Assignment 7: Runway Throughput and Capacity

Date Due: March 23, 2018 (under my door)   Instructor: Trani

Problem 1

Figure 1 shows the interface of there Webtrak system for Chicago Department of Aviation (CDA). The system is available on the internet at: webtrak5.bksv.com. Figure 2 shows the configuration of the airport. Use the replay feature of the Web Tracker to study the operations at ORD on March 15, 2018, 2017. Consult the airport map provided in Figure 2.

Figure 1. Webtrak system for Chicago Department of Aviation (CDA).

a) Use the replay feature in Webtrak5 to estimate the total number of hourly landing operations (i.e., throughput) at O'Hare runway 27L airport in the 10-11 AM morning period.

b) Use the replay feature in Webtrak5 to estimate the total number of hourly departure operations at O'Hare runway 28R airport during the period 10-11 AM.

c) Observe traffic departing on runway 22L and the arrivals on runway 28C. Explain what type of coordination is needed to operate these two runways during the peak morning period.

d) Using traffic during the period 10-11 AM, estimate the closest distance between an arrival on runway 28C and a departure on runway 22. Use Google Earth to estimate distances shown in the WebTrack

system. For example, the Web Track system shows highway I-171, Route 43, etc. in the map. These distances can be used as reference in your estimate.

e) Explain the airspace organization to feed and meter arrival traffic to runways 27R, 27L and 28C. Are the arrivals independent of each other? Compare to the airspace traffic pictures for Atlanta shown in class. Explain.

f) If the hourly arrivals and departures estimated in parts (a) and (b) represent maximum runway throughput or capacities, estimate the runway capacity of the airport in West flow configuration with arrivals on runways 27R, 27L, 28C and departures on runways 28C and 22L.
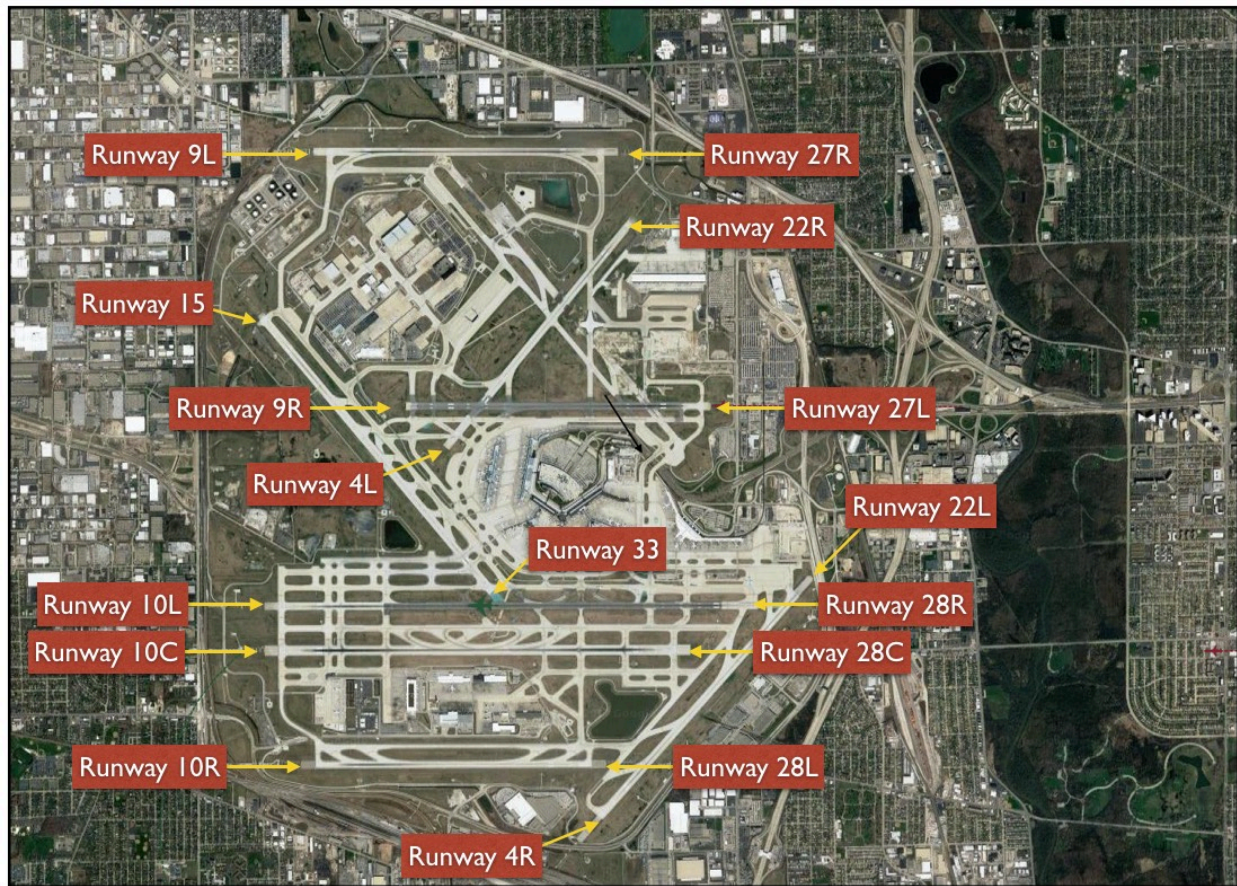

Figure 2. Chicago ORD Runway Configuration.

Problem 2

Review the runway configuration of México City airport (see Figure 3 and consult Google Earth if necessary). Runway 5L is normally used for departures. Runway 5R is used for arrivals. Because the close proximity of the runways, ATC controllers block departures on runway 5L when an arrival is inside the "reserved zone" in Figure 3 to reduce the risk of a simultaneous go-around on runway 5R and a departure on 5L. Aircraft in line and wait position are clear to depart once the arrival is outside the reserved zone. Table 1 shows the fleet mix for México City. Figure 4 shows the standard ICAO separations applicable to México City (IMC conditions). Table 2 shows the typical departure-departure separations used in México City. Mexico has standard airport surveillance radar. The common approach length is 10 nm. Use a probability of violation of 1%. The ATC controllers are conservative and use an in-trail position error of 22 seconds.
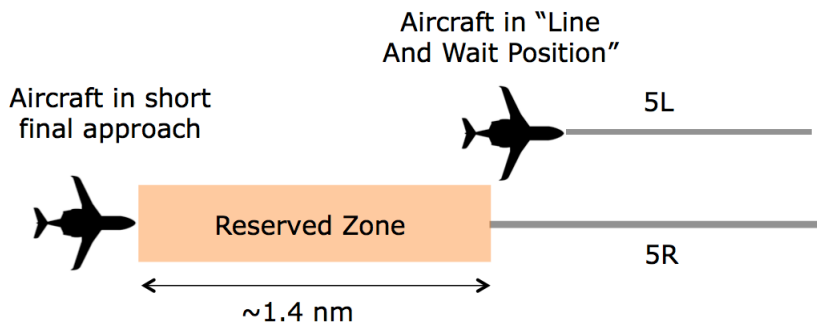

Figure 3. Close Parallel Configuration of Mexico City Airport.

Table 1. Runway Operational Parameters and Fleet Mix for México City Airport.

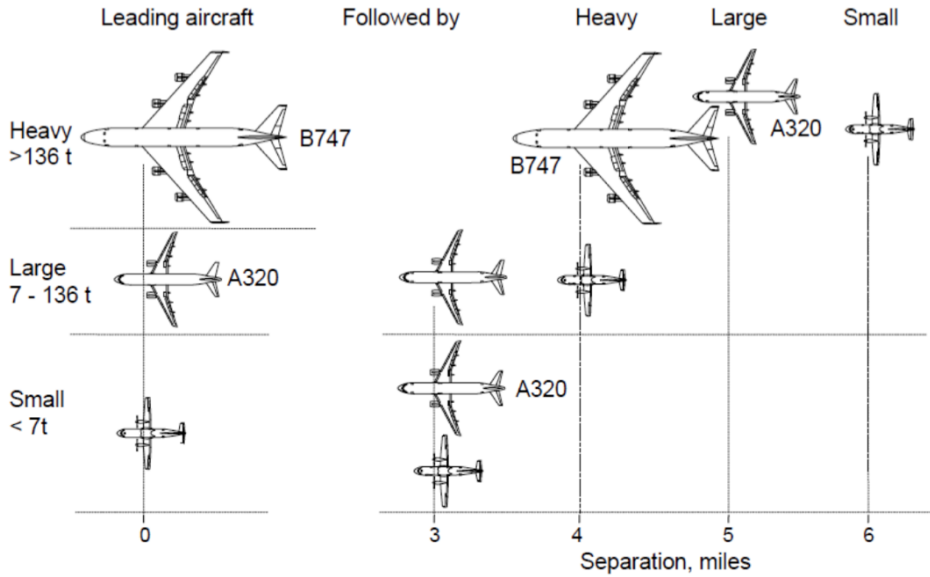| Aircraft	Percent Mix (%)	Runway Occupancy Time (s)	Typical Approach Speed (knots) from FAF
Small	4	50	126
Large	72	54	146
Heavy	22	61	161
Superheavy	2	76	158
Totals	100		

Figure 4. ICAO Recommended IMC Separations. Source: Lang et al., 2010. Arrival-Arrival Separations.

Table 2. Minimum Departure-Departure Separations. Columns are the Following Aircraft. Values in are seconds.

Aircraft	Small	Large	Heavy	Superheavy
Small	70	70	90	90
Large	70	70	70	70
Heavy	120	120	120	120
Superheavy	180	120	120	120

a) Find the IMC capacity diagram for this airport. Clearly explain how did you accounted for the dependency between arrivals and departures.

b) Plot the Pareto diagram for the two runways operated in IMC condition.

c) A new airport in Mexico City will open in the year 2020. The new airport will have three parallel runways. Two close parallel runways separated by 450 meters and the third runway will be located 1700 meters from the closest runway. Find the capacity of the new airport under arrival priority when two runways are used for arrivals and one for departures.

Problem 3

Review pages 28-31 of the handout on aircraft classifications. Review the runway configuration of Chicago O'Hare. Assume IMC conditions, with arrivals to runways 27R, 27L, 28C and departures from runways 28R and 22L. The airport fleet mix is shown in Table 3. Assume the departing aircraft acceleration is 2.1 m/s². Consider the interactions between arrivals on runway 28C and departures on runway 22L. The airport has a PRM radar at the facility. In the analysis consider the ATC human factor time lag and engine spool-up time (8 seconds). For this analysis we use the following technical parameters: a) in-trail delivery error of 18 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 - page 29).

Table 3. 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	12	61	153
C	10	57	146
D	37	58	142
E	36	54	138
F	5	51	127
Totals	100		

Table 4. 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) Shown in detail your analysis to account for the dependency between operations on runways 22L and 28C. Estimate the arrival and departure capacity diagram for the runway pair 22L and 28C.
b) Find the complete IMC capacity diagram for this airport.
c) Plot the IMC capacity diagram.
d) In the year 2021, ORD will have a new runway on the North side with 6 parallel runways. Review the presentation https://www.oharenoise.org/sitemedia/documents/resources/modernization/ORD%20Hot%20Spot_CRO%20Presentation%2010%20November%202015%20final.pdf to gain more perspective on the final configuration. Estimate the IMC arrival-departure capacity diagram with 6 runways. State which runways are selected for arrivals and departures.