Aviation Environmental Design Tool (AEDT)

OVERVIEW

Presented to: TRB AEDT/APMT Workshop #4
By: Gregg G. Fleming–Volpe
Date: December 6-8, 2006

AEDT Development Team
Co-Managed by Lourdes Maurice and Gregg Fleming
Outline

- **Statement of needs and motivation**
  - ICAO/CAEP and JPDO
  - TRB Guidance
  - User community
- **AEDT Version 1.0 – Current State**
  - Databases
  - Modules
  - Other
- **Capability Demonstration**
- **Schedule**
- **Next steps and summary**

Motivation: ICAO/CAEP and JPDO

- **Upon completion AEDT is designed to interface with EDS and APMT to provide users with the necessary information for future aircraft so as to:**
  - Enable more informed Federal research, policy and budgetary decision-making (JPDO, FAA, NASA, EPA, Industry)
  - More effectively assess and communicate environmental effects, interrelationships, and economic consequences based on integrated analyses (JPDO, FAA, ICAO-CAEP, Industry)
  - Facilitate international agreements on standards, recommended practices, and mitigation options for international policy making (ICAO-CAEP, FAA, Industry)
  - Serve as a mechanism for an expert-driven process for collecting, incorporating and quantifying long-term technology impact assessments (JPDO, FAA, NASA, ICAO-CAEP, Industry)
## Vision and Objectives for AEDT

<table>
<thead>
<tr>
<th></th>
<th>Status</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The AEDT should provide <strong>clear benefits</strong> to the current users of existing analytical tools and should be designed so that these users can <strong>easily access it</strong>. When developed, the AEDT should be able to serve <strong>multiple users</strong>.</td>
<td>✔</td>
<td>1,000’s of local installations; global web-based interface</td>
</tr>
<tr>
<td>2. It is important to assure <strong>international acceptance</strong> of the AEDT and to make the tool consistent with <strong>international databases</strong>.</td>
<td>✔</td>
<td>ICAO model and database work ongoing; engagement with SAE groups</td>
</tr>
<tr>
<td>3. Existing tools such as Integrated Noise Model (INM) and Emissions &amp; Dispersion Modeling System (EDMS) should be <strong>upgraded</strong> as the AEDT is developed.</td>
<td>✔</td>
<td>INM Versions 6.2, 6.2a &amp; 7.0; EDMS Version 4.3, 4.4, 4.5, 5.0</td>
</tr>
</tbody>
</table>

## Status

<table>
<thead>
<tr>
<th></th>
<th>Vision and Objectives for AEDT</th>
<th>Status</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. The AEDT should be <strong>open, available</strong>, and <strong>transparent</strong> in concept and execution; in addition, original versions of certain models should be retained and be accessible for call up if needed.</td>
<td>✔</td>
<td>Versioned controlled modules and databases</td>
<td></td>
</tr>
<tr>
<td>5. The AEDT should have flexibility to <strong>adapt</strong> to and <strong>accept future modifications</strong>, be able to respond to changing future needs, and be able to access future <strong>technologies</strong> and new functionalities. It should also be <strong>modular</strong> and <strong>flexible</strong>, to allow users to incorporate other tools.</td>
<td>✔</td>
<td>Modularization enables this, e.g., multiple emissions methodologies currently being coded</td>
<td></td>
</tr>
<tr>
<td>6. The AEDT should have <strong>interactive capability</strong> between noise and emissions, and it should have <strong>modularity</strong> to accommodate various components of these two attributes.</td>
<td>✔</td>
<td>See #5 above</td>
<td></td>
</tr>
<tr>
<td>7. The AEDT should be developed through use of an <strong>integrated database management system</strong>.</td>
<td>✔</td>
<td>Common Database Access Module being developed</td>
<td></td>
</tr>
<tr>
<td>Vision and Objectives for AEDT</td>
<td>Status</td>
<td>Notes</td>
<td></td>
</tr>
<tr>
<td>-------------------------------</td>
<td>--------</td>
<td>-------</td>
<td></td>
</tr>
<tr>
<td>8. The first version of the AEDT (“alpha version”) should be <strong>PC based</strong>.</td>
<td>✔️</td>
<td>AEDT-Local – public; AEDT-Global – limited access via web.</td>
<td></td>
</tr>
<tr>
<td>9. The information incorporated within the AEDT should be <strong>consistent across all models</strong> that are developed for similar or closely related purposes.</td>
<td>✔️</td>
<td>Achieved through harmonization</td>
<td></td>
</tr>
<tr>
<td>10. The AEDT should be able to <strong>manage uncertainties</strong> within its modeling capacity.</td>
<td>✔️</td>
<td>In cooperation with SAE groups</td>
<td></td>
</tr>
<tr>
<td>11. The AEDT should have a <strong>predictive capability</strong> as part of its functionality.</td>
<td>✔️</td>
<td>FOM applies FESG and other forecasts; EDS will define future technology</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vision and Objectives for AEDT</th>
<th>Status</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>12. The AEDT inputs must be <strong>nonproprietary</strong>.</td>
<td>✔️</td>
<td>Use agreement with EUROCONTROL on BADA</td>
</tr>
<tr>
<td>13. The AEDT should be able to accommodate additional and newer aircraft types, such as helicopters and general aviation and various military aircraft. It should also have the capability to include significant variations within existing fleets of aircraft.</td>
<td>✔️</td>
<td>Integration with EDS</td>
</tr>
<tr>
<td>14. The AEDT should be able to accommodate additional emissions species and fates that have not been subject to analysis in the past.</td>
<td>✔️</td>
<td>Modularity enables this (e.g., FOA, HAPs)</td>
</tr>
</tbody>
</table>
## Vision and Objectives for AEDT

<table>
<thead>
<tr>
<th>Objective</th>
<th>Status</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>15. The AEDT should be able to accommodate weather factors within its analyses—especially analyses that consider dispersion of emissions.</td>
<td>✓</td>
<td>Comprehensive weather database in AEDT</td>
</tr>
<tr>
<td>16. <strong>Certification standards</strong> should be available to evaluate AEDT performance.</td>
<td>✓</td>
<td>Working closely with SAE groups</td>
</tr>
<tr>
<td>17. The AEDT should have built-in <strong>validation functions</strong>, and tools that are subsets of the AEDT should be validated before they are incorporated.</td>
<td>✓</td>
<td>Working closely with SAE groups</td>
</tr>
</tbody>
</table>

## Next Steps in AEDT Development

<table>
<thead>
<tr>
<th>Step</th>
<th>Status</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The AEDT should be developed with <strong>active stakeholder involvement</strong>; the following steps would be useful to assure that goal:</td>
<td>✓</td>
<td>AEDT Local DRG, EDS TAB; ICAO CAEP WG2</td>
</tr>
<tr>
<td>a. Conduct periodic surveys of the user community.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Create partnerships with the relevant international community.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Establish steering groups with diverse viewpoints and expertise to help guide major decisions.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. The AEDT development process should include a validation plan that involves input from a variety of stakeholders.</td>
<td>✓</td>
<td>Working with SAE groups</td>
</tr>
<tr>
<td>3. The development process should include a plan to assure a smooth transition from existing models to the AEDT.</td>
<td>✓</td>
<td>INM and EDMS releases harmonized; AEDT Local DRG</td>
</tr>
</tbody>
</table>
### TRB November 2004

<table>
<thead>
<tr>
<th>Next Steps in AEDT Development</th>
<th>Status</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. The development process should set priorities for emissions requirements and noise requirements.</td>
<td>✓</td>
<td>Working with SAE groups, DRG, EDS TAB</td>
</tr>
<tr>
<td>6. The AEDT should incorporate best practice tools as part of the development process.</td>
<td>✓</td>
<td>See #5 above</td>
</tr>
<tr>
<td>7. The AEDT development plan should include realistic schedules, accurate definitions of level of effort, go/no-go decision points, and parallel efforts for some aspects of the process.</td>
<td>✓</td>
<td>INM and EDMS releases harmonized; detailed MS Project schedules; milestones tied to ICAO CAEP</td>
</tr>
</tbody>
</table>

### TRB April 2005

<table>
<thead>
<tr>
<th>AEDT Priorities, Schedule &amp; Budget</th>
<th>Status</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>The committee recommends that FAA develop a more rigorous process for determining the required budget for developing AEDT measured against clearly stated priorities within the development process. The committee is concerned that current budget allocations will not cover the plans outlined.</td>
<td>✓</td>
<td>Detailed, multi-year integrated budget and task planning process</td>
</tr>
</tbody>
</table>
| There is also a need to establish consensus-based priorities for FAA’s goals in accomplishing AEDT and APMT.  
For example, harmonizing the global models (SAGE and MAGENTA) will require rewriting of at least one of the models (a very costly endeavor) because each is essentially monolithic. This harmonization effort could use most of the available resources, and, therefore, its priority within the total AEDT must be examined continually. | ✓                       | TRB process initiated this                                           |
TRB April 2005

<table>
<thead>
<tr>
<th>AEDT Project Management</th>
<th>Status</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>The committee recommends that FAA establish a stronger project management program, including one <strong>designated full-time project manager</strong> to centralize communications and accountability.</td>
<td>✔</td>
<td>Volpe technical and project management lead</td>
</tr>
<tr>
<td>In addition, a more <strong>detailed plan of work</strong> over the next year is essential for better evaluation of FAA’s process and approach.</td>
<td>✔</td>
<td>Work plan, architecture, module and database documents available</td>
</tr>
<tr>
<td>Budget estimates presented by FAA indicate that the total costs of maintaining all models will begin to decrease by the end of CY 2008, when models begin to operate on common data sources. Whether these <strong>cost savings</strong> will be achieved <strong>must be continually evaluated.</strong></td>
<td>✔</td>
<td>“Efficiencies” in legacy models/processes continually being realized</td>
</tr>
</tbody>
</table>

**Notes:**

9 The committee recommends that FAA establish a stronger project management program, including one **designated full-time project manager** to centralize communications and accountability.

9 In addition, a more **detailed plan of work** over the next year is essential for better evaluation of FAA’s process and approach.

9 Budget estimates presented by FAA indicate that the total costs of maintaining all models will begin to decrease by the end of CY 2008, when models begin to operate on common data sources. Whether these **cost savings** will be achieved **must be continually evaluated.**

**Status:**

- ✔ = good progress
- ✔ = limited progress

---

TRB April 2005

<table>
<thead>
<tr>
<th>AEDT Project Management</th>
<th>Status</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>The committee also recommends that FAA indicate how it plans to <strong>coordinate with international and national nongovernmental organization (NGO) stakeholders.</strong></td>
<td>✔</td>
<td>More prominent lead in ICAO CAEP and other groups</td>
</tr>
<tr>
<td><strong>FAA should initiate interaction with international stakeholders</strong>, international and domestic governmental entities, NGOs and corporations, and U.S. air carriers.</td>
<td>✔</td>
<td>Same as previous</td>
</tr>
<tr>
<td>The committee recommends that future workshops <strong>include</strong>, especially during the APMT discussions, <strong>more participants</strong> from airlines and manufacturers that have an economic stake in the outcome.</td>
<td>✔</td>
<td>Dedicated workshop</td>
</tr>
</tbody>
</table>

**Notes:**

9 The committee recommends that FAA establish a stronger project management program, including one **designated full-time project manager** to centralize communications and accountability.

9 In addition, a more **detailed plan of work** over the next year is essential for better evaluation of FAA’s process and approach.

9 Budget estimates presented by FAA indicate that the total costs of maintaining all models will begin to decrease by the end of CY 2008, when models begin to operate on common data sources. Whether these **cost savings** will be achieved **must be continually evaluated.**

**Status:**

- ✔ = good progress
- ✔ = limited progress
TRB Workshop Guidance

• In summary:

AEDT development is following the guidance of the TRB study committee and workshop participants

AEDT Users

SAGE and MAGENTA
• Used by FAA and FAA development team
• Support ICAO/CAEP and JPDO analyses
• Migrates to AEDT-Global

EDMS and INM
• Used by over 1000 organizations worldwide
• Support various environmental analyses, e.g., EIS, Part 150s, etc.
• Migrates to AEDT-Local
Legacy Model Development Timelines

First public release of AEDT-Local in 2010

AEDT Overview
December 6-8, 2006

Federal Aviation Administration

Analysis with AEDT

AEDT

Relevant airport information, e.g., lat, lon, rwy, country, etc.

GUI

Aircraft Acoustics
Aircraft Emissions
Emission Dispersion
Fleet and Operations
Aircraft Performance

AEDT Airports Database

AEDT Movements Database

AEDT Fleet Database

Aircraft/engine model and registration information

Operations and trajectory information
Airport Database

Relevant airport information, e.g., latitude, longitude, runway, country, etc.

AEDT-Local: Provides basic airport template to support analysis

AEDT-Global: Provides “key” for attributing noise and emissions to airport, country, region, etc.

Airports Database

Main Airports Database

Runways
Helipads
Entry Fix Points
Navaids
Weather

Tracks / Track Segments
Operations
Capacities
Detailed Layouts

“General”- Data already existing in global airport databases. Some examples are airport reference point (ARP) positions, runways, and navaids.

“Specialized”- Data that needs to be acquired on an airport-by-airport basis. Usually compiled for local models. Some examples are trajectories, area population, and airport boundaries.
Fleet Database

AEDT Fleet Database

- Aircraft/engine model and registration information
- AEDT-Local: Provides information on aircraft/engine
- AEDT-Global: Additional aspects to include certification and registration information

Movements Database

AEDT Movements Database

- Operations and trajectory information
- AEDT-Local: Operational data by airport; limited terminal area trajectory information
- AEDT-Global: Operational data by airport; gate-to-gate trajectory information
Project Status - Databases

- Redesigned database structure to support all legacy tools (i.e., INM, EDMS, MAGENTA, SAGE)
- Data harmonized across legacy tools
- Harmonization with available international sources ongoing
- Scaled-down version of global databases available to AEDT-Local tools

Aircraft Acoustics Module

Acoustic computation in AEDT; compliant with international standards
**Emissions Module**

Emissions computation in AEDT; currently no applicable international standards

**Dispersion Module**

Emissions dispersion computation in AEDT; based on EPA’s AERMOD
Fleet and Operations Module

Generates a future fleet, based on ICAO/FESG forecast

AEDT Fleet and Operations Module

---

Performance Module

Computes aircraft performance parameters required for noise and emissions computations, e.g., speed, thrust, etc.

AEDT Performance Module

---
Project Status - Modules

- Redesigned computational modules, e.g., emissions (Boeing Fuel Flow Method 2), aircraft performance (including BADA fuel burn)
- Harmonized common modules across legacy tools
- Integrated common modules across legacy tools

Initial AEDT Capability Demonstrations

- AEDT Initial Capability Demonstrations:
  - NOx Stringency
  - Continuous Descent Profile (CDA)
  - Reduced Vertical Separation Minimum (RVSM)
  - Goal Assessment (ICAO/CAEP)
<table>
<thead>
<tr>
<th>AEDT 2005/2006 Accomplishments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Standardized software and database documentation discipline (i.e., ICDs, etc.)</strong></td>
</tr>
<tr>
<td><strong>Standardized software development environment, including architecture design tools (i.e., MS.NET, MS Visio)</strong></td>
</tr>
<tr>
<td><strong>Software module exchange protocol (including source code)</strong></td>
</tr>
<tr>
<td><strong>Annual global noise and emissions inventories (AEDT/SAGE and AEDT/MAGENTA)</strong></td>
</tr>
</tbody>
</table>

| Legacy model releases (INM 6.2, 6.2a, 7.0-BETA; EDMS 4.3, 4.4, 4.5, 5.0-BETA) | ✓ |
| **Society of Automotive Engineers (SAE) Aerospace Information Report (AIR) 5662, “Method for Predicting the Lateral Attenuation of Airplane Noise”** | ✓ |
| **ICAO/CAEP Support (Goals Assessment, Model Evaluation, Database Harmonization, Circular 205 Update, Reduced Thrust Sample Problem)** | ✓ |
Next Steps

- **AEDT**
  - JPDO analysis support
  - Database harmonization process (primarily ICAO/CAEP-centric)

- **AEDT-Global**
  - ICAO/CAEP model evaluation and acceptance process, sample problems and analyses
  - Web-based query tool migrating to full application (limited availability)

- **AEDT-Local**
  - INM 7 and EDMS 5 release
  - Integrated local graphical user interface (GUI); developed and coordinated with an integrated design review group (public availability)
Summary

- From November 2004 to December 2006 we have harmonized the legacy databases and modules of AEDT based on a set of requirements and overall model architecture and work plan
  - Fully-consistent with prior TRB workshop recommendations
- We have exercised the tool suite for a series of significant sample problems as well as “real” analyses
- We will be pleased to share much more with you
- We welcome your input and engagement

?? Questions ??

FAA Environmental Tools web site:

http://www.faa.gov/about/office_org/headquarters_offices/aep/models/