• Aviation Environmental Design Tool (AEDT) presentation to the American Association of Airport Executives Environmental Management Conference, June 2nd, 2014
• Presentation given by Chris Sequeira, FAA Office of Environment and Energy
• All photos by Chris Sequeira
• AEDT project managers
  • Fabio Grandi: AEDT co-manager, succeeding Becky Cointin
  • Chris Sequeira: AEDT co-manager, succeeding Ralph Iovinelli
AEDT evaluates the environmental consequences of aviation activity.

- Fuel burn
- Noise
- Emissions
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- AEDT evaluates the environmental consequences of aviation activity.
  - Fuel burn
  - Noise
  - Emissions
  - Air quality using AERMOD
  - Military aircraft from NOISEMAP included within AEDT
• Legacy tools:
  • Public regulatory tools
    • Integrated Noise Model (INM)
    • Noise Integrated Routing System (NIRS)
    • Emissions and Dispersion Modeling System (EDMS)
  • FAA-internal domestic and international policy analysis tools
    • System for Assessing Aviation’s Global Emissions (SAGE)
    • Model for Assessing Global Exposure to the Noise of Transport Aircraft (MAGENTA)
• Functionality of all five tools will exist in AEDT
• What makes AEDT 2b better than the tools it’s replacing?
• Why was AEDT created?
  • AEDT was created to unify noise and emissions analysis in the same software tool
• Previously, you had to use separate tools for noise and emissions
  • INM: fly aircraft, get single-airport noise
  • NIRS: fly aircraft, get noise for air traffic airspace and procedure actions
  • EDMS: fly aircraft, get single-airport emissions and local air quality consequences
  • SAGE: fly aircraft, get domestic and global fuel burn and emissions
  • MAGENTA: fly aircraft, get domestic and global noise
• AEDT: Get fuel burn, noise, emissions, and air quality consequences in the same tool
• Noise, emissions, and fuel burn are highly interdependent and occur simultaneously throughout all phases of flight
  • The unifying factor: aircraft performance
• AEDT can show how scenario changes made to respond to one environmental consequence area can affect other environmental consequence areas
• Imagine two situations:
• The original flight path takes the aircraft right next to the noise-sensitive area
• An alternate flight path take the aircraft further away from the noise-sensitive area
  • Further away means lower noise
  • However, longer flight path means more fuel burn and emissions
• Primary categories of user inputs:
  • Aircraft flight paths
  • Fleet mix
  • Number of operations
  • Weather
  • Elevation/terrain information
• Primary categories of system inputs
  • Airports
  • Fleet data
• Geographic information system (GIS)-based: uses latitude and longitude coordinates
  • Leverages Esri GIS technology
• Graphical user interface: enables user to drive the software through mouse point and click
• AEDT databases are relational databases with Structured Query Language (SQL)
  • Leverages Microsoft SQL Server technology
  • Default system databases contain information on fleet (3200+ airframe/engine combos), airports (35,000+ airports globally)
  • Outputs are stored in relational databases
  • Scaleable from a single flight to global (yes, it’s possible to put tens of millions of flights into AEDT)
• External files: enables import of data and studies
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• The legacy tools are driven by structure.
• Working from left to right:
  • Define structure first
  • Then put data into the proper structural elements
  • Then run study and get results
• Must remember why you structured your study in a certain way
  • Anyone else who works with your study also must understand your structure!
• To reorganize your data, must redesign and redefine your study structure!
• AEDT is driven by results.
• Working from right to left:
  • Define the results you want
  • Then link data with the results definitions
  • Then run the definitions and get results.
• No rigid structure to remember; can group data however you want!
  • Can put the same data into multiple metric results definitions and multiple groups
- AEDT has a built-in geographic information system (GIS)
- Leverages Esri GIS technology
- With an internet connection, AEDT can access online basemaps, such as the streetmap shown in the picture
- You can import your own basemaps and shape files
- The blue lines are example flight tracks
• Using layer controls, you can add multiple layers and blend them
• The screenshot shows a blend of streetmap and satellite imagery online basemaps
• The blue lines are example flight tracks
AEDT is based around detailed relational databases with Structured Query Language (SQL)

Leverages Microsoft SQL Server

Microsoft SQL Server is the critical technology enabling scaling from a single flight to an entire global analysis

Example: AEE created a global fuel burn and emissions inventory for the year 2010.
  • Over 28 million flights
  • Over 3500 airports
  • Database over 700 gigabytes in size

This is a screenshot of Microsoft SQL Server Management Studio
  • Left pane shows a subset of tables in an AEDT study database
  • Upper right pane shows a SQL query used to show a subset of records in the table highlighted in the left pane
  • Lower right pane shows the results of the query
- AEDT is a multi-threaded application, to take advantage of multiple processor cores
- AEDT enables distributed computing (cooperative computer processing using multiple computers)
- AEDT full installation exists on the primary machine, known as the taskmaster (TM)
- Smaller AEDT installations exist on the remote processing computers
- Taskmaster and remote processing computers share workload, reducing study runtime
• Substantial decrease in runtime is possible by adding just a few remote processing computers
• Adding remote processing computers gives diminishing returns
AEDT Version 2b
AEDT 2b’s Intention

To replace AEDT 2a, INM, EDMS, SAGE, and MAGENTA for environmental compliance, research, and policy analysis.
• What will AEDT 2b have that EDMS doesn’t have?
- AEDT 2b supports curved flight paths
  - EDMS has straight-in/straight-out flight paths only
- Three ways to input flight paths
  - Track nodes: user-specified points representing latitude/longitude locations along the flight track, with optional altitude controls
  - Track vectors: content representing straight paths with user-specified distances and curves with user-specified radii
  - Sensor paths: where AEDT takes user-specified radar data, smoothens it, and calculates aircraft performance
    - User-specified radar points contain latitude, longitude, and altitude
      - Points can also contain aircraft speeds above 10,000 feet AFE
    - AEDT then calculates the thrust needed to reach the given points
• These colored receptors show CO 8-hour concentrations from the curved flight tracks in the screenshot.
  • Gray: Concentrations essentially zero
  • Blue: Low concentrations
  • Red: High concentrations
• AEDT can fly flights well beyond the airport mixing height
• AEDT can fly flights well beyond the airport mixing height ... even from airport to airport!
• The blue trajectories are notional runway-to-runway flights between various airports
• FAA uses AEDT to generate runway-to-runway fuel burn and emissions inventories for domestic and international reporting and policy-making, including the ongoing CO2 standard-setting initiative within the International Civil Aviation Organization’s Committee on Aviation Environmental Protection
The flight performance report in the screen shot shows the altitude profiles of several flights, including climb, cruise with step climbs, and descent.
• AEDT will not include an integrated version of US EPA’s Motor Vehicle Emissions Simulator MOVES), which is the replacement for EPA’s MOBILE model for computing onroad mobile source ground emissions
• MOVES is a much more detailed model than MOBILE, and MOVES2014 is still in active development
• Screenshot source: MOVES2010b User Guide (PDF) (EPA-420-B-12-001b, June 2012)
AEDT 2b: Beyond INM
Altitude control algorithms existed in NIRS but not in INM.

Altitude controls represent “air traffic control commands” for aircraft to fly at, above, or below certain altitudes.

Three types of altitude controls, with approximately +/- 300 foot tolerance:
- **At**: fly to maintain a user-specified altitude.
- **AtOrAbove**: fly to and remain at or above a user-specified altitude.
- **AtOrBelow**: fly to and remain at or below a user-specified altitude.

Altitude control algorithms are built into AEDT, so if changing aircraft vertical profiles using altitude controls, no need to produce a justification document package for FAA review and approval.

The two fictional aircraft approach vertical profiles in the screenshot each have an “At” altitude control at 16,000 feet AFE.

Let’s look at the fictional red profile, which has no further altitude controls.
• 300 fictional flights flying in the daytime along the red profile give the colored noise receptor grid shown here.
  • Purple colors: lower noise
  • Red colors: higher noise
• The fictional green profile has two “At” altitude controls of 5,000 feet, representing an altitude hold near the airport.
• 300 fictional flights flying in the daytime along the green trajectory (with altitude hold) give the colored noise receptor grid shown here.
  • Purple colors: lower noise
  • Red colors: higher noise
• Compared with the fictional red trajectory (no altitude hold -- shown here), the fictional green trajectory (with altitude hold) has different noise levels.
  • Purple colors: lower noise
  • Red colors: higher noise
• Fictional fuel burn from profile start (16,000 feet) to landing roll
• 300 fictional flights on the red (no altitude hold) trajectory
• 300 fictional flights on the green (with altitude hold) trajectory
• Fictional emissions from profile start (16,000 feet) to landing roll
• 300 fictional flights on the red (no altitude hold) trajectory
• 300 fictional flights on the green (with altitude hold) trajectory
For further information

http://aedt.faa.gov/
A Trip Through AEDT 2b
(Demo Video)

http://youtu.be/fl5K2qT4ijs