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A DECISION SUPPORT TOOL FOR ROUTING AND SCHEDULING OF GROUND AIRCRAFT MOVEMENTS BASED ON ADVANCED ATM PROCEDURES

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Abstract (Topic: Air Traffic Control, Aircraft Operations, Airports, Safety)

Air traffic over Europe is growing at an average rate of 5% every year and the number of flights over Europe may double in the next 20 years. At the same time delays caused by Air Traffic Management (ATM) flow are a critical issue. The challenge for the European aviation sector is the following: how to gain additional capacity in a limited airspace while maintaining the highest degree of safety and efficiency. However, even if en-route capacity increasingly matches demand, airport constraints reveal themselves more dominant. In fact airport capacity is becoming the limiting factor in overall system performance.

The objective of our research activity was to develop a decision support tool for Air Traffic Controllers, for route scheduling and route allocation in airport, based on advanced ATM procedures, in order to ensure that ground traffic management, of which Air Traffic Control is a part, remains safe along with the increase of the efficiency and the reduction of delays. The biggest challenge for safety is traffic growth because when traffic doubles, risk is squared.

SESM (Sistemi Evoluti per la Sistemistica e i Modelli), a Finmeccanica Company, is the research centre of SELEX Sistemi Integrati, third supplier of ATM systems in the world. SESM has developed a research project, funded by Italian Ministry of Education, University and Scientific Research (MIUR) whose title was “Integrated system for the assessment and design of airport safety”.

Case study scenario of the research project was Malpensa Airport.

The final result was the development of a tool for decision support, able to suggest the best taxi-route schedule to the Air Traffic Controllers, taking into account safety constraints and a low cost-benefit ratio, without impacting on airport capacity.

Runway incursion is the incident that mostly affects safety in airports. On average there are two runway incursions everyday in Europe. For this reason, ICAO’s safety goal in runways is zero fatalities from runway incursions.

Malpensa Airport experiences an average of 100 runway incursions per year and it is the greatest example of complex operational environment, for its traffic, meteorological, topographical conditions and, above all for its technological innovation.

From the beginning of the project, SESM involved SELEX-SI system engineers, SEA and ENAV’s Air Traffic Controllers responsible for Malpensa Airport operation management.

Ground traffic management is handled by Air Traffic Controllers, who solve the conflicts locally and one by one without the support of information tools, assign a finite number of taxi-routes to the pilots.

Air Traffic Controllers need a decision support tool, able to suggest them the most appropriate solution for conflict prediction and resolution on the aerodrome, complying with pollution reduction constraints and
traffic efficiency. The tool has to adapt to Air Traffic Controllers’ way of working, by suggesting credible, applicable and effective solutions.

The developed tool is compliant with requirements that have been established together with Air Traffic Controllers. The algorithms assign a taxi-route according to safety criteria to avoid conflicts. Furthermore the tool aims at reducing the holding time at the stop-bar position with the engine on, noise production and lack of safety because of separation reduction. Taxing time is reduced thanks to the preventive conflict resolution approach.

The objectives of the decision support tool, translated in terms of constraints for the algorithms are:

- Acoustic pollution reduction
- CO2 pollution reduction
- Safety in the intersections between runway and taxiway
- Take off safety separation
- Taxiway safety separation
- Intersections safety separation
- Solution efficiency, considering costs and taxing time.

Our tool determines and assigns a taxi-route for each aircraft in a selected time window: for arrival flights the taxi-route starts at the runway exit-point and ends at their parking position; for departure flights it starts at their parking position and ends at runway entry-point. Arrival flights list comes from Arrival Manager System; Departure Flights list comes from Departure Manager System.

Tool’s functionalities allows to assign automatically a taxi-route to each aircraft, calculating waypoints time, finding a resolution for conflicts that can occur in ground movements at Malpensa Airport, with safety and efficiency constraints.

The tool determines conflicts in taxi-plans automatically. At Malpensa most of conflicts are due to the crossing of runway 35L and taxiways. Taking arrival and departure flights into account, a taxi-route is assigned to each flight, with waypoints time, determining possible conflicts.

If conflicts are found, a solution is suggested to Air Traffic Controllers, identifying consequences of the scheduling and assignment of a new taxi-route.

A validation activity has been performed, comparing real data and computed ones: conflicts identified are minimised and taxi-time is almost equal to ideal taxi-time (in the hypothesis that an aircraft would cover its taxi-route without any conflict, so without any stop). The reduction of queues on the taxiways has as a consequence on the reduction of pollution, due to fuel consumption and noise, which means also increase of safety and decrease of costs.

References