ACOUSTIC IMPACT OF CAPODICHINO AIRPORT BY THE USE OF THE AEDT SOFTWARE

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About the study of the acoustic impact of the Capodichino airport (Naples), a new acoustic simulation software was used to generate the study of noise propagation in the area near the airport and relative footprint.

In the past, the INM (Integrated Noise Model) calculation code provided by the FAA (Federal Aviation Agency) has been represented the standard code for these simulation operations and widely used all over the international airports.

Anyway, in the last three years, a new code has been implemented by the FAA, to overcome some of the limitation of the INM. This new tool, named Aviation Environmental Design Tool (AEDT) present a new management of the acoustic parameters (as, for instances the implementation of innovative sound absorption model such as the SAE-AIR-5534) and a different management of the acoustic maps definition (as, for instances, the use of dynamic grids) . It also allow to a contextual management of acoustic and air pollution (CO2) problems.

AEDT also presents a catalog of aircraft updated and constantly updated, which INM did not have and for which equivalent aircraft should have been taken.

In the framework of the present study, AEDT provisional results have been compared with data already available and based upon the use of the INM code.

An in-depth study has been also dedicated to the comparison of numerical forecasted data and experimental one measured at specific target point through the use of the Capodichino Airport remote monitoring noise system.

The study has highlighted some of the peculiarities of the new software consolidating the opportunity to use AEDT as future planning tool for Capodichino and other airport's scenario.

Keywords: **Airport, aircraft noise, AEDT, INM.**

1. Introduction

The assessment of the noise produced by aircraft concerns the take-off and landing phases, which certainly represent the main sources of disturbance for the population residing in the vicinity of an airport settlement, represents an activity of particular interest, especially for infrastructures located near urbanized areas for which it becomes it is difficult to have free areas of sufficient size to be used exclusively for airports. In view of this, the legislation on the regulation of noise emitted by air transport must cover several requirements:

- *protection of the population*;
- *allow the development of air traffic, which is now constantly growing*;
- *allow the expansion of airport infrastructure*;
- *identify limitations to spatial planning in the vicinity of such infrastructures*.

This activity is generally supported by the use of forecasting software able to estimate the isophonic footprint on the ground as a function of the landing and take-off operations characteristic of the airport. The forecast data must obviously be verified by means of punctual experimental measurements, which are functional to the verification and possible calibration of the numerical model.
One of the software that for years has been the "standard" for such activities is INM (Integrated Noise Model) produced by the FAA, which, has during the last years introduced a new tool with advanced calculation features, named AEDT.

2. Introduction to the differences between INM and AEDT

The FAA's Aviation Environmental Design Tool (AEDT) was developed to replace a set of legacy FAA tools for modeling noise, emissions and fuel consumption. These legacy tools include the Integrated Noise Model (INM), Emissions and Dispersion Modeling System (EDMS), and Integrated Noise Routing System (NIRS).

Although there is a significant overlap of functionalities and underlying methodologies between AEDT and legacy tools, AEDT has a fundamentally different system of architecture, design and functionality that allow the user to simultaneously model aeronautical noise, fuel consumption and emissions within a common interface and common inputs.

Many updates and fixes representing the best available science have been incorporated into AEDT, and will result in differences when comparing AEDT results with legacy tools. During AEDT's development extensive verification and validation work was performed on both legacy instruments and "gold standard" data such as Cockpit Flight Data Recorder data to ensure that AEDT was capturing the aircraft's performance and positioning correctly. These types of validation exercises have been acquired as part of the AEDT documentation to increase confidence that AEDT is a more accurate model than legacy tools.

In AEDT, the new algorithms led to differences in the calculation of noise at receptor positions. These differences are foreseen and should not be of concern, as the methods used in the EMCDDA are based on the best available science to produce more accurate and plausible environmental results.

We will provide a summary of the improvements to AEDT and the expected differences in results.

For a more detailed description of the differences in modelling methodologies, the AEDT user should review the AEDT2a Uncertainty Quantification Report and AEDT2b Technical Manual, available on the FAA EMCDDA website.

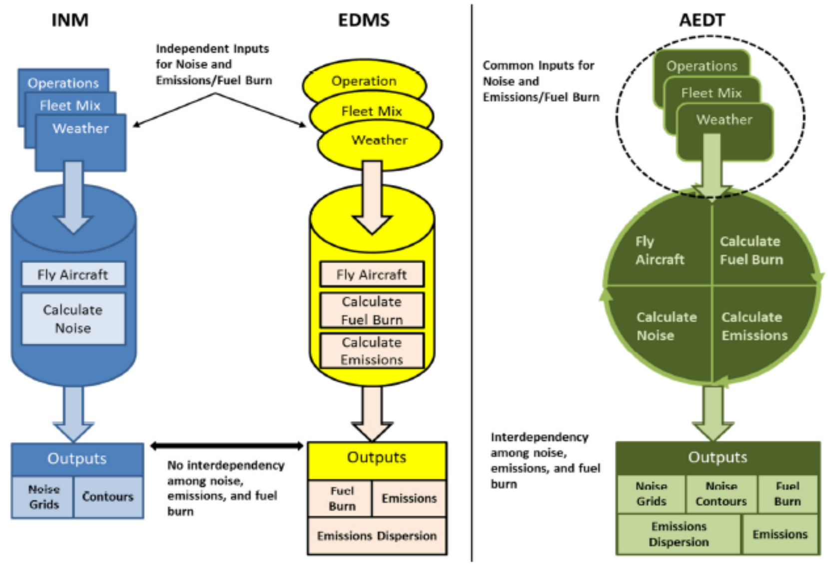


Figure1 -

2.1 Noise, emissions and fuel consumption calculations

The calculation of noise, emissions and fuel consumption we know to be influenced by the flight path of the aircraft, the local weather and the characteristics of the aircraft. The updates made by AEDT will lead to some differences in noise calculation, emissions and fuel consumption. We will see how all flight conditions, weather and aircraft characteristics have been implemented in AEDT.

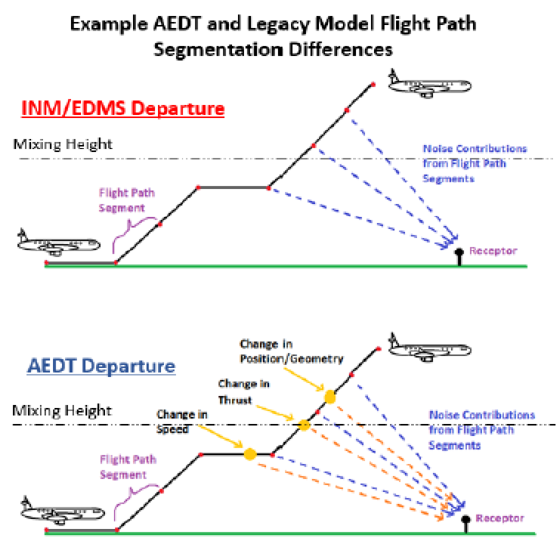


Figure 2 - Example of flight path segmentation differences between AEDT and the legacy instruments.

2.2 Flight path comparisons

AEDT and legacy instruments shape long-distance aircraft. AEDT and INM/EDMS separate flight paths into smaller pieces, called "flight path Segments". Each segment of the flight path contains aircraft-specific data including: engine power, aircraft status (angle of attack, deflector adjustment, etc.), aircraft speed and position. These values are used to calculate noise, fuel consumption and emissions.

Flight paths in AEDT usually have more segments than INM/EDMS flight paths. More segments (e.g., shorter segment lengths) better approximate changes in aircraft status, and thus predict noise more reliably.

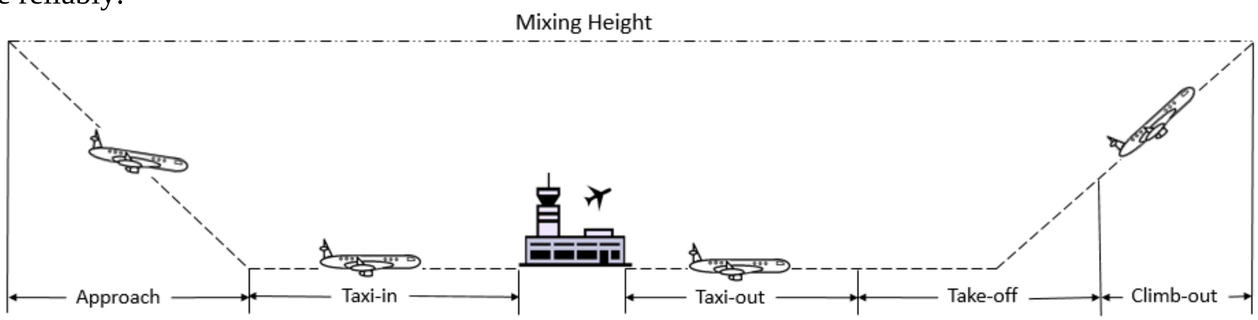


Figure3 – A schematic overview of main flight operations

The modeling of the performance of the aircraft has a direct impact on time and in a particular (eg, take-off, climb-out, and approach) on fuel consumption. These modeling improvements cause differences in fuel consumption and emissions that vary depending on the aircraft.

2.3 Comparison of INM and AEDT weather data

Both AEDT and previous models allow users to enter meteorological data into a study (temperature, atmospheric pressure, relative humidity and wind). The performance of aircraft along a flight path and noise, emissions and fuel consumption calculations are affected by these weather parameters. For example, temperature can affect engine thrust, wind can affect the climb of the aircraft, and humidity can affect the noise traveling from the plane to the ground.

Sound levels tend to be lower in low-humidity environments as well as in high-humidity ones due to the higher atmospheric absorption associated with lower humidity.

EMCDDA includes several improvements over INM and EDMS, such as:

Default Weather Data - The default weather data in AEDT differs from INM because the default AEDT time data is specific to the airport being modeled (they can be customized by the user if necessary). This is consistent with EDMS in that the data is drawn from the same 30-year normal data as EDMS.

Ground based vs. High Fidelity Weather **-** Weather data for aircraft performance in AEDT differs from INM and EDMS because AEDT allows the use of data that varies according to the altitude and location of the aircraft ("high fidelity" weather), while legacy instruments only use terrestrial weather data.

Methods for Computing the Effects of Weather on Noise - INM includes two methods for processing the effects of bad weather on noise: methods for unregulated time (SAE-AIR-1845) and airport time specific (SAE-ARP-866A). AEDT differs from INM, because in addition to these two methods, AEDT includes a new airport-specific climate method (SAE-ARP-5534), which represents the best available science. FAA requires modeling with SAE-ARP-5534 for noise analysis of FAA actions. Example the differences in atmospheric absorption are illustrated below.

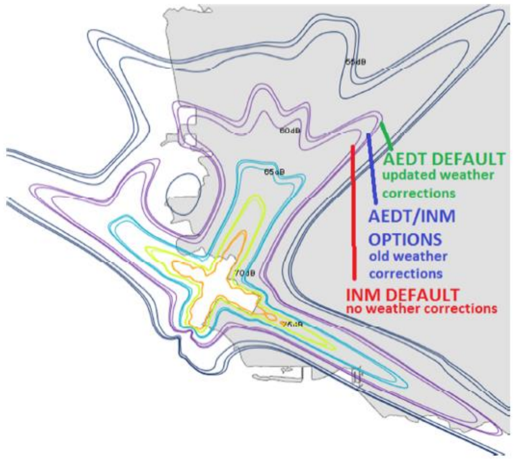


Figure4 - Noise profile disturbances due to atmospheric absorption.

2.4 Noise Countour

Contours are calculated differently from INM. In both instruments the area where the calculated noise is present, and consequently the drawn contours, are based on a grid of receptors. AEDT and INM use different methods to calculate contour grids.

Some of these methods use contour grids with variable spacing to reduce the calculation time and increase the quality of the contour.

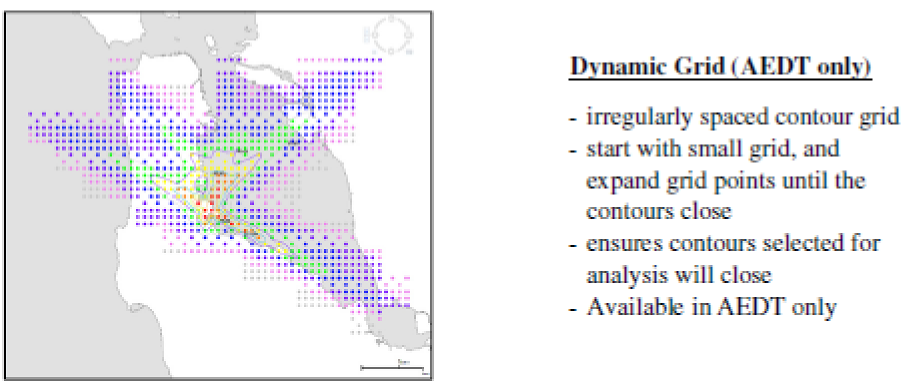
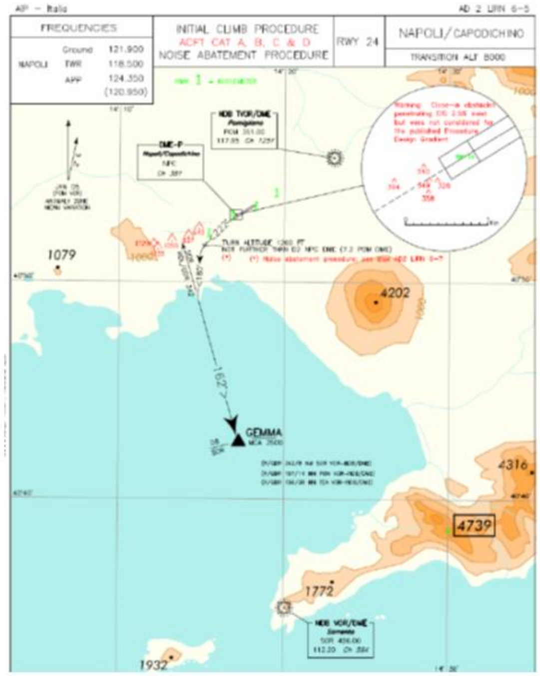


Figure5 – Example of dynamic grid management

Due to the inherent differences between INM recursive grids and AEDT dynamic grids, only fixed grids need to be imported from the INM into AEDT.

3. Modeling of the Naples Capodichino Airport

A modeling activity has been related to the Naples Capodichino Airport whose overview data are reported in the following pictures, including the number of flight operation per year and one of the take-off flightpath.



Anno	Passeggeri	Movimenti
2000	4.136.508	61.918
2001	4.003.001	60.916
2002	4.132.874	63.690
2003	4.587.163	65.016
2004	4.632.388	59.962
2005	4.588.695	58.002
2006	5.095.969	61.708
2007	5.775.838	72.330
2008	5.642.266	68.548
2009	5.322.161	64.032
2010	5.584.114	63.564
2011	5.768.873	62.878
2012	5.801.836	61.115
2013	5.444.422	55.940
2014	5.960.035	58.681
2015	6.163.188	59.456
2016	6.775.988	63.093

Tabella 9: Traffico aeroportuale

Caratteristiche	
Nome aeroporto	Napoli Capodichino
Codice ICAO	LIRN
Codice IATA	NAP
Coordinate geografiche	40° 53' 04" N 14° 17' 27" E
Altitudine	90 m
Numero di piste	1
Superficie pavimentata complessiva	2.3 kmq
Tipo di gestione	diretta
Società di gestione	Gesac

Tabella 8: Caratteristiche principali dell'aeroporto

Runway Lenght: 2750 m

Runway Width : 45 m

Figure6 – Naples Capodichino Airport

Once defined the landing and take off flight routes, the flight mix has been defined in terms of single operation (type of aircraft, destination distance, time of the operation and others).

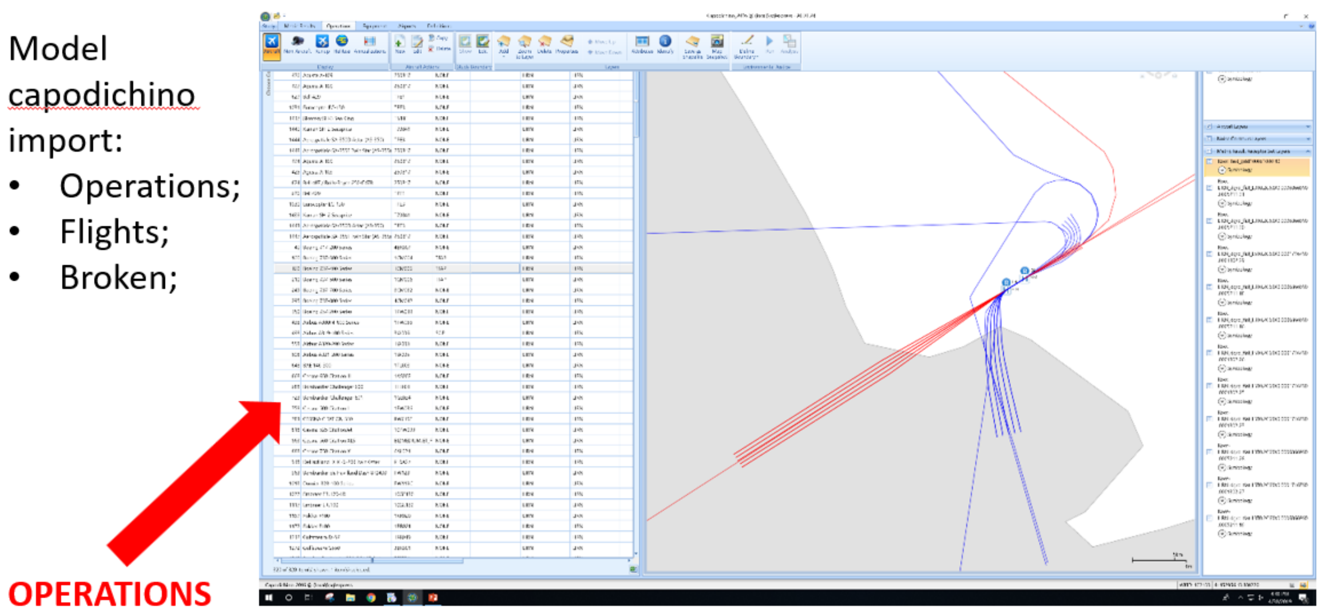


Figure7 – Model definition

As a final result, the noise contours at ground have been computed with AEDT and INM codes and compared.

Figure8 – Noise Contours

4. Conclusions

This preliminary activity has highlighted a good agreement of the INM and AEDT codes, with slight differences due to the different management of the weather influence and the better management of the computational grid, and as a consequence of the contours of the AEDT. Further activities are still on going, aimed at the definition of forecasting scenario for the Airport growing number of operation and possible future flight paths under stusy.

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