AN ASSESSMENT ON THE SAFETY AND COMPLEXITY OF THE INNOVATIVE DESIGN OF ISTANBUL’S NEW TMA

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LTFM Airspace Design

- Filling a blank page and defining a new airspace all over again by making radical changes

- Istanbul Airport (LTFM) has inherited the aviation code “IST” from Atatürk Airport (LTBA) - opened in 1953 and ranked seventeenth worldwide in terms of passenger traffic in 2018 by Airports Council International on 6 April 2019
Conceptual Framework

- To make a comparative analysis of the new and old Istanbul Terminal Manoeuvring Area (TMA) designs according to the evolution of traffic safety and complexity issues
Point Merge System

- Developed at EEC in 2006
- Predictability
- Create and maintain spacing
- Continuous Descent Operations (CDO)
- Continuous Climb Operations (CCO)
- Situational Awareness
- R/F Occupancy & workload reduced
Point Merge System

- Transition procedure & LNAV in LTFM
 Complexity Indicators

- «Complexity Metrics for ANSP Benchmarking Analysis” for the Performance Review Commission by the ACE Working Group on Complexity, 2006
  - Function of complexity
  - Based on the adjusted density and structural index
- Davis, Danaher and Fischl (1963)
- Stein (1985)
LTTFM TMA Deployment and Process

**AIRPORT/TMA ATFM DELAY YEAR-TO-DATE**

Top 20 delay locations for year-to-date Airport ATFM delays

- 640
- 1082
LTFM TMA Deployment and Process

- Well-re-organized air space design without compromising the safety of air traffic management and aviation
- Human factors to create the innovative and collaborative environment enabling the learning organization in this team
- New systems and infrastructure for providing the interoperability
- Well-organized and inclusive coordination with all stakeholders
Methodology

- The following hypotheses are tested; by reorganizing the Istanbul’s new TMA all over again
  - The adjusted density of the TMA has been decreased.
  - The PRU complexity of the TMA has been decreased.
  - The conflict number per aircraft has been decreased.
Methodology

**TOOL**

The actual and initial traffic from Demand Data Repository (DDR2) from Eurocontrol

- We obtain indicators on safety and complexity using the Network Strategy Tool (NEST)

**DATA COLLECTION**

<table>
<thead>
<tr>
<th></th>
<th>LTBA</th>
<th>LTFM</th>
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<tbody>
<tr>
<td>Thursday</td>
<td>14.06.2018</td>
<td>13.06.2019</td>
</tr>
<tr>
<td>Friday</td>
<td>15.06.2018</td>
<td>14.06.2019</td>
</tr>
<tr>
<td>Saturday</td>
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<td>15.06.2019</td>
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<tr>
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</tr>
<tr>
<td>Wednesday</td>
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<td>10.07.2019</td>
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Methodology

Complexity Score = Adjusted Density × Structural Index

Adjusted Density

Structural Index = HDIF + VDIF + SDIF

HDIF = Hours of horizontal interactions / Flight Hours

SDIF = Hours of speed interactions / Flight Hours

VDIF = Hours of vertical interactions / Flight Hours

Adjusted Density = Hours of Interaction / Flight Hours

Structural Index = HDIF + VDIF + SDIF
Methodology

- **The hours of interactions** are the sum of all durations of all the interactions including vertical, horizontal and speed, in all cells between FL85 and FL245.

- The sum of the flight durations controlled in all cells in a defined area over a period is called **flight hours**. The 3D dimensions of cells are 20 NM x 20 NM x 3000 FT and flight time in these cells averaged during discrete 60-minute periods represents “flight hour”

- **Conflict**, defined as a pair of flights being detected a loss of vertical or horizontal separation by NEST, is calculated daily with calculations steps of 10 seconds, taking into account average delays of 120 seconds with standard deviation of 120 seconds and 3 NM horizontal separation within the defined Istanbul TMA.
# Results

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<tr>
<td>Hours of interactions</td>
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<td>Flight hours</td>
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<td>4816</td>
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<td>Number of Traffic (Initial)</td>
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<td>2093</td>
<td>2033</td>
<td>2210</td>
<td>2125</td>
<td>2146</td>
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</tbody>
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<tr>
<td>Hours of interactions</td>
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</table>
The new TMA design for LTFM has decreased the density of traffic on selected dates.

The average of the difference of density between LTBA and LTFM TMA is **17.9%** for the selected dates.
Results

- Pearson’s correlation coefficient between adjusted density and flight hours in LTBA TMA is found as **0.76** while the same correlation in LTFM TMA (**0.52**) is not as high as in LTBA.

- The new design breaks the strong positive relationship between the traffic level expressed in flight hours and the density of the traffic.
The PRU complexity score of LTFM TMA is **0.28**, on average
The PRU complexity score of LTBA TMA is **0.34**, on average
Overall **20%** decrease in the complexity
- 51% of the conflict numbers based on FTFM is captured by the conflicts based on CTFM in LTBA TMA, whereas this ratio is 58% in LTFM TMA

- The conflict number per aircraft has decreased to 0.35 in LTFM TMA while this number is calculated as 0.45 in LTBA TMA
## Results

<table>
<thead>
<tr>
<th>LTBA TMA</th>
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<tbody>
<tr>
<td># TRAFFIC (INITIAL)</td>
<td>2172</td>
<td>2093</td>
<td>2033</td>
<td>2210</td>
<td>2125</td>
<td>2146</td>
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<td>CONFLICT PER AC (INITIAL)</td>
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<td>0.34</td>
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<table>
<thead>
<tr>
<th>LTFM TMA</th>
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<tr>
<td>CONFLICT PER AC (INITIAL)</td>
<td>0.37</td>
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<tr>
<td>COMPLEXITY</td>
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<td>0.27</td>
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<td>0.30</td>
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Conclusion

- High level objective; fulfilling our responsibility with a high quality service while maintaining safety level
- The drastic and reformative changes in Istanbul’s new TMA (LTFM TMA) are introduced and the overall benefit is presented with a snapshot of the safety and complexity, comparing to the LTBA TMA.
Conclusion

- The hours of interactions and flight hours have decreased in LTFM TMA though the traffic numbers have increased.
- The complexity of LTFM TMA has decreased (0.28 on average) compared to LTBA TMA (33.5 on average).
- Conflict number per aircraft reducing from 0.45 in LTBA to 0.35 in LTFM.
- The adjusted density of LTFM TMA has decreased considerably.

The correlation results and safety statistics show that implementing the point merge system successfully and the efficient redesign of LTFM terminal airspace with radical and innovative changes have increased the predictability and consistency of one of the most fast-growing and busiest terminal areas.
Thank you and Questions