Charlotte Pfamatter, Earl Rimel, & Katelyn Weber

26 March 2019

PHYS 103 Interactive Test: Airplanes

**Introduction**

The Boeing 747 aircraft was one of the most popular commercial jets that airlines use worldwide from 1960 to today. It has become popular due to its reliability and and speed, making this model desirable for competing airlines. The model has evolved over time to accomodate for more passengers, with the 747-400 being the latest upgrade. Recently, Boeing 747-400 models are slowly being phased out and are being retired by major airlines in order to keep up with the most updated models. Now, they are mainly used by a handful of international airlines and are used mostly for carrying cargo (traveltips.usatoday.com). The Board of Directors of a commercial airline is looking to reduce costs associated with the 747-400 model that they have, and the following factors will be considered: reducing cruising altitude by 10%, reducing speed of flight by 10%, reducing luggage weight allowed by 10%, removing comfort items, and changing the model.

**Reducing cruising altitude and speed of flight by 10%**

 Reducing the cruising altitude or the speed of the plane may not bring the best solution. Cruising altitude should not be reduced because it can alter many aspects of the quality of the flight. For all jets in general, there is a perfect altitude called the “sweet spot” where there is the least amount of air resistance for the plane. Specifically for the Boeing 747-400, the “sweet spot” cruising altitude is about 35,000 feet (travller.com/au). If the cruising altitude of the Boeing 747-400 was lowered, it would increase the air resistance for the plane, which would decrease fuel efficiency and increase operational costs. Also, it would be more costly to the aircraft because it would have to work harder to increase oxygen for the engines. In addition, reducing the cruising altitude could have environmental repercussions, such as disturbing wildlife patterns or interacting more with bad weather. Safety concerns could rise when lowering the altitude such as an increase in turbulence and less time for the pilot to adjust for errors (traveltips.usatoday.com). That puts passengers at risk, therefore it is not the safest aspect to change in order to reduce costs.

 Reducing the speed could lead to similar economical and efficiency issues. The speed of the plane relates to Newton’s second law, F=ma. This equation helps determine the thrust of the plane, which is how air moves through the front of the engine to to the back of the engine in order to create kinetic energy and push the aircraft forward (youtube.com). If speed is reduced, thrust will reduce, therefore making the aircraft less efficient and putting more stress on the physical components of the aircraft. However, reducing speed increases fuel efficiency, which saves the company money (alum.mit.edu). From a business perspective, customers would become dissatisfied with using an airline with a slower speed. People have places they need to be, so this could be a deciding factor when customers are choosing an airline. They would be more likely to choose an airline that goes faster so they can get to where they need to be quicker, therefore reducing the speed may not be the best solution when cutting costs.

**Remove luxury items and reduce luggage weight by 10%**

 To calculate if the airline should decide to remove magazines, blankets, and pillows from flights, the weight of an average pillow (18oz)(www.target.com), average blanket (16oz)(blog.thetravelinsider.info), and average magazine size (11.52oz) are added together to get a number of 45.52 oz (target.com). Assuming the 747 plane was full with 416 passengers and each had a pillow, blanket, and magazine, the additional weight on the ground sums up to 18,936.32 oz or 536.84 kg. By switching to the 777 model, which carries 350 passengers, the weight on the ground sums up to 15,795 oz or 447.79 kg. By removing magazines, blankets, and pillows on the flight, the airplane is able to fly at higher speeds while using less fuel to propel its momentum. On a shorter flight like the trip from JFK to LAX this is a reasonable option, but on longer flights it would not be recommended.

Similar to removing luxury items, reducing the luggage weight by 10% enables the airplane to fly at a faster speed as well. Although these solutions create faster travel times, there are negative consequences for the customers. When reducing luggage weight, customers are more likely to be charged more for their carry on where their flight experience would encourage them to be more likely to change airlines and lose the company business.

**Change airplane model**

The best solution to cut the costs of the Boeing 747-400 flight from JFK to LAX is to change the model of the airplane. The Boeing 777-200LR is a much better fit to suit the company’s needs. The initial cost of the 747-400 is 240.00 million dollars, while the 777-200LR costs 291.20 million dollars. However; in the long run, the company would end up saving money due to the increased efficiency of the newer model. Some of the main factors that play a part in deciding which airplane model is better include the carrying capacity of passengers, the amount of kilometers traveled per tank for fuel, and the total hours the flight would take. For the 747-400, there would be more spots open for passengers on the plane than in the 777-200LR. In the 777-200LR, there are 317 spots open for passengers, making it easier to fill the flight than the original model currently being used (traveltips.usatoday.com). It is better to have a smaller flight and fill all of the seats rather than having a larger flight that has some seats open. When seats are left open, the airline company tends to lose money instead of making a profit. By having the model changed to the 777-200LR, the business will gain more of a profit from the flights, and the customers will be happier as well since the price will decrease per person. Also, the kilometers traveled per tank of fuel plays an important part in choosing the 777-200LR over the 747-400 model. For the 747-400, the fuel tank capacity is 216,846.64 litres and the fuel economy is 0.06 kilometers per litre (aircraftcompare.com). If we multiply those two values together, we get an answer of 13,010.7984 kilometers. That is able to show how many kilometers the airplane is able to travel off of a full tank of fuel. The 747-400 model proves to be less efficient than the 777-200LR. For the new model, the fuel tank capacity is 202,291.78 litres and the fuel economy is 0.08 kilometers per litre (aircraftcompare.com). When we multiply those two values together, we get an answer of 16,183.3424 kilometers. This shows how the 777-200LR not only uses less fuel than the 747-400, but it also is able to travel a farther distance off of a full tank of fuel. Switching the model to the 777-200LR would be more economically beneficial for the commercial airline business because they would pay less money for the fuel, and they would get more distance traveled for less money. Lastly, the total number of hours the flight takes would be shortened with the new airplane model. The distance from JFK to LAX is 3983 kilometers (airmilescalculator.com). To calculate the number of hours it would take on the 747-400 airplane model we have found that the maximum cruising speed is 910.00 kilometers per hour (aircraftcompare.com). We then would use the speed formula (distance divided by time) and once calculated, the total time the flight would take is 4.38 hours. However, the total flight time it takes for the 777-200LR model is slightly lower. The maximum cruising speed for the new model is 944.66 kilometers per hour (aircraftcompare.com). This number is once again put into the speed formula and the value comes out to the 4.22 total hours for the flight. By having the amount of time in the air shortened, the passengers will be happier leading to more business for the airline. The 747-400 is a good airplane model, but in order to reduce the costs that the airline is looking for, the 777-200LR model is a better fit for the company.

**Conclusion**

In conclusion, the most effective way to cut the costs of the flight from JFK to LAX would be to change the model of the airplane. By changing over to the Boeing 777-200LR model, some of the others factors considered while trying to reduce the cost will be resolved as well. The airplane would not have to reduce its cruising altitude by 10%, it would not have to reduce its speed by 10%, and due to there being less passengers the luggage weight and luxury items, the weight would reduce in general with the model change. While each suggestion has positive and negative aspects, changing the model of the airplane would not only benefit the business economically, but it would also be able to provide great customer service for passengers in a time where airlines have become highly competitive.

**Sources**

<https://www.dkfindout.com/us/science/forces-and-motion/how-does-plane-fly/>

<https://traveltips.usatoday.com/three-types-commercial-aircraft-used-major-airlines-63148.html>

<http://www.flugzeuginfo.net/acdata_php/acdata_7474_en.php>

<https://www.youtube.com/watch?v=FCtrFOsCbRw>

<http://www.traveller.com.au/why-planes-fly-at-35000-feet-the-reason-for-high-altitude-flights-guxhc9>

<https://traveltips.usatoday.com/altitude-plane-flight-100359.html>

<https://alum.mit.edu/slice/why-hasnt-commercial-air-travel-gotten-any-faster-1960s>

<https://www.airmilescalculator.com/distance/jfk-to-lax/>

<https://www.aircraftcompare.com/manufacture-aircraft/boeing/1>

<https://blog.thetravelinsider.info/2017/11/airline-travel-blankets.html>

<https://www.target.com/p/plush-pillow-standard-queen-white-room-essentials-153/-/A-13970482>