proactive customer relationship management is critical to help customers set proper expectations when placing their orders. Better communication with customers throughout the development process enables a company to manage customers' perceptions throughout the entire product development process. Had Boeing set proper expectations about the delivery schedules of its 787 Dreamliner, the airlines may have managed their aircraft replacement schedule differently, say by ordering more 737s and 747s and delaying or ordering fewer 787s. Without an aggressive delivery schedule to its customers, Boeing could have reduced the penalty caused by the delayed delivery schedule. Through continuous engagement and open communication about the challenges and Boeing's contingency plans, Boeing could have better managed

its customers' perception. By earning the trust from its customers, Boeing could have prevented the erosion of Boeing's reputation.

11.6 Conclusion

Boeing's Dreamliner program involves dramatic shifts in supply chain strategy from traditional methods used in the aerospace industry. In addition, the airplane itself required novel manufacturing techniques and used technological advances never before tested on a project of this scale. Such dramatic shifts from convention done in parallel involve significant potential for encountering risks throughout the process. Boeing's issues with meeting delivery deadlines were a direct result of its decision to change many elements of such a complex system simultaneously without having the proper management team in place. Further, this team did not proactively assess the risks that were later realized and did not develop strategies for effectively mitigating them. While it may be impossible to identify all potential risks and create contingency plans for all eventualities before a project begins, Boeing could have done many things differently. It is instructive for managers in any industry to view the issues that Boeing faced to learn from mistakes that were made before engaging in similar supply chain restructuring for a new product. Some of these lessons are:

1. *Assemble a leadership team with requisite supply-chain expertise.* On the surface, it appears that Boeing's fundamental problem was caused by its attempts to take on too many drastic changes simultaneously: unproven technology, unconventional supply chains, unproven supplier's capability to take on new roles and responsibilities, and unproven IT coordination systems. However, the underlying reason for Boeing to take on so many drastic changes was due to the fact that the 787 leadership team underestimated the risks associated with all these changes. Had Boeing constituted a multi-disciplinary team with expertise to identify and evaluate various supply chain risks, Boeing could have avoided and anticipated potential risks, and developed proactive mitigation strategies and contingency plans to reduce the impact of various supply chain disruptions.
2. *Obtain internal support proactively.* Partnerships between management and labor are essential for smooth operations for companies to implement any new initiatives including new product development programs. While their interests are often misaligned, better communication of business strategies with union workers can be step towards avoiding costly worker strikes. Also, aligning the incentives for both parties proactively can reduce potential internal disruptions down the road.
3. *Improve supply chain visibility to facilitate coordination and collaboration.* A company must cultivate strong commitment among its suppliers for accurate and timely information. Overly relying on IT communication is highly risky when managing a new project. To mitigate the risks caused by partners further upstream or downstream, companies should strive for complete visibility of the entire supply chain. Having this capability would enable a company to take corrective action quickly, which would certainly reduce the negative impact of a disruption along the supply chain (recall Chapter 5 about responding to risk events).
4. *Proactively manage customer expectation and perceptions.* Due to the inherent risks associated with new product development, it is critical for a company to help its customers set proper expectations proactively, providing a range of potential outcomes regarding product specification and delivery schedule reflecting the uncertainty. Setting proper expectations reduces potential customer dissatisfaction down the road. During the development phase, it is advisable for the company to maintain open and honest communication with customers regarding the actual progress, technical challenges, and corrective measures. Such efforts could gain customers trust, which would improve customer loyalty in the long run.

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To

Katarzyna Zechenter,

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and

Richard Paegelow