ECOR 1010 – INTRODUCTION TO ENGINEERING

[TYPE AUTHORS[1]]

ASSIGNMENT #1

Laboratory 1: Engineering Reporting

Fuel Efficiency and CO_2 Emissions, Aircraft vs. Automobiles

TO Marking TA:

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FROM:

INTRODUCTION

Assessment of long term environmental effects is necessary in engineering together with the use of accurate and comparable measures. The following is an investigation of competing claims of aircraft and automobile manufacturers that their product is more fuel efficient with lower CO_2 emissions. The purpose is to compare three modes of transportation (E-1010 air craft, sedan car and mini-van) to determine the most fuel efficient, least environmentally harmful mode in relation to manufacturer claims. This is done in a standard engineering report format.

MATERIALS AND METHODS

Comparisons were made with regard to a trip from Halifax to Vancouver for each of the products. Supplied data (Tables 1 and 2) on the trip parameters and specifications on each transportation mode were utilized. The price of jet fuel in Canada was taken as the average monthly price from data in Figure 1 for a 13 month period. For each vehicle, based on a full passenger capacity, the following were calculated: fuel consumption per 100km per capita, fuel cost (total and per capita) CO_2 emission (total and per capita.), total travel time and required trees to offset CO_2 emissions. (See Appendix 2 for sample calculations). From this information, the vehicles were compared for fuel efficiency and carbon emissions.

RESULTS

Using per person measures with full capacity passenger loads, the efficiency (least to most) of the three transportation modes are ranked as follows .

Total fuel consumption per capita: 1) E-101 airplane, 3.11 litres /100 km, 2) car, 1.59 litres/100 km, 3) minivan, 1.19 litres/100 km
Fuel cost per capita: 1) car, $115.95, 2) E-101 airplane, $115.32, 3) minivan, $65.89.
CO_2 emission per capita: 1) model E-101 airplane 366.00 k g, 2) car 220.54 kg 3) minivan. 165.04 kg.
Requirement to offset CO_2 emission: 1) E-101 airplane, 17 trees, 2) car, 10 trees, 3) minivan, 8 trees.
Travel time: 1) car and minivan (each) 150.40 hours, 2) model E-101 airplane 5.70 hours.

It is seen that the minivan is most efficient in terms of fuel consumption, fuel cost and CO_2 emission per person as well as trees required to offset emissions. Conversely, the airplane is least efficient regarding these factors. Fuel cost efficiency of the car and airplane are similar. However, time efficiency of both the minivan and car is very low where they take about 23 times longer than flying. Table 3 provides the calculation summary for all variables considered in the assessment. Table 4 shows a comparison by number of passengers in a car in relation to fuel costs and emissions. With only 1 or 2 car passengers, aircraft travel becomes more efficient in terms of fuel cost, fuel consumption and emissions.

DISCUSSION

Theoretically, a comparison of the full passenger load, per person for the three modes of transportation show the minivan to be most efficient. However, full capacity passenger trips are infrequent in automobiles, being seen more often in a family, team trips etc. Single business travellers cannot easily carpool. When a single person drives it is less efficient in terms of fuel consumption, cost and emissions (6.35 L/100km, $461.25, 366.41 kg respectively) compared to flying (3.11 L/100km, $115.95, 867.14 kg respectively). Flying is also more efficient compared to 2 in a car (see Table 4). As automobiles move closer to their full passenger capacity, fuel consumption, CO2 emissions, CO2 offsets (trees) per person are decreased.

CONCLUSIONS

In meeting the purpose of this report, it is determined that with full passenger capacity a minivan is most efficient in per person in fuel consumption and CO2 emissions, followed by a full 4-person sedan car and the full passenger airplane. The Aircraft manufacturer claim that flying it is more efficient, consuming half the fuel of one person driving, is correct in the case of full flights. Saying that more people should fly, is reasonable, only if cars have 1 or 2 people. With 4 in a car, fuel consumption per person is about half that of when flying on a full flight (1.59 vs. 3.11 L/100 km), so the car manufacturer`s claim is correct, only with this qualification. Claims of manufacuters must be qualified by measures that are quantified and can be compared.

APPENDIX 1- FIGURES AND TABLES

Table 1: "BlueSky" model E-1010 airplane specifications.

Aircraft model	Max. no. of seats	Max. range*	Max. takeoff weight	Max fuel capacity**	Cruise speed @ 35,000 feet ***
		(Km)	(Kg)	(kg)	(Km/h)
E-1010	250	4 655	67 775	32 389	896

*Maximum distance airplane can fly without using reserve fuel.
** Maximum mass of fuel airplane can hold in its fuel tanks, including reserve fuel.
*** Average speed assumed at 95% of cruise speed.

Table 2: Information - Vehicles, Emissions and Trip

Automobile fuel price	**1.25**	**$/L**
Fuel density (aircraft and automobile)	**0.80**	**kg/L**
Aircraft reserve fuel	**10.50**	**%**
Automobile average speed	**85.00**	**km/hr**
Aircraft fuel price (average over 13 mos)	**0.80**	**$/L**
Automobile CO2 emission	**2.35**	**kg/L**
Airplane CO2 emission	**3.16**	**kg CO2/kg Fuel**
Halifax to Vancouver distance by car	**5 811**	**km**
CO2 fixed by the average tree per year	**50.0**	**lb CO2/tree/year**

Table 3: Calculation Summary Table

	Fuel Consumption L/100 km	Fuel Cost for the vehicle to travel the distance ($)	Fuel Consumption per person: 100% occupied seats L/100 km	Fuel Cost per person: 100% occupied seats ($)	CO2 Emission (kg)		Total Travel Time (hr)	Total Travel Time		No. of trees to offset CO2 emission /yr/person
					Total	per person: 100% occupied seats		*hr*	*min*	
E-1010 250 passengers	778.41	28988.15	3.11	115.95	91602.570	366.4103	5.469	5	28	17
Car– Sedan 4 passengers	6.35	461.25	1.59	115.31	867.1465	216.7866	150.4024	150	24	10
Minivan 7 passengers	8.35	461.25	1.19	65.89	867.1465	123.8781	150.4024	150	24	6

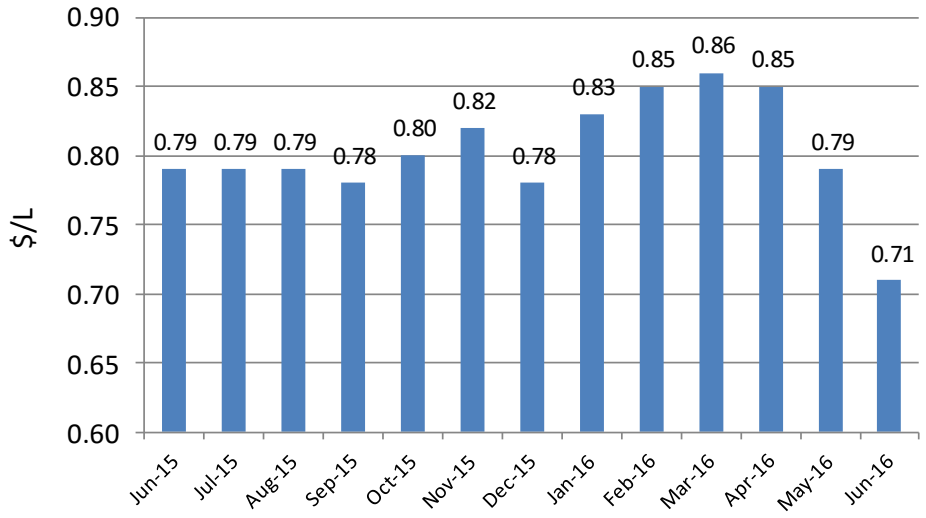

Figure 1: Jet fuel monthly price in Canada $/L

Table 4: Comparison Selected Factors by Number of Passengers in Sedan Car and Full passenger E-1010 Airplane for Halifax-Vancouver Trip

		Fuel Cost per person $	Fuel Consumption per person: L/100 km)	Co2 Emission per person (kg)	No. of tress to offset Co2 emission/yr/ person
Car	4 passengers	115.31	1.59	216.7866	10
Car	3 passengers	153.75	2.17	289.0488	13
Car	2 passengers	230.62	3.18	433.57325	19
Car	1 passenger	461.25	6.35	867.1465	38
Airplane E-1010		115.95	3.11	366.4103	16

APPENDIX 2-SAMPLE CALCULATIONS

Kg Airplane fuel required for trip

Maximum fuel capacity (incl. fuel reserve): 32389 kg
Reserve fuel (% of total): 10.5
Fuel excl. reserve (%): 89.50

Required kg fuel for trip = max fuel capacity X % fuel excl. reserve
= 32389 kg X 0.895
= 28988.155 kg

Litres of fuel required for trip

Fuel density: 0.80 kg/L
Kg of required fuel X density (kg/L)
= 28988.155 kg X 0.80 kg/L
= 36235.194 L

Litres of Fuel per km of trip
Trip distance: 4655 km
Litres of Fuel per km of trip = 36235.194 L/4655 km
= 7.7841 L/km

Fuel Consumption L/100 km = L/km X100

= 7.7841 L/km X100

= 778.414 L/100km

Fuel Costs for Trip

Airplane

Fuel for trip: 36235.194 L
Fuel cost per L: $ 0.80
Total cost = 36235.194 L X $ 0.80 = $28988.155

Automobiles (Car and minivan)
Fuel for trip=fuel consumption L/km X trip distance km
= 6.35 L/km X 5811 km = 368.9984 L
Fuel cost per L: $ 1.25
Total cost = 368.9984L X $ 1.25= $461.248

Fuel Costs for Trip per Capita = total cost of fuel/ passengers

Airplane
= $28988.155/250
= $115.95

Car
= $461.248/4
= $115.31

Minivan
= $461.248/7
= $65.89