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EMBRY-RIDDLE

Aeronautical University

DAVID B. O'MALEY COLLEGE OF BUSINESS

FIN 623 ISTAT U

Aircraft Funding Legal & Financial Analysis

AIRCRAFT SELECTION

CASE STUDY



OVERVIEW

The aircraft selection procedure is a part of the fleet planning process. Fleet planning is intricate for any airline. Factors such as aircraft economies, commonality, aircraft performances, finance, market evaluation, availability, technology advancement and more, are crucial. The market and the environment in which the aircraft will operate are predictable in the short run however, it becomes uncertain when time increases. Decisions related to the fleet configuration and fleet size will be made while evaluating the above factors.

This case study is concentrated on a cargo airline, namely the FedEx Express. We will see how an aircraft type that triumphs on some of the above factors will fail on others. Our objective is to prepare a reasonable analysis in ruling the most suitable answer to the specific fleet question, mission, focusing both economic and non-economic factors. The fundamental revenue contributor for any airline is brought by operating its aircraft fleet. Buying or leasing of an aircraft requires huge investments, therefore assessing, selecting and handling the ideal fleet are key factors of success or failure for an airline.

Keywords

*Air Cargo Industry – Major Hub/Network – Mission – Fleet Diversification – Technology –
Network Opportunity – Availability – Economics – Financing*



INTRODUCTION

According to IATA (2018), IATA Cargo Strategy report: *Air cargo represents more than 35% of global trade by value. When it comes to combined passenger and cargo airlines, the cargo business generates 9% of airline revenues on average, representing more than double the revenues from the first class segment.*

Today's cargo trade consists of three market sectors: express or "time definite" packages (weighing less than 100 lb.), heavyweight freight shipments (packages greater than 100 lb.) and mail transport. Combined cargo businesses such as FedEx and UPS operate all three kinds, however there exists plenty of other carriers that offer service to only one of the above sectors. Today aerial transportation is essential in many ways. Its speed and reliability allow the transportation of perishable goods (e.g., flower, food, & etc.). The global network connects consumers and e-commerce operators, such as eBay and Amazon, all around the world. In addition, it is considered the most humane mean of transporting live-animals.

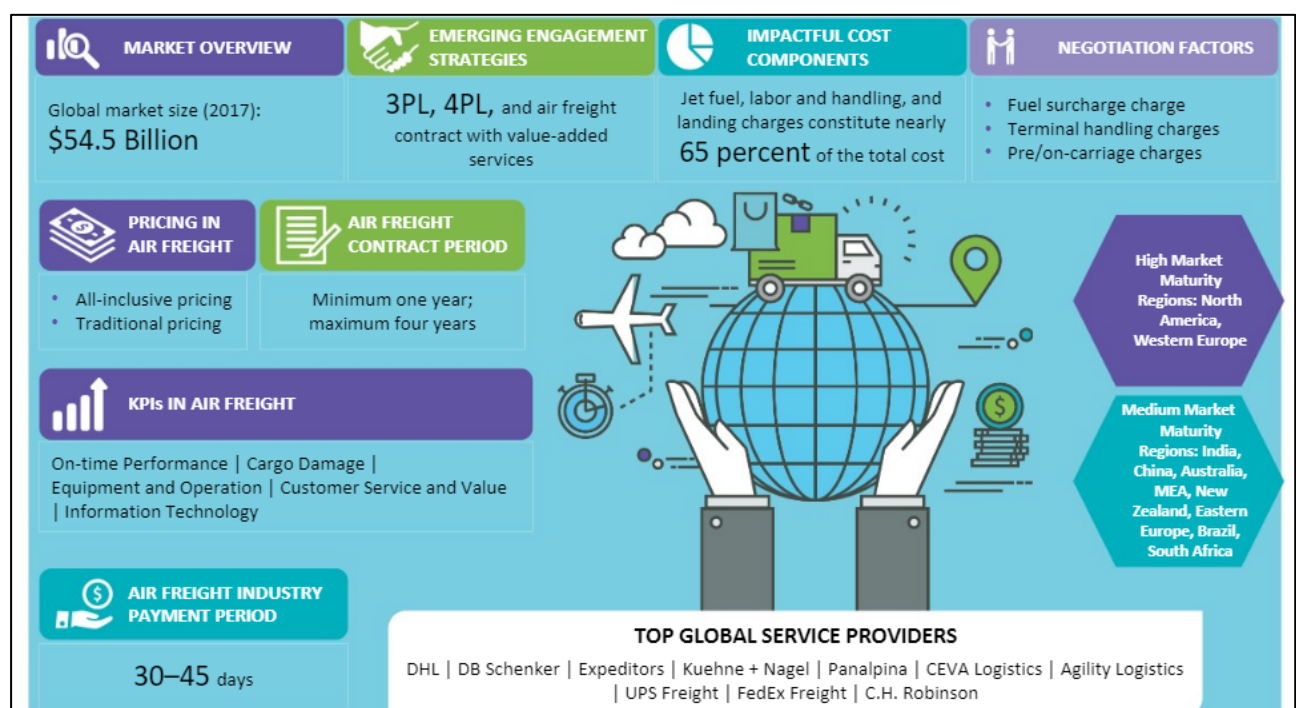


Figure 1. 1 Global Market Outlook on Global Air Freight, 2018

In a typical day, aerial cargo industry handles over 80,000 flowers, 20 million parcels, 1.1 million smartphones, 6,849 lives saved, 100,000 aircrafts take off, 140,000 t. of cargo carried, \$18.6 billion values in cargo shipped, over 200 horses, and 898 million letters. The value of goods carried by airlines is expected to exceed \$6.2 trillion in 2018, representing 7.4% of world GDP. The greatest advantage in aerial transportation is the speed. It is also considered safer and more reliable, that is, the number of people who are involved in the business between the origin and destination is kept minimal, thus, likelihoods of theft, mishandling, and damaging are very low. On the other hand, aerial transportation can be more complex than ground or maritime vessels. Payload capacity on aircrafts are much smaller compared to other transportation vehicles which raises the operational expenses, therefore shipping rates. Despite the disadvantages, there remains opportunities for growth. Rapid growth in e-commerce sector in recent years increased the demand for aerial cargo transportation. Parcels carries via air rose from 6.7 billion to 7.4 billion. Furthermore, the volume of goods transported via air and the industry's revenue are growing.

Federal Express, commonly known as FedEx is a company that specializes in transportation of goods through its network that reaches all corners of the world. FedEx officially began its operation in 1973. However, the founder Frederick W. Smith constructed the blueprint of FedEx while he attended Yale University, in 1965. Today, FedEx operates with 678 aircrafts and more than 85,000 motor vehicles, providing services in over 220 countries and territories. FedEx is currently the fourth in its market share; first being the UPS, second DHL, and third USPS.

As the rate of flying one ton of cargo falls, the aircraft size increases (because fixed costs are evenly divided throughout big capacity), this is causing the larger freighters to replace smaller cargo aircraft rapidly. The advancement in aircraft size is very vital for airport hub operations, which is a must as it is required to be flexible to house larger aircraft.

FedEx Express is based in Memphis, Tennessee-USA. In addition to its shipping services, FedEx offers a wide range of business services.

Market Capitalization	\$36.2 billion
Packages (average daily volume)	> 6 million
Pounds of Freight (average daily volume)	> 30 million
Airports	375; served with 10 hubs US: MEM, EWR, ANC, IND, OAK, AFW Int'l: CDG, CAN, MIA, CGN, DXB
Fleet Size ^[1]	In service: 570 (91.9% Owned & 8.1 % Leased) In storage: 32 On order:162
Countries & Territories	> 220

Table 1. 1 Based on 255 operating days a year (Source: <https://about.fedex.com/our-story/company-structure/express-fact-sheet> & CAPA Fleet Database^[1])

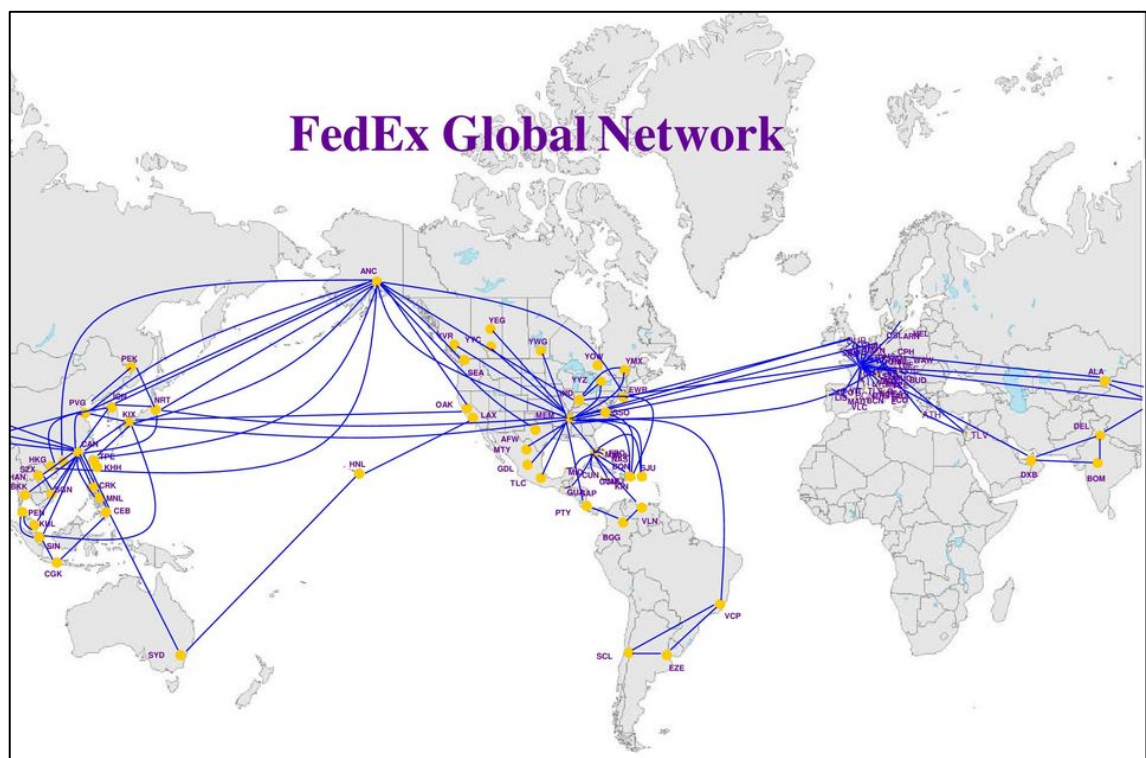


Figure 1. 2 Map shows combination of FedEx routes

AIRCRAFT SELECTION

Mission

Piedmont Triad (2018). Facts about the FedEx Expansion at Piedmont Triad International Airport: *FedEx will expand its activity at PTI beginning on or about September 4, 2018 and will be adding as many as 400 new jobs. The expansion will also add a net total of eight new FedEx flights at the airport, nearly doubling existing operations. These flights will primarily consist of B757 aircraft. With few exceptions, the hub operations will be limited to four nights per week (Monday – Thursday).*

All of these new flights, plus two small turboprop feeder aircraft (that replace two similar feeders that currently operate earlier in the day), will arrive late at night and depart early morning.

The environmental analyses done for the FedEx Hub operations, and the Authority's Part 150 Noise Compatibility Program contemplated as many as 63 flights per night operating in the head-to-head pattern. The currently planned number of ten is significantly fewer.

Finally, many of the 63 flights in earlier planning were to be operated with B727 aircraft, one of the noisiest aircraft flying at that time. FedEx has since retired all of its B727 fleet. The new flights will be operated with more modern and quieter aircraft.

Domestic: From the above article, FedEx is expanding its operation at PTI and will primarily consist of the B757. However, we will compare reasonable aircraft(s) close to B757 to provide a better option or prove that B757 is indeed an ideal aircraft. For this case study, we will analyze a hypothetical situation if FedEx were to operate from PTI and MCO (465.77 nmi)

Fleet Diversification

FedEx Express' overnight services nearly spreads across the entire United States. This airline offers the highest widespread freight service in the industry, backed by real-time tracking, money-back guarantee and advancements in custom clearance. All this is primarily possible because they make sure to 'use the right aircraft for the right mission'. FedEx Express phased out B727's with B757 as the latter was said to be 36% more fuel efficient on payload regulated.

For the above mission, FedEx is planning to operate their 757's and small turboprop feeder aircrafts.

Origin – Destination distance (nmi)		465.77	
Daily frequency		2	
	Boeing 757-200F	Boeing 737-800 BCF (Next Best)	Boeing 767-300BCF (in house)
In service	111	-	65
On order	0	-	58
Engine	Turbofan	Turbofan	Turbofan
Payload (lbs.)	59998	52800	119049
Max Range (nmi)	2935	2024	3300
MTOW (lbs.)	220000	187700	186880 kg
Cargo Volume (ft ³)	6600	5000	15724
Fuel Capacity (gal)	11276	7837	24140
Fuel Efficiency (lbs./mi)	16.63 ^[2]	12.23 ^[2]	19.5 ^[3]
Fuel pound for each flight (miles)	8746.92771	6802.5709	10230.6381
Fuel gallons/day @8.35 lbs = 1 gal (2 flights)	2095.07251	1629.3583	2450.45223

[2] Source: Analyzing the options for 757 replacement.
http://www.aircraft-commerce.com/sample_articles/sample_articles/fleet_planning_2_sample.pdf

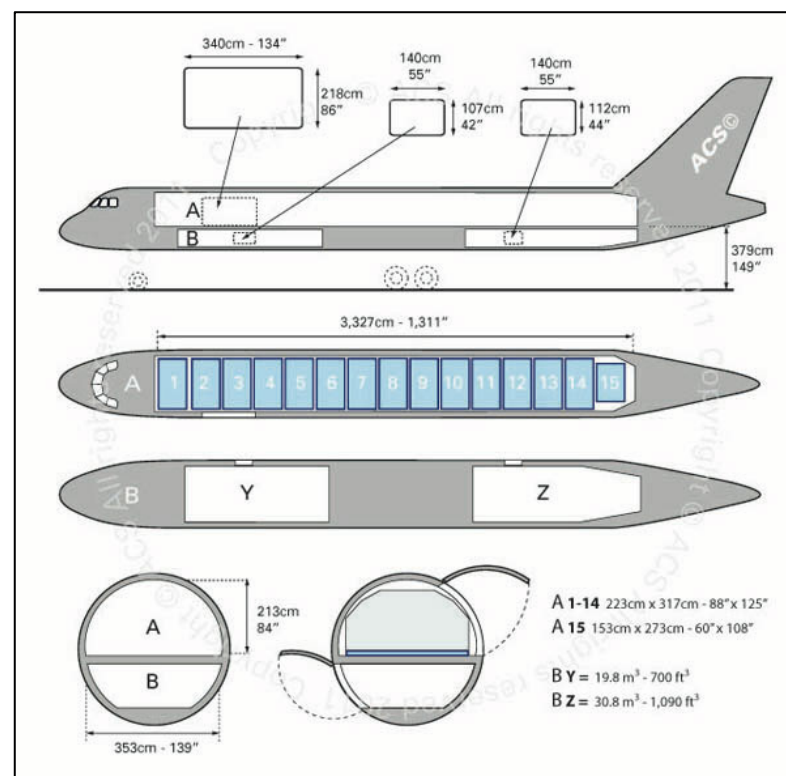
[3] Source: 767-300 Performance Summary.
https://web.archive.org/web/20150415224410/http://www.boeing.com/assets/pdf/commercial/startup/pdf/767_perf.pdf

Fuel cost per gal (USD \$) (\$2.79/gal)	5845.25229	4545.9096	6836.76171
Fuel Cost for 2 flight/day (@51%) ^[4]	\$11,461.28	\$8,913.55	\$13,405.42

Table 1. 2 B757-200F vs. B737-800 BCF vs. B767-300 BCF

Mission Capability

As the flights will be operated at night i.e. arrive late in the night and depart early in the morning. It is important to consider the noise level. Although FedEx phased out the B727's with B757's for better fuel efficiency and better noise control, the 757 are getting old with the advancement in technology. This cause worries on whether the 757's maintenance costs are increasing at a high rate, and if its fuel burn is high in relation to the aircraft that could potentially replace it. There are other potential replacement aircrafts such as the 787-3, A330-200, A321 and 737-900, the smaller A320, A319, 737-800 and 737-700. The 757's are over 20 years old on average, further consumption of the material will directly increase the cost of maintenance and base checks.

Figure 1.3 B757-200F Aircraft Layout. Source: www.aircharterservice.com

[4] Fuel cost represents 51% of operational cost

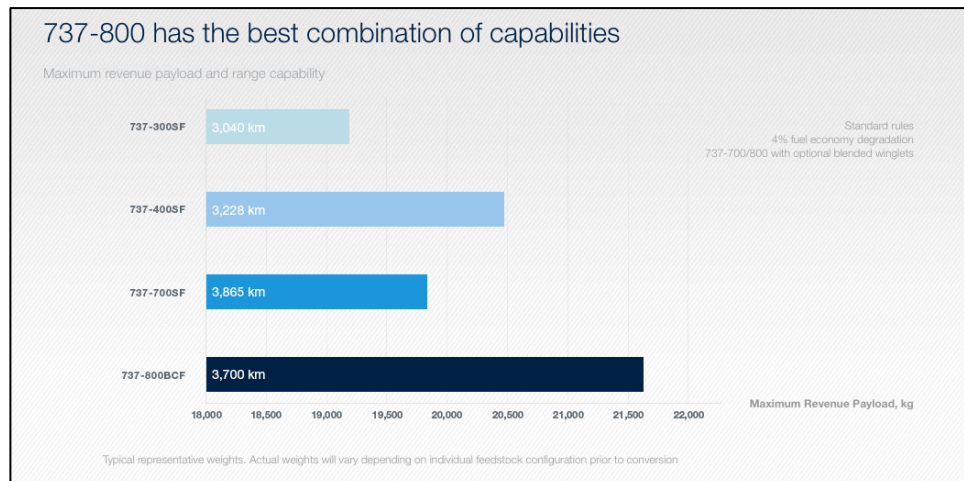


Figure 1. 6 B737-800 BCF Capabilities. Source: www.boeing.com

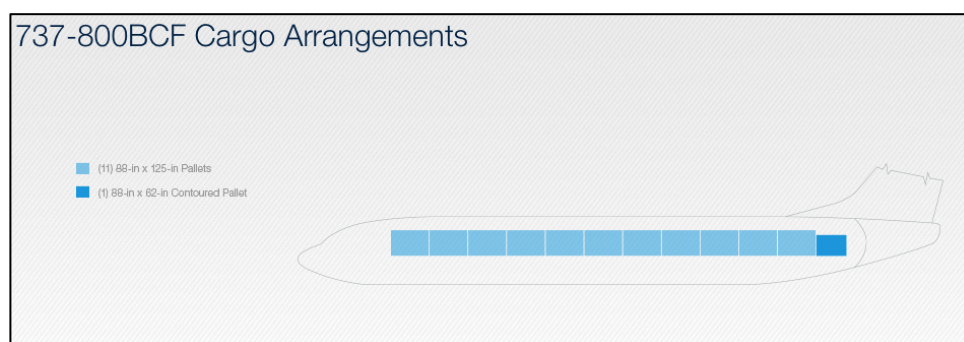


Figure 1. 5 Boeing 737-800 BCF Cargo Arrangements. Source: www.boeing.com

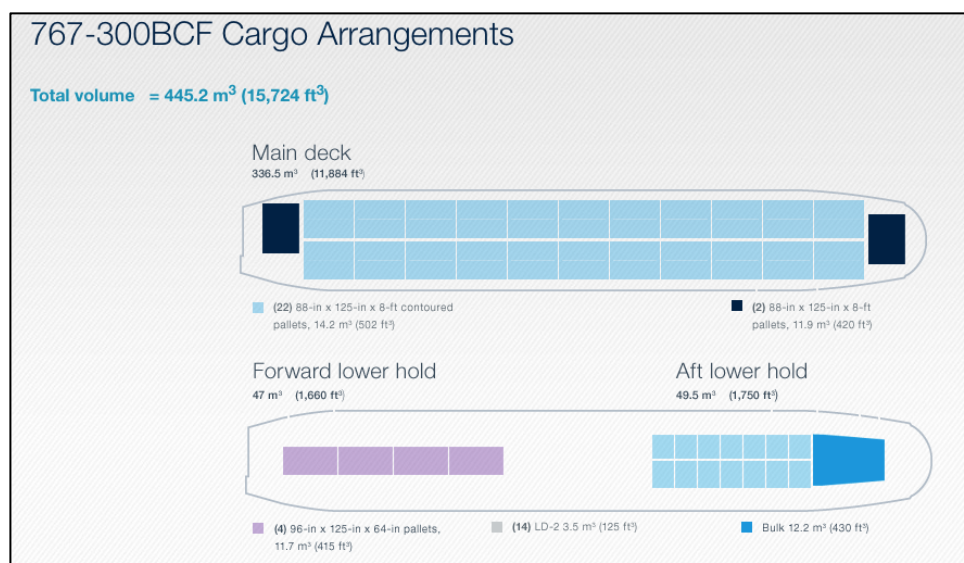


Figure 1. 4 Boeing 767-300 BCF Cargo Arrangements. Source: www.boeing.com



From table 1.2. we can validate that the next best options for FedEx Express' 757's is the 737-800 BCF & 767-300 BCF. Although 737-800 is a passenger aircraft, it is less expensive to convert a passenger to cargo than buying a new aircraft. Transforming a 20-year-old aircraft is roughly a third of the expense of a brand-new aircraft. Based on the type of operation, buying used and converting can make moral financial sense. Likewise, Boeing has successfully converted and delivered its first 737-800 BCF to West Atlantic as report on April 19, 2018^[5]. Thus, both the B737-800 BCF and B767-300BCF are dependable, fuel efficiency, relatively quieter compared to the B757-200F.

Technology

FedEx is aiming to reduce their aircraft emission by 2010 20% (per ATM's) by 2020 –which they are heading towards with the 777's and 757's. As report in the 2018 FedEx Global Citizen Report: 'In FY17 we avoided more than 2.3 million metric tons of CO₂e emissions across the enterprise. This is equivalent to the emissions from more than half a million passenger cars in one year.' They have also switched to electric models from internal combustion model for the Ground supper equipment and operations, which save 1.5 hours of engine use each trip and 1 million gallons of fuel each month.

With respect to aircraft sustainability, they have phased out 727's with 757's which has brought down the fuel consumption by 47% per ton mile transported. Currently one of their major goals is to reduce aircraft emission intensity by 30% from a 2005 baseline by 2020. This has results is a huge cost savings as much as \$285.5 million. They have achieved 22% of the 30% with reduction in aircraft emission as shown in Figure 1.7. Likewise selecting the 737-800 BCF and/or the 767-300 BCF will help them achieve this goal in turn increase the cost savings for the company.

[5] Boeing (2018). <https://boeing.mediaroom.com/2018-04-19-Boeing-Delivers-First-737-800-Boeing-Converted-Freighter>

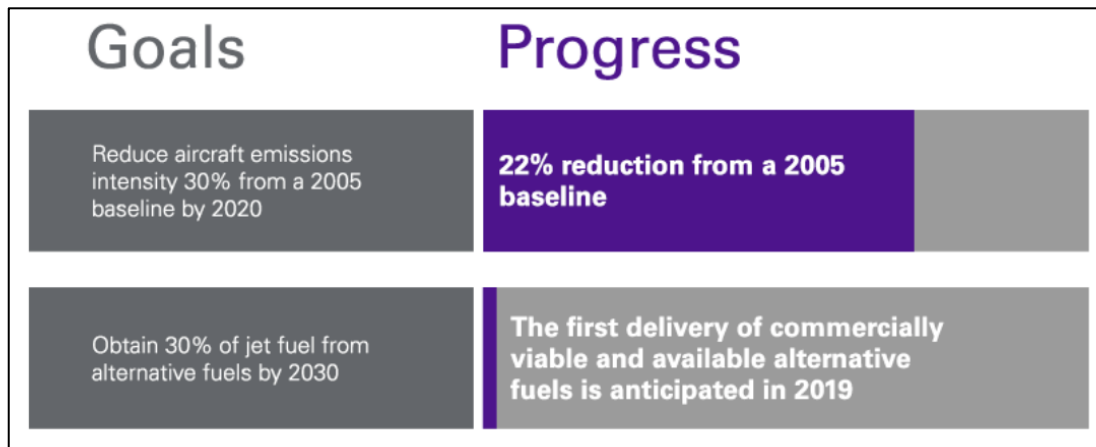


Figure 1. 7 FedEx Environment Goal. Source: www.fedex.com

New Network Opportunities

With the market saturated and heavy competition from fellow cargo airlines such as UPS, DHL and more, new network opportunities look slightly dim. However, with the aging of the 757's and new technologies, it opens the doors to phase in 737's for short/medium routes and 767's for medium/long haul routes. But at PTI, it carries enormous potential.

Availability

As of July 17, 2018 GECAS (GE Capital Aviation Services) have signed an agreement with Boeing for 20 firm orders and 15 options, with the aim of serving the growing cargo market. The Boeing market outlook forecasts that in the next 20 years, the demand for standard-body converted freighter will reach 1100. An estimate time of delivery is unknown for these aircrafts.

Economic Consideration and Availability of financing

IBA's Freightier Conversion Whitepaper (2019). *Boeing forecasts, in their Current Market Outlook 2018-2037, that the freighter market will require 2,650 additional freighters (1,670 conversions and 980 new) with Airbus predicting in their Global Market Forecast 2018-2037 that an additional 2,386 freighters (1,560 conversions and 826 new) will be needed.*

According to IATA's October 2018 Freight Analysis report, global freight volumes rose by 3.1% year-on-year.

E-commerce items reportedly make up 20% of global air-cargo volume. Current market conditions still favour older generation aircraft, feedstock is still available for the short term and fuel prices are low. However, the market is facing a transition to new generation converted freighters for the long term. IBA expects an acceleration for replacement and growth from 2020, but not before, due to current high market value of new generation feedstock aircraft for conversion.

B767-300 BCF	In Service: 68 On order: 58	\$ 212.2 million – unit cost
B737-300 BCF	-	\$ 85.8 million – unit cost >\$11 million (Typical conversion cost) ^[6]

Table 1. 2 Unit costs of B767-300BCF & 737-800BCF

Only the wide-body aircraft (>40 tons) fall into the new production category such as the B747-8F, B777F, B767-300ERF and A330-200F. Whereas, active cargo conversion are for medium-body aircrafts (40 – 80 tons). Currently there are no active conversions for the narrow-body aircrafts (<40 tons), except special orders for the 737-800 C. An aircraft's useful market life today is commonly less than 25 years, but converting to a freighter extend the aircraft's operating life by 15-20 year further, given the utilization is lower when compared to that of a passenger plane.

IBA's Freight Conversion Whitepaper (2019) states that before an airlines forward with an investment in aircraft conversion, critical questions will require to be evaluated, such as

1. Economic evaluation for Mid-Life aircraft – Refurbish/Sale/Lease/Part-Out or Convert
2. When is the right time to convert?

[5] Based on this analysis, IBA forecasts that B737-800 feedstock for conversion at the \$11m price point will become more available in 24-36 months, with an acceleration for replacement and growth from 2020 onwards

3. What is the anticipated cost to convert?
4. What is the anticipated conversion turnaround time?
5. What will be the aircraft market value after conversion?
6. What are the anticipated lease rates after conversion?
7. Are in-house resources available to manage a converted freighter asset through the extended life?

It is predicted that the timeline to get a converted aircraft will be around 24-36 months with will see an acceleration and growth from 2020 onwards.

International: FedEx offers the best of both worlds — global reach backed by local expertise. Their worldwide network is served by five regions outside the U.S.: Canada; Asia Pacific (APAC); Europe; Middle East, Indian Subcontinent and Africa (MEISA); and Latin America, Caribbean (LAC).



Figure 1. 8 The worldwide network of FedEx Express

In this part, China will be taken into consideration especially because it's home to 1.3 billion people — more than four times the population of the U.S. — with 11 of the world's 50 largest metro areas and roughly 260 cities with populations of 1 million or more people. China became the world's largest exporter in 2010, and the U.S. was the No. 1 destination for those goods. And China is the third-largest export market for the U.S., as well as the third-largest market overall for luxury goods. So, the outlook for international expansion of business may shine brightest in China.

Present Market

Competition

For better selection of the aircraft type, we can refer to present operating situation and choose one appropriate competitor.

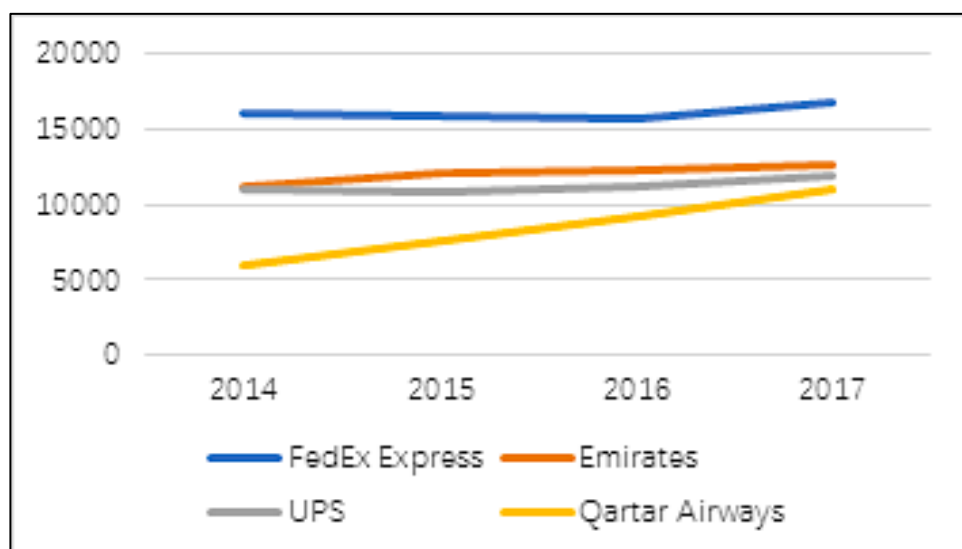


Figure 1. 9 Top 4 cargo Carrier-Scheduled RFTK (million)

Although FedEx Express' RFTK is the highest, it not only didn't grow but dropped slightly from 2014 to 2016. It is worth noting that Qatar Airlines keep high speed linear growth these four years and catch up with Emirates and UPS.

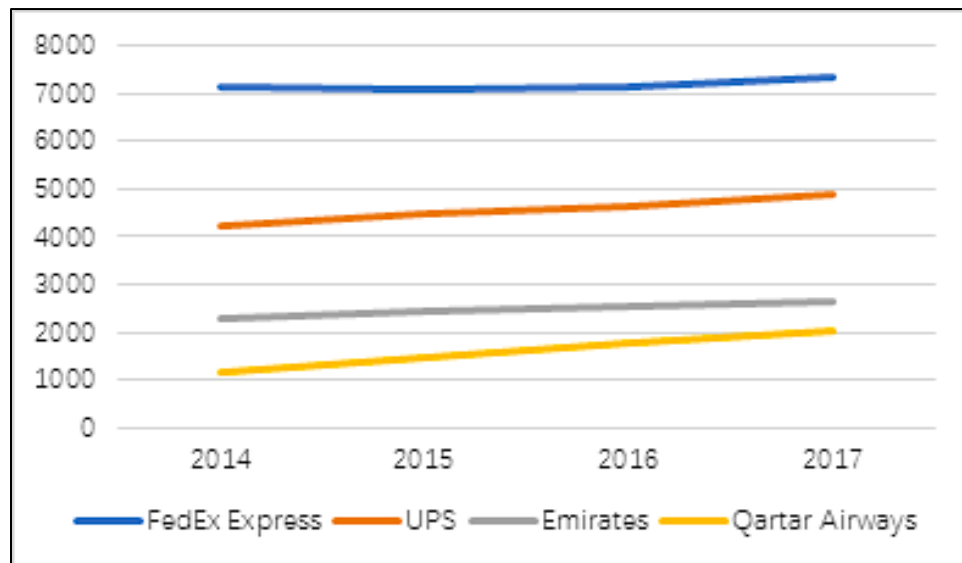


Figure 1. 10 Top 4 Cargo Carriers-Scheduled Tons (000)

The top 4 cargo carriers with scheduled tons are shown in figure 3. As we can see, FedEx Express is far more than the others in the weight of the cargo. Combine figure 2 and figure 3, we can know that the domestic business ratio in FedEx is bigger than that of UPS. And the large increase of FedEx in RFTK in 2017 is due to the expansion of international business. Although FedEx is in the lead, we can still see the difficulty in development of it. Expanding multinational business could be the way.

Mission capability

Choosing UPS as the comparison is because its similarity in size, operating mode, market and quick development. For mission capability analysis, the route from U.S. to Hongkong is been selected because the Headquarters of FedEx in Asia Pacific is in Hongkong and the demand is large and frequent.

Airlines	Origin	Transfers	Destination	Aircraft
FedEx Express	Memphis	Anchorage	Hongkong	777-200LR/F
UPS	Louisville	Anchorage	Hongkong	747-800

Table 1. 3 Routes of FedEx and UPS from U.S. to Hongkong

i. Payload-Range analysis

The distance from Memphis (MEM) to Anchorage (ANC) is 2740 nautical miles, the distance from Louisville (SDF) to ANC is 2713 nautical miles, and the distance from ANC to Hongkong (HKG) is 4415 nautical miles. Refer to the payload-range diagrams of these two aircrafts, the Boeing 747-800 F and the 777 cargo freighters are capable of carrying 308,000 pounds and 224,900 pounds correspondingly. It is a great decision for FedEx and UPS to transit on Anchorage, because they will not need to sacrifice their payload due to the total range. Internationally known for its location some 9.5 hours from 90 percent of industrialized centers in the world, ANC offers a fuel “tech” stop allowing aircraft to trade fuel weight for precious paying cargo. This allows each aircraft a quick turnaround near or at its halfway point to distant destinations and saves carriers between \$100,000 and \$125,000 dollars per flight. More than this, ANC has no slot (scheduled takeoff and landing time) restrictions or curfews and remains operational twenty-four hours a day—snow or no snow it has never been closed. ANC is a five-time winner of the Balchen Post Award for Large Airport Snow Removal Programs. Both UPS and FedEx have sorting facilities and are the major carriers at Anchorage by tonnage for US carriers for imports and exports of freight. Both predict larger growth in the Pacific Rim as trade with China increases and traffic increases among other Far East countries as they thrive. FedEx Express is the largest of the cargo facilities at ANC and can sort as many as 13,400 packages per hour. UPS’s hub handles parcels at a rate of 5,000 per hour. So, in this part, the Boeing 747-800 F seems to be the better selection.

ii. Destination airport characteristics

Both Anchorage and Hongkong airport are accommodated for B747-800 F and B777 F to operating, so it is no need to concern the size of the aircraft.

Fleet Diversification

	Gross Max Structural Payload (Lbs/Aircraft)	May 31			As of Nov. 30	To Be Delivered/(Retired) in FY					
		2016	2017	2018	2018	2019	2020	2021	2022	2023	2024
<u>Trunk (Jet) Aircraft:</u>											
Boeing 757-200	63,000	119	119	119	119	-	-	-	-	-	-
Boeing 767F ¹	127,100	32	46	57	66	7	17	18	12	6	-
Boeing MD10-10	137,500	30	26	25	23	(5)	(11)	(7)	-	-	-
Boeing MD10-30	175,900	13	13	13	13	-	-	(7)	(6)	-	-
Boeing MD11	192,600	56	57	57	57	-	-	-	-	-	-
Boeing 777F ²	233,300	27	30	34	36	2	5	2	3	4	1
Boeing 747-400	261,400	2	2	2	2	(2)	-	-	-	-	-
Airbus A300-600	106,600	68	68	68	68	-	-	-	-	-	-
Airbus A310-300	83,170	<u>10</u>	<u>10</u>	<u>10</u>	<u>10</u>	<u>-</u>	<u>-</u>	<u>-</u>	<u>-</u>	<u>-</u>	<u>-</u>
Subtotal - Trunk Aircraft		357	371	385	394	2	11	6	9	10	1
<u>Feeder (Turboprop) Aircraft:</u>											
Cessna 208B	2,830	239	239	239	238	-	-	-	-	-	-
Cessna 408 ³	6,000	-	-	-	-	-	-	12	12	12	14
ATR-72	17,970	21	21	21	21	-	-	-	-	-	-
ATR-72 600F ⁴	17,600	-	-	-	-	-	-	5	6	6	6
ATR-42	12,070	<u>26</u>	<u>26</u>	<u>25</u>	<u>25</u>	<u>-</u>	<u>-</u>	<u>-</u>	<u>-</u>	<u>-</u>	<u>-</u>
Subtotal - Feeder Aircraft		286	286	285	284	-	-	17	18	18	20
Aircraft Fleet Total		643	657	670	678	2	11	23	27	28	21
<u>Scheduled Lease Expirations:</u>						2019	2020	2021	2022	2023	2024
Boeing MD11 ⁵						1	2	1	-	2	3
Airbus A300-600 ⁵						1	8	10	1	2	7
Boeing 777F ⁵						-	-	-	-	-	3
Boeing 747-400F ⁶						2	-	-	-	-	-

Figure 1. 11 FedEx Express Aircraft and Vehicle Fleet

Refer to the fleet of FedEx Express, for the wide-body part, it has B767 F, B777 F, and B747-400. B767 F will not be considered because it is for domestic market the payload of it is much less than the other two aircrafts. There are only 2 B747-400 aircrafts in the fleet and will be retired in 2019. And there are 36 B777 F aircrafts in the fleet which also will be continuously delivered in the next 6 years. Obviously, it is not a good idea to select B747 due to the effects on both tooling and training for mechanics and crew though it has the bigger payload.

New technology implication

As part of the continuing effort to accelerate aerospace innovation, Boeing and FedEx Express, work together to fly the next ecoDemonstrator. Started in 2018, a new Boeing 777 Freighter

made for FedEx Express will test emerging technologies, such as propulsion advancements and flight deck innovations.

The Boeing 777F ecoDemonstrator is equipped with lasers, cameras, flies on 100% biofuel, and has a cargo bay outfitted with rows of computer test stations. Boeing tests 35 new technologies on a FedEx 777F plane. It's the latest of their ecoDemonstrator program designed to make the future of flying safer and more efficient.

The newest 777F is a unique one. It's part of the eco Demonstrator program, and will be used for a series of tests to improve environmental performance and safety of future airplanes. A large range of technologies will be tested, including compact thrust reversers, flight deck innovations, and fuel efficiency.

Economic considerations

The average prices for Boeing aircraft as of January 2018 shows that the average initial purchase prices of B747-800 F and B777 F are 403.6 million dollars and 339.2 million dollars respectively. B748 F is about 19% more expensive than B777 F, but the payload is approximately 37% more than the B777 F. In this aspect, B748 F seems to be more economy. But the operating cost of B748 F is also much higher. B777 F achieves the lowest trip cost of any large freighter. Just take the fuel efficiency for example, the fuel burn of B748 F and B777 F on the long-haul flight is around 39 lbs./mile and 26.9 lbs./mile correspondingly.

Furthermore, the table below showing the state of the order book for the B777 F and B747 8F, correct as at end November 2018.

Aircraft type	Orders	Deliveries	Unfilled
Boeing 747 8F	103	83	20
Boeing 777 F	203	150	53

Table 1. 4 Boeing 777F and 747 8F Order and Delivery

The market of B777 F is more liquid, so the purchase, leasing and resale of this freighter is more available and economy than B747 8F.

Conclusion

As discussed above, the Boeing 777 F is a great and the best choice of FedEx Express to fly at the route from U.S. to China and any other long-range international route like it.

Potential

If FedEx wants to expand its network and worldwide business, Zhengzhou, China is highly recommended for at least the following reasons:

1. Zhengzhou is planned to be the new international cargo aviation hub in China.
2. Multiple national support policies.
3. Comprehensive transportation location advantage.
4. Zhengzhou is an important comprehensive transportation hub and strategic hinterland in China, and basically forms an integrated transportation system with high-speed railway, ordinary railway, expressway and civil aviation as the main body.
5. In 2012-2017, the rank of cargo throughput of Zhengzhou airport increased from the 15th to the 7th in China, and the business volume increased by 27% annually.
6. The development of the airport industry system.

So, the proposed route for FedEx Express is from Memphis via Anchorage to Zhengzhou (CGO). And the distance from MEM to ANC is 2740 nautical miles and the distance from ANC to CGO is 3792 nautical miles. Both FedEx Express and UPS do not have the route from U.S. to Zhengzhou. Since the existence of Anchorage, the situation is very similar to the route from Memphis to Hongkong, so Boeing 777 F will be the best one.