Assignment 10: Small Project (Groups of 2 People)

Final Mini Project : ORD Airport

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Due: May 7, 2018 Via Email
Final Exam is a Miniproject
Requirements for this Miniproject: 8-10 page report with your findings for all 4 problems.

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Problem 1

Read the articles below to get a context of the problem at Chicago O'Hare International Airport.

https://www.faa.gov/airports/airport_development/omp/

http://www.chicagotribune.com/news/local/politics/ct-met-city-hall-story-20180223-story.html

https://www.oharenoise.org/sitemedia/documents/resources/modernization/ORD%20Hot%20Spot_CRO%20Presentation%2010%20November%202015%20final.pdf

Figure 1 shows the airport configuration today (left diagram) and in the future (right diagram).

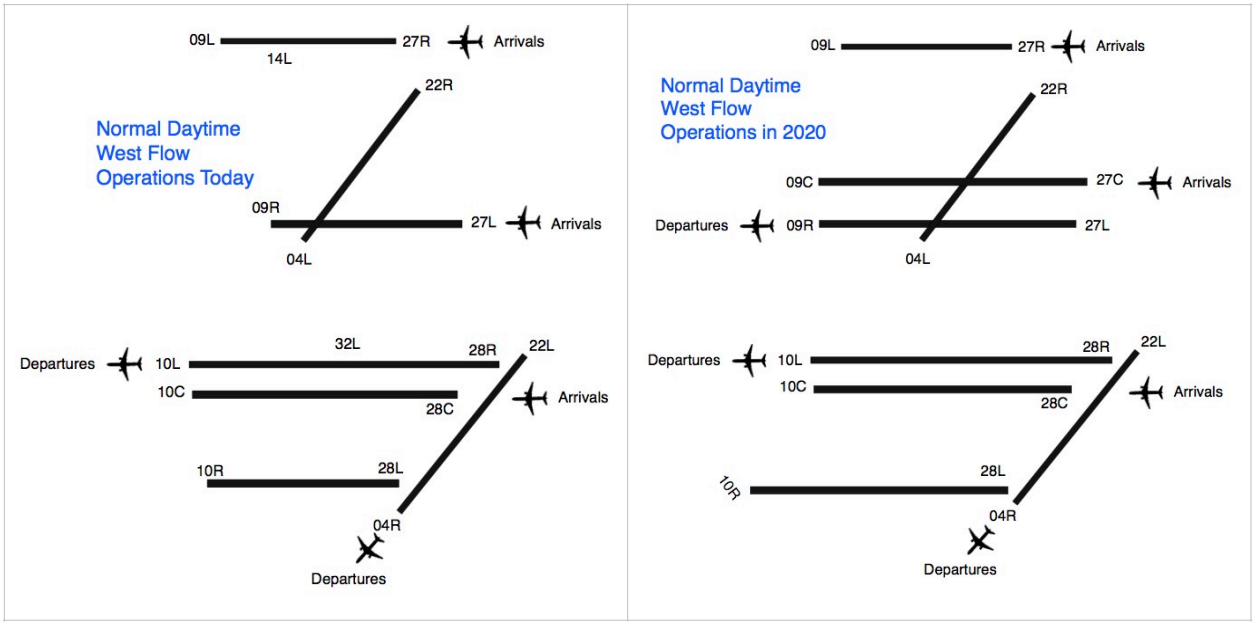

Figure 1. ORD Runway Configurations. Left is Today Configuration. Right is the Configuration in Year 2020.

The airport fleet mix today is shown in Table 1. Assume the departing aircraft acceleration on runway 22L is 2.1 m/s^2. Consider the interactions between arrivals on runway 28C and departures on runway 22L in your analysis. The airport has a PRM radar at the facility. In the analysis consider the ATC human factor time lag and engine spool-up time (10 seconds). For this analysis we use the following technical

parameters: a) in-trail delivery error of 16 seconds under IMC conditions, b) probability of violation is 5%. Arriving aircraft are “vectored” by ATC to the final approach fix located 8.5 miles from the runway threshold. Assume the fleet mix for all the runways is the same (to simplify the problem). The minimum separation matrix for ORD is shown on page 29 of the Aircraft Classification handout. ORD has good runway exits and hence minimum radar separation is 2.5 nm (empty cells in Table 5-2-2 - on page 29).

Table 1. Runway Operational Parameters and Fleet Mix for ORD Airport. RECAT Groups.

Aircraft RECAT Group	Percent Mix (%)	Runway Occupancy Time (s)	Typical Approach Speed (knots) from FAF
A	0	N/A	N/A
B	7	62	153
C	8	60	146
D	42	58	142
E	40	54	138
F	3	51	127
Totals	100		

Table 2. Departure-Departure Separations with Buffers Included. Columns 2-7 are the Following Aircraft. First Column Presents the Lead Aircraft. Values in are seconds (include departure buffers).

Aircraft	A	B	C	D	E	F
A	125	125	130	130	130	180
B	75	130	130	130	130	130
C	65	65	90	120	120	120
D	65	65	65	65	65	65
E	65	65	65	65	65	65
F	65	65	65	65	65	65

a) Estimate the runway capacity for ORD today. Your analysis should account for the dependency between operations on runways 22L and 28C for today’s configuration and for the future configuration. Today’s operations are such that ATC tower controllers release departures on runway 22L if an arrival on runway 28C is at least 2.5 nm from the runway threshold. Othwerwise, departures on 22L have to wait for the next arrival gap on runway 28C. Show the complete Pareto diagram (arrivals and departures) for the West Flow ORD configuration under IMC conditions.

b) Estimate the runway capacity for ORD in the year 2020 with the new runway 9C-27C. Consider in your analysis the dependency between operations on runways 22L and 28C as explained above. Show the complete Pareto diagram (arrivals and departures) for the West Flow ORD configuration under IMC conditions in 2020.

Problem 2

Use the arrival and departure runway capacity results obtained in Problem 1 and the deterministic queueing model presented in class (you can use the Matlab script if desired) to answer the following.

a) Estimate the aircraft departure queues that were likely to be experienced during a busy day in August as shown in Table 3.

b) Estimate the average delay per departure at ORD using the deterministic queueing model.

c) If the same schedule is used for the year 2020, estimate the departure delays using the new capacity obtained in Problem 1.

Table 3. Typical Arrival and Departure Schedule at ORD Airport. Busy Day of August 2017. Source: FAA ASPM Database (https://aspm.faa.gov/apm/sys/AnalysisAP.asp.)

Hour of Day	Scheduled Departures	Scheduled Arrivals
0	4	6
1	1	1
2	1	0
3	0	0
4	0	10
5	9	17
6	58	76
7	104	85
8	98	65
9	79	67
10	81	55
11	52	106
12	110	87
13	90	55
14	50	96
15	85	66
16	68	88
17	87	74
18	82	105
19	91	90
20	91	77

21	72	40
22	14	20
23	4	26
Totals	1331	1312

Problem 3

A new proposed set of terminals for the airport is shown in Figure 2. A study of the passenger flows inside the terminal estimates the design hourly passenger flow between terminals T5 and the new Global Terminal (labeled T6 in Figure 2) to be 9,400 passengers per hour. A proposal is to design an underground Automated People Mover (APM) using Bombardier Innovia APM 100 vehicles (https://en.wikipedia.org/wiki/Bombardier_Innovia_APM_100) with a maximum capacity of 80 passengers per vehicle. According to the manufacturer, a maximum of 4 vehicles can be coupled to make a transit unit.

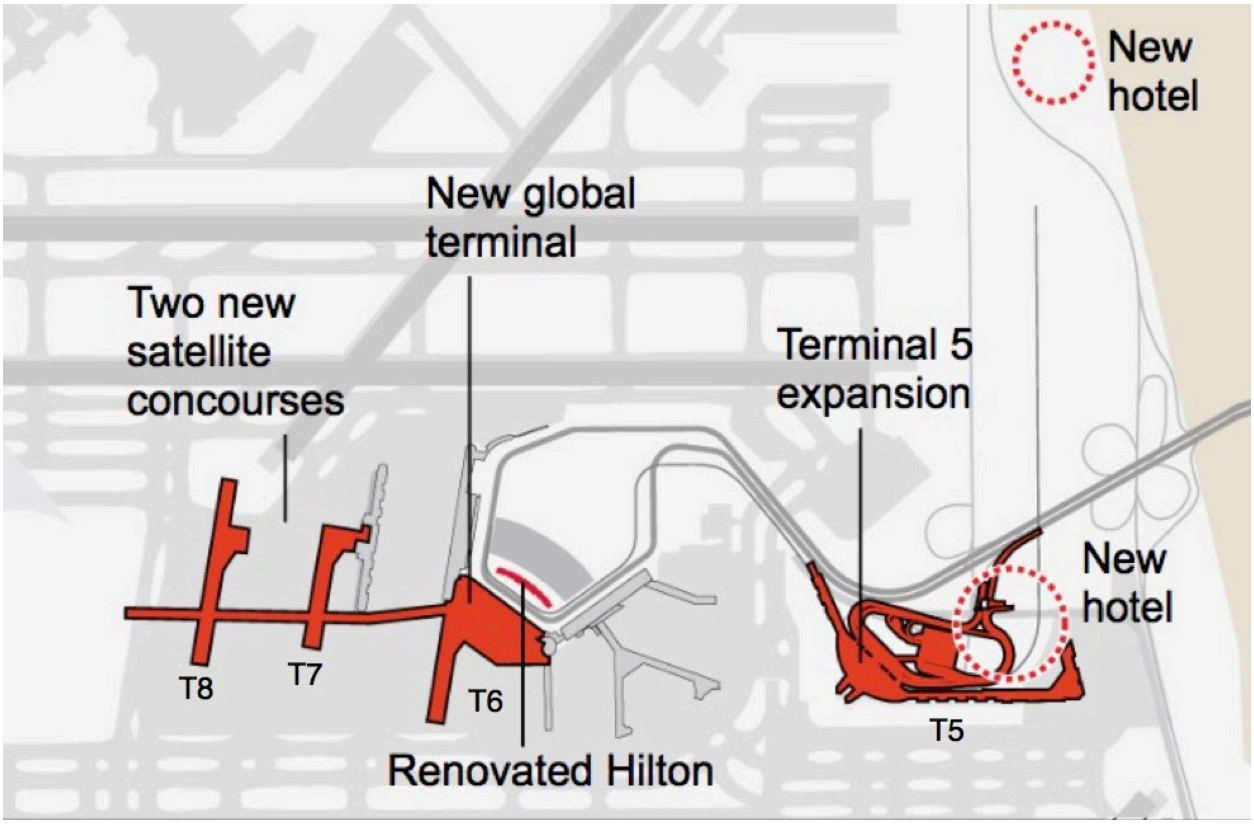

Figure 2. Proposed ORD Terminal Configuration.

a) Estimate the number of vehicles per transit unit to satisfy the design peak flow requirements of the airport. The airport would like to operate the APM with headways (time between TU arrivals to a station) no less than 1.5 minutes between transit units.
b) Plot the APM capacity as a function of headway (from 1.5 to 4 minutes).
c) Suggest the best APM track configuration for this application. Consult the Landside handout.

Problem 4

Table 4 illustrates the typical aircraft fleet mix operating at ORD Airport in the typical day. This aircraft mix will be used to estimate the noise contours and the capacity of the airport. In the typical day of the year 2014, the airport handled **2,660 operations daily**. Half of them arrivals and the other half departures. Recent airport data suggests 135 departures and 135 arrivals occur at night between 10 PM and 7:00 AM in the morning. The simplified fleet mix operating at the airport is shown in Table 1. The table also shows the average stage length (miles flown) by each departure.

Table 4. ORD Fleet Mix and INM Aircraft to be Used in the Study.

Aircraft	% Fleet Mix in 2014	INM Aircraft to Use	Wake Class	Average Stage Length Flown (statute miles)
Embraer 145	18	E145	Large	335
B737-800	25	737700	Large	1260
747-8/A380	4	747400	Super-heavy	5200
B767	5	767CF6	Heavy	3656
A320 (318-321)	23	A320-232	Large	1170
CRJ (200-900)	18	CL601	Large	359
B777 (200-300)	7	777300	Heavy	6534
Total	100			

Perform a basic noise study for the ORD airport considering the fleet mix shown presented in Table 4. The arrival and departure flow patterns are shown in Figure 3. Consider the number of arrivals and departures performed during the day and night time as described in the previous section.

a) Find the noise contours around the airport from 55-80 LDN. Plot using your CAD and INM skills. Export the noise contours to a DXF file and then read the file using Autocad or equivalent application.

b) Estimate the area under the 55 and 65 LDN contours.

c) Suggest improvements to reduce the noise at this airport.

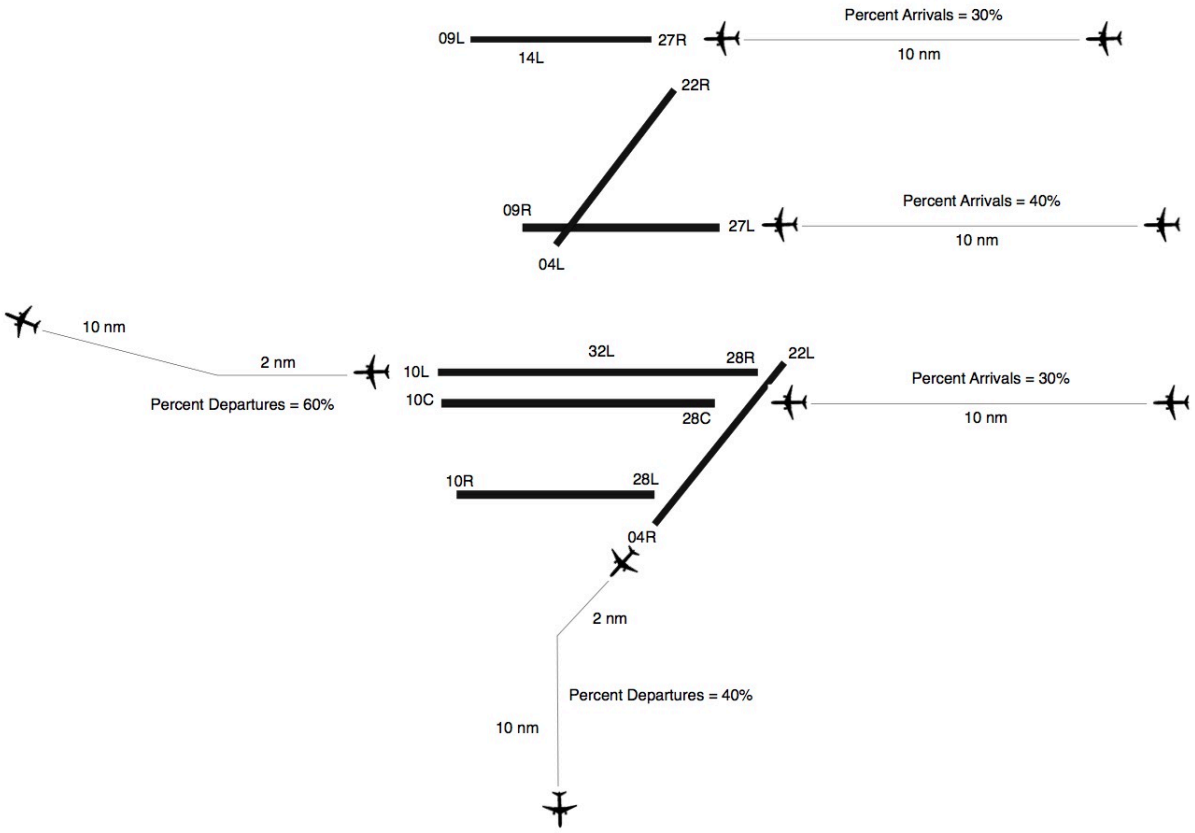

Figure 3. Basic Structure of Arrival and Departure Routes at ORD Airport.

Bonus: Export the contours to Google Earth and superimpose the contours exported as an Image Overlay (or layer) of the Google Earth satellite picture.