TRB TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

LETTER REPORT

WORKSHOP #1
FAA AVIATION ENVIRONMENTAL DESIGN TOOL (AEDT)

March 31 – April 2, 2004
Washington, DC

November 2, 2004

Mr. Carl Burleson
Director, Office of Environment and Energy
Federal Aviation Administration (AEE-1)
800 Independence Avenue, SW
Washington, DC 20591

Dear Mr. Burleson:

Even though recent progress has been made in reducing the impact of aircraft on the environment, aircraft noise and air pollutant emissions remain critical issues affecting local communities, further expansion of existing airports, emissions standards, aircraft design, siting of new airports, and airport operations. Further, international concerns regarding both these issues and the emissions of substances that might affect global climate may influence future emissions standards, airport access, taxation, and other factors important to the future of aviation. The Federal Aviation Administration (FAA) increasingly recognizes that the interdependence of noise and emissions must be considered and ultimately integrated into its processes because actions undertaken to influence one of these two factors are likely to have significant consequences for the other. The aviation community needs better tools, methods, and technologies to examine the noise and emissions implications of different aircraft propulsion systems, certification standards, infrastructure designs, and operational measures. They also need a robust tool to examine costs and benefits to industry and society of various options to mitigate environmental impacts.

With these factors in mind, the FAA asked the Transportation Research Board (TRB) of the National Academies to assist it in defining the attributes and requirements of a new Aviation Environmental Design Tool (AEDT) and an Aviation Environmental Portfolio Management Tool (APMT) to complement the AEDT. The AEDT is intended to provide a common, transparent, integrated capability for computing and identifying interrelationships between noise and emissions and among various emissions at the aircraft, local, regional, and global levels. The APMT will supplement the AEDT by providing a capability to conduct related cost-benefit analyses. When the FAA develops these tools, it will use the input from TRB's efforts to help guide this development.

TASK STATEMENT AND CHARGE TO THE COMMITTEE

The FAA asked TRB to gather input from the aviation user, operations, manufacturing, and research communities concerning its plans to develop new tools for an integrated assessment of noise, energy, and emissions impacts associated with aviation infrastructure development and for economic assessment of environmental aspects of airport operations. This input will be obtained through a series of sequential workshops. The first workshop's results are intended to assist FAA in initiating the development of the AEDT and a second workshop (to be held after the FAA prepares its AEDT work plan) will review FAA progress and elicit comments and additional input on its work plan. Other workshops to follow will incorporate considerations of economic consequences and the development of the APMT tool as well.

In response to this request, TRB appointed a committee to plan and facilitate the workshops, summarize the results, and make its own assessment of needs and opportunities for improvements. Enclosure 1 provides the membership of the committee. This letter report summarizes the first of the workshops and presents the committee's findings, conclusions, and recommendations, which are based on the first workshop.

INITIAL AEDT WORKSHOP

The first workshop consisted of a 3-day meeting of potential developers and stakeholders, including manufacturers, airlines, airports, academia, and the international community. Enclosure 2 lists the workshop participants. The workshop was held March 31 to April 2, 2004, in Washington, D.C.

Workshop participants were asked to provide input about needs and requirements as well as the process by which the FAA is developing the AEDT. Workshop participants were divided into five work groups:

A. Environmental Design Space (EDS)
B. Inputs
C. Individual Assessment of Modules
D. Noise/Emissions Modules Framework Architecture
E. Output

The workshop began with a plenary session consisting of a series of FAA presentations describing the AEDT context, the current tools available for noise and emissions analyses, and the FAA's definitions of user needs that the AEDT would address. The participants then received instructions for follow-on breakout sessions. The remainder of the workshop was devoted to breakout sessions and interaction among the five groups. A final plenary session allowed each group to summarize its findings and present its observations to the full workshop membership and provided an opportunity for general discussions by all. Enclosure 3 provides the workshop agenda and outlines how the breakout groups were organized, what the focus issues were for each group, and how the discussions flowed among the breakout groups.

The results of each of the five work group discussions were summarized by selected participants and are provided in Enclosure 4. Each group summary was prepared by the author indicated in Enclosure 4, who was chosen by the group to record discussions. These summaries provide an overview of the types of questions and considerations that participants brought to the discussions of each work group subject and can be used by the FAA as reference material when it develops its work plan.

The committee evaluated the results of the workshop and the work group reports that were presented and discussed by all in the plenary sessions. In addition, the participants were asked to identify two types of findings that each considered noteworthy. At the final plenary session, these findings were summarized by the committee and discussed by all participants.

Throughout the workshop, the participants discussed the merits and concerns associated with the continued development of the AEDT. During the early portion of the workshop, many expressed skepticism that development of the AEDT was the best approach at this time. By the close of the workshop, however, most concluded that development of this integrated model would be prudent as long as it did not jeopardize the continued improvement of the existing models.

COMMITTEE FINDINGS AND RECOMMENDATIONS

On the basis of its review of the results of the workshop, the committee developed the following findings and recommendations. The findings are of two types: AEDT requirements findings and AEDT development process findings. Requirements findings are the attributes that the AEDT must have to function adequately and to perform needed analyses for the intended users. Process findings are those actions that the FAA or other decision makers must take to assure success of the AEDT development process. The committee believes that the FAA should carefully consider these findings as it proceeds with the AEDT work plan.

Findings: AEDT Requirements

The committee’s review of the responses from workshop participants generated the following list of the major requirements that the AEDT should satisfy.

1. The AEDT should provide clear benefits to the current users of existing analytical tools and should be designed so that these users can easily

access it. When developed, the AEDT should be able to serve multiple users.

2. It is important to assure international acceptance of the AEDT and to make the tool consistent with international databases.

3. Existing tools such as Integrated Noise Model (INM) and Emissions & Dispersion Modeling System (EDMS) should be upgraded as the AEDT is developed.

4. The AEDT should be open, available, and transparent in concept and execution; in addition, original versions of certain models should be retained and be accessible for call up if needed.

5. The AEDT should have flexibility to adapt to and accept future modifications, be able to respond to changing future needs, and be able to access future technologies and new functionalities. It should also be modular and flexible, to allow users to incorporate other tools.

6. The AEDT should have interactive capability between noise and emissions, and it should have modularity to accommodate various components of these two attributes.

7. The AEDT should be developed through use of an integrated database management system.

8. In addition to the AEDT, there is a need for a tool with an economic dimension or an ability to accommodate future economic functions.[1]

9. The first version of the AEDT ("alpha version") should be PC based.

10. The information incorporated within the AEDT should be consistent across all models that are developed for similar or closely related purposes.

11. The AEDT should be able to manage uncertainties within its modeling capacity.

12. The AEDT should have a predictive capability as part of its functionality.

13. An important input to the AEDT is the capture of aircraft design features within the EDS analyses.

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[1] Subsequent discussions suggested that an additional tool (AMPT) could be developed to incorporate these economic functions.

14. The AEDT inputs must be nonproprietary..

15. EDS must be able to interface with existing tools and the AEDT.

16. 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.

17. The AEDT should be able to accommodate additional emissions species and fates that have not been subject to analysis in the past.

18. The AEDT should be able to accommodate weather factors within its analyses—especially analyses that consider dispersion of emissions.

19. Certification standards should be available to evaluate AEDT performance.

20. The AEDT should have built-in validation functions, and tools that are subsets of the AEDT should be validated before they are incorporated.

Findings: AEDT Development Process

The committee's review of the responses from workshop participants resulted in the following list of important considerations for the AEDT development process.

1. The AEDT should be developed with active stakeholder involvement; the following steps would be useful to assure that goal:

    a. Conduct periodic surveys of the user community.
    b. Create partnerships with the relevant international community.
    c. Establish steering groups with diverse viewpoints and expertise to help guide major decisions.

2. The AEDT development process should include a validation plan that involves input from a variety of stakeholders.

3. The development process should include a plan to assure a smooth transition from existing models to the AEDT.

4. The development process should assure that EDS and the AEDT are developed on parallel tracks.

5. The development process should set priorities for emissions requirements and noise requirements.

6. The AEDT should incorporate best practice tools as part of the development process.

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.

CONCLUSIONS AND RECOMMENDATIONS

The committee considered results of the workshop, comments of participants, and general discussions to reach its conclusions and recommendations to the FAA regarding the continued development of the AEDT and the most appropriate process to assure success in meeting its goals. The committee agrees with many of the workshop participants who encouraged the FAA to work cooperatively with the stakeholder community as it develops the AEDT. The committee also agrees that the FAA should commit sufficient resources to the development effort while, at the same time, continuing to upgrade existing noise and air quality tools.

From its review of the workshop results, the committee concludes that the above lists of both requirements and process findings are appropriate guidance for the FAA and should be used by the FAA and the stakeholder community in developing the AEDT. The committee also concludes that the AEDT has the potential to significantly improve the ability of the FAA and the aviation community to meet future needs for aircraft noise and emissions analyses.

The committee therefore recommends that the FAA continue to develop the AEDT and prepare its work plan, incorporating the workshop findings on requirements and process as appropriate.

The committee also recommends (*a*) that the FAA supplement the AEDT by creating a tool that includes economic considerations and (*b*) that the resulting tool have the means to evaluate the economic impact of decisions. To accommodate these added economic dimensions, the committee will expand its statement of task accordingly, add appropriate economic expertise to its membership, and integrate economic planning into the topics covered in subsequent workshops.

Finally, the committee cautions that the AEDT is a large and complex undertaking, with potential risks to achieving its goals. The AEDT also could have an impact on the ability of current tools to meet critical evolving needs. However, the committee believes that the likely benefits of success in integrating environmental considerations outweigh the risks of possible failure. Therefore, the committee recommends that the FAA fully support the development of the AEDT while maintaining adequate support for current modeling tools and their potential incremental successors.

Sincerely yours,

Wesley L. Harris
Chair, Committee for Developing Aviation Environmental Design and Aviation Environmental Portfolio Management Tools

Enclosures:

1) Committee Roster
2) Workshop Participants
3) Workshop Agenda and Breakout Group Organization
4) Summaries of Workshop Group Outputs

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AVIATION ENVIRONMENTAL DESIGN TOOL (AEDT) WORKSHOP

Sponsored by
TRANSPORTATION RESEARCH BOARD and
FEDERAL AVIATION ADMINISTRATION
March 31–April 2, 2004
Washington, D.C.

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AGENDA: AVIATION ENVIRONMENTAL DESIGN TOOL (AEDT) WORKSHOP

March 31–April 2, 2004

Day	***Time***	***Event***	***Rm.***	***Gp.***	***Moderator/ Speaker***	***Topic/Comments***
DAY 1: WEDNESDAY, March 31	*7:30-8:00am*	*Continental Breakfast*	*100*	*ALL*	--	
	8:00am	Welcome/Admin	"	"	J. Breen	
	8:15-8:30	Welcome/Introduction to AEDT	"	"	W. Harris	
	8:30-9:00	Background Briefings	"	"	L. Maurice	**Context of AEDT and FAA objectives.**
	9:00-9:30	"	"	"	T. Connor	**Overview of noise analytical tools.**
	9:30-10:00	"	"	"	C. Holsclaw	**Overview of emissions analytical tools.**
	10:00-10:15	*Break*	"	"		
	10:15-10:45	Background Briefings	"	"	G. Fleming	**Commonalities of FAA noise & emissions tools.**
	10:45-11:05	"	"	"	W. Dodds	**AIA EDS feasibility study.**
	11:05-11:30	"	"	"	I. Waitz	**MIT/Stanford EDS efforts.**
	11:30-12:15	*Lunch*	*Atrium*			*3rd Floor Cafeteria—Blue Cards*
	12:15-12:35	Background Briefings	100	"	D. Mavris	**Other tools available for AEDT foundation.**
	12:35-1:00	"	"	"	L. Maurice	**Overview of outputs FAA expects AEDT to address.**
	1:00-1:30	Instructions and Assignments	100	ALL	L. Craig	Workshop flow and Day 1 breakout groups designated & tasked.
	1:30-3:40	Working Groups Breakout				**Groups E1 thru E4 address output questions.**
		E1	105	E1	I. Jopson	E1: Jopson/Benzakein/+FAA
		E2	109	E2	L. Craig	E2: Craig/Vigilante+FAA
		E3	204	E3	J. Putnam	E3: Faeth/Putnam/Valeika+FAA
		E4	110	E4	D. Mavris	E4: Mavris/Schmidt+FAA
	3:40-5:00	Feedback from E1 thru E4	100		W. Harris	
				E1	Group E1	**Spokesperson for each group summarizes activities.**
				E2	Group E2	
				E3	Group E3	
				E4	Group E4	
	5:00-6:00	Synthesize Group E1-E4 work on AEDT Output	100	ALL	W. Harris & AEDT Committee	**Integrate inputs from each group (E1 thru E4) into a summary.**
	6:00	**Participants Adjourn**				
	6:00-6:30	FAA/TRB Administrative	100	FAA/ TRB	W. Harris L. Maurice	
	6:30	Adjourn				

Day	Time	Event	Rm.	Gp.	Moderator/ Speaker	Topic/Comments
DAY 2: THURSDAY, April 1	7:30-8:00AM	*Continental Breakfast*	*100*	*ALL*	--	
	7:30-8:00	TRB/FAA Closed Session	101	TRB/ FAA	W. Harris L. Maurice	**AEDT committee and FAA sponsors.**
	8:00-9:00	Recap AEDT Output Discussions	100	ALL	W. Harris & AEDT Cmte	**Agree on Group E input to Groups A, B, C, & define additional issues Group E addresses.**
	9:00-9:15	Expectations & Assignments	100	ALL	L. Craig	**Objectives/questions for each group.**
	9:15-11:30	Groups A B C	101 105 110	A B C	M. Benzakein M. Vigilante I. Jopson	**Groups A, B, C address questions posed.** *Individual breaks as needed.*
		Group E	109	E	J. Putnam	**Group E refines feedback/interacts with Groups A, B, C as needed & writes up discussions.**
	11:30-12:15	*Lunch*	*Atrium*	*ALL*		***3rd Floor Cafeteria—Blue Cards***
	12:15-12:45	All Groups continue morning assignment in breakout rooms	--	--	--	**Breakout groups prepare to present feedback.**
	12:45-2:45	Feedback from Breakout Groups	100	ALL	W. Harris	
		E A B C			Group E Group A Group B Group C	**Spokesperson for each group summarizes activities.**
	2:45-3:00	*Break*	*100*	*ALL*		
	3:00-4:00	Compile Groups A, B, C, E			W. Harris & AEDT Committee	**Summarize and integrate all inputs.**
	4:00-4:30	Considerations for bringing together AEDT Architecture	100	ALL	D. Mavris	
	4:30-5:30	Define Considerations for AEDT Architecture	100	ALL	D. Mavris	
	5:30	**Participants Adjourn**				
	5:30-6:30	FAA/TRB Administrative	100	FAA/ TRB	W. Harris	
	6:00	Adjourn				

Day	***Time***	***Event***	***Rm.***	***Gp.***	***Moderator/ Speaker***	***Topic/Comments***
DAY 3: FRIDAY, April 2	7:30-8:00AM	*Continental Breakfast*	*100*	*ALL*	--	
	7:30-8:00	TRB/FAA Closed Session	201	TRB/ FAA	W. Harris L. Maurice	
	8:00-8:45	Recap Groups A, B, C and E, and considerations for Group D.	100	ALL	W. Harris & AEDT Cmte	
	8:45-9:00	Expectations & Assignments	100	ALL	L. Craig	**Objectives/questions for each group.**
	9:00-11:30	Groups A B C	201 206 202	A B C	G. Faeth L. Craig J. Schmidt	**Groups A, B, C work on refining their output.** *Individual breaks as needed.*
		Group D	203	D	D. Mavris	**Group D addresses questions posed.** *Individual breaks as needed.*
	11:30-12:15	*Lunch*	*Atrium*	*ALL*		***3rd Floor Cafeteria—Blue Cards***
	12:15-12:45	All Groups continue morning assignment in breakout rooms	--	--	--	**Breakout Groups A, B, C complete documentation; Breakout Group D prepares to present feedback.**
	12:45-1:15	Feedback from Group D	100	ALL	Group D	**Spokesperson for Group D summarizes.**
	1:15-1:45	Comments on Group D's work	100	ALL	D. Mavris	**Group D facilitates.**
	1:45-2:30	Summary and Assignments	100	ALL	W. Harris	**Findings summarized and necessary follow-up assignments made.**
	2:30	**Workshop Participants Adjourn**				
	2:30-3:30	FAA/TRB Administrative	100	FAA/ TRB	W. Harris L. Maurice	
	3:30-4:00	AEDT Committee Closed Session	100	TRB	W. Harris	
	4:00	Meeting Adjourned				

Transportation Research Board Workshop
on
FAA Aviation Environmental Design Tool (AEDT)
[March 31–April 2, 2004]

Summary of Group Outputs

Introduction

The Transportation Research Board (TRB) of the National Academies held a workshop in Washington, D.C., from March 31 to April 2, 2004, to assist the Federal Aviation Administration (FAA) in defining the attributes and requirements of a new environmental tool, Aviation Environmental Design Tool (AEDT). AEDT is intended to provide a common transparent, integrated capability for computing and identifying interrelationships between noise and emissions and among emissions at the aircraft, local, regional, and global levels. The workshop participants included aircraft manufacturers, airlines, airports, academia, and the international community.

The workshop participants were divided into the following five work groups to facilitate more detailed considerations and discussions of certain major topics of interest:

A. Environmental Design Space (EDS)
B. Inputs
C. Individual Assessment of Modules
D. Noise/Emissions Modules Framework Architecture
E. Output

As members of these groups, the workshop participants provided substantial input on needs and requirements for the AEDT that the FAA will be able to use to help guide its development of a work plan for the AEDT. The following summaries of the discussions of each of the above five groups were prepared by the authors noted in each summary. The authors endeavored to capture key comments and concerns of individual participants. The summaries are notes of the group discussions and highlights of some of the major topics covered. They are intended to supplement the committee report on this workshop but do not reflect in any way a consensus either of the committee or of the participants in the workshop.

Summary of Group A: Environmental Design Space (EDS)

Author: Dr. Karen E. Willcox, MIT

Introduction

Group A discussed the Environmental Design Space (EDS) aspect of AEDT. The group consisted of individuals listed on the final page of this summary.

1 Definition of EDS

EDS is an integrated aircraft system design framework that can be used either as a standalone tool or in conjunction with AEDT. EDS spans aircraft design, engine design, and aircraft operations. The space also encompasses both existing and future technologies and aircraft configurations. EDS will be used to identify the interdependencies within this space among noise, emissions, and airline/manufacturer costs.

2 Role of EDS within AEDT

EDS provides predictive capabilities for noise, emissions, and, potentially, economics at the aircraft level. Within AEDT, these capabilities enable the assessment of technologies, aircraft configurations, and operating procedures not in existence today. As well as future aircraft, a key element of EDS is the ability to handle current technology, configurations, and procedures.

EDS also provides the capability to assess the impact of uncertainties in inputs and modeling assumptions on these interdependencies at the aircraft level. EDS should be limited to the aircraft level, and fleet issues should be handled in AEDT; however, the two models will interact, and fleet issues that could influence aircraft design will be fed back to EDS.

3 Key Requirements of EDS

A number of key requirements exist for EDS. These requirements were identified by participants and are summarized below in three main groupings: EDS framework requirements, EDS predictive capability requirements, and EDS scope of analysis requirements.

3.1 EDS Framework Requirements

A primary requirement is that the EDS framework be open, available, and transparent. It is also critical that the framework is flexible and modular and has the capability to evolve over time. EDS should have a standalone capability and the capability to integrate with AEDT. In addition, design constraints should be consistent across all models.

3.2 EDS Predictive Capability Requirements

EDS should have predictive capabilities on the three axes of noise, emissions, and, potentially, economics. For noise, EDS should provide "3-D" (the noise hemisphere) sources plus spectra plus time dependence for various power settings and aircraft configurations. For emissions, EDS should provide estimates of NO_x, HC, CO, particulates, CO_2, H_2O, SO_x, and eventually others (e.g., speciation of HC), on the ground and at cruise. For economics, EDS should address manufacturer and airline costs directly. On the larger-scale economic question of cost-benefit (effectiveness) analysis, EDS will interact with PMT through AEDT. This cost-benefit analysis should not be an explicit part of EDS. The need for accuracy of absolute versus delta costs early in the process should be evaluated. Existing aircraft cost tools (e.g., ALCCA, among others) should be incorporated and refined.

3.3 EDS Scope Requirements

The scope of analysis for EDS must incorporate current capabilities to treat individual aircraft and operations. In addition, EDS should have the capability to incorporate future technologies and configurations. A third important aspect to consider is the interaction between the aircraft portion of EDS and the fleet analysis of AEDT. The capability for this interaction must be encompassed within the EDS framework.

4 EDS Development

It was strongly suggested that EDS development be undertaken in a phased approach. The initial goal should be to capture current capabilities (EDS + INM/EDMS), followed by a phased implementation of future capabilities. This phased approach should be implemented while considering the requirement stated above that the EDS framework be configured to facilitate its evolution over time. Other suggestions were made as follows regarding the development process, the content of EDS, and the development group.

4.1 EDS Development Process

It was considered important for the EDS development process that a steering group composed of industry, government, and academia be established. In addition, this steering group should have international representation. This should be a small, focused group (not to exceed 10 members). Other stakeholders should not be a core part of the steering group but should be called as appropriate (e.g., consultants, advocacy groups, etc.).

Early in the process, it is important to identify and distinguish between the implementation issues (e.g., software development, interfaces) and the deeper intellectual challenges and research questions.

In addition, the EDS development process should ensure connectivity with the CAEP process and CAEP goals. The next CAEP meeting is in 2007, with subsequent meetings every 3 years. In addition, lessons learned from EPA, NASA, and others should be used effectively.

4.2 EDS Content Development

The EDS tool comprises two main parts: the underlying architecture/framework and the EDS modules. The first step in the development of the EDS framework should be a determination of the state of the art in each of these areas. Potential EDS architectures and modules should be identified and assessed. These include architecture and modules currently in development at Stanford, MIT, Georgia Tech, and NASA, among others.

The base modules of EDS must be open and nonproprietary, but the capability should be maintained to insert proprietary modules.

4.3 EDS Development Team

The EDS development team should include industry, academia, and government. In addition, collaborations should be developed on both a national and an international basis. In general, contributions such as modules, data, and expertise should be accepted from different stakeholders.

5 EDS Challenges

The participants suggested that a vast number of challenges associated with the development of EDS exist. The following discussion highlights those areas thought to be most challenging or most important.

The issue of validation is extremely important and challenging. Where possible and appropriate, validated data (e.g., proprietary data) should be used; however, there is a need to protect intellectual property, and availability of proprietary data might be limited. The key validation should be done by stakeholders, and the steering committee should take an active role to resolve validation issues.

A related and equally important issue is fidelity. Most participants held the view that the required level of fidelity varies considerably between users and applications. For example, for some users and applications, a “90%” answer may be sufficient, while for design studies, much more accurate results may be required. In addition, the wide possible range of modules and representations must be managed effectively. For example, there could be a number of parametric representations of the aircraft and engine; the level of analysis of individual modules could vary (e.g., empirical vs. physics-based models); or different applications could require the evaluation of local, regional, or global effects.

The need for flexibility was raised many times over the course of the workshop. Although the requirement is clear, its achievement remains one of the most challenging problems to address. Some of the aspects that must be considered include flexibility to incorporate different modules (e.g., base vs. proprietary, high fidelity vs. low fidelity), flexibility to satisfy different user requirements, and flexibility to incorporate modules that evolve over time.

A process must be developed to agree on future technology assumptions for policy uses. There is a need to reconcile the information about the fleet, how technology changes it, and how to feed it to EDS. Even though EDS will not handle fleet issues directly, it must respond to these assumptions and changes through AEDT.

Potential stakeholder limitations were identified as a challenge. These limitations include run time, overhead, upfront investment, and others.

Finally, misuse of EDS should be discouraged. This was felt to be a problem especially if nonexpert users were to have access to the tool. An example of misuse might be using EDS to establish possible environmental impact reductions while exceeding known boundary conditions like the 80-m box.

6 EDS Users

EDS users were divided into primary and secondary users. Early focus for the tool development should be on primary users. The need for absolute fidelity versus relative fidelity is dependent on the user.

Primary users were identified as regulatory and standards setting agencies (FAA, EPA, and ICAO, among others) for national and international policy, research establishments and manufacturers for technology investment decisions, and airlines for fleet planning.

Secondary users were identified as universities and their students (beyond developers), advocacy groups, airports, consultants, and air navigation service providers.

7 EDS Output

In terms of EDS output, a key consideration is that the framework must work as an integrated database management system. EDS must be interactive with AEDT (particularly INM and EDMS at the start), and, in particular, AEDT and EDS should be able to query the same databases. The issue of flexibility is again important: EDS should have both a flexible framework and flexible output.

Confidence levels should be incorporated as part of the EDS output. Fidelity requirements vary widely among users; therefore, specifying a priori fidelity requirements on the tool is not appropriate. EDS should have a probabilistic capability that provides predictive estimates for noise, emissions, and cost and also the relative confidence in those estimates. This confidence information is crucial for effective decision-making use of EDS (e.g., policy decisions, design tradeoffs, and technology investment decisions).

Configuration control and data archiving should be addressed from the start. This is a critical aspect because EDS and AEDT require configuration control to maintain regulatory effectiveness.

FRIDAY–GROUP A BREAKOUT LIST
Room 201

AEDT Workshop–4/2/04 Group A Breakout List				
FRI	**First Name**	**Middle Initial**	**Last Name**	**Organization**
A	Meyer	J.	Benzakein	General Electric Aircraft Engines
A	Joseph		DiPardo	Federal Aviation Administration
A	Willard	J.	Dodds	General Electric Aircraft Engines
A	Douglas	P.	DuBois	The Boeing Company
A	Gerard	M.	Faeth	University of Michigan
A	Philip	R.	Gliebe	General Electric Aircraft Engines
A	William	H.	Herkes	Boeing Commercial Airplanes
A	Alain		Joselzon	Airbus
A	Robert	E.	McKinley	NASA Langley Research Center
A	Edward	L.	McQueen	Federal Aviation Administration
A	Richard	C.	Miake-Lye	Aerodyne Research, Inc.
A	Herold		Olsen	SINTEF DELAB
A	Robert	E.	Owens	Pratt & Whitney
A	Kenneth	J.	Plotkin	Wyle Laboratories
A	Christopher	J.	Roof	U.S. DOT, Volpe Center Acoustics Facility
A	Ian	A.	Waitz	Massachusetts Institute of Technology
A	Chowen	C.	Wey	ARL/NASA Glenn Research Center
A	Karen	E.	Willcox	Massachusetts Institute of Technology

Summary of Group B: Inputs

Author: Theodore G. Thrasher, CSSI, Inc.

Introduction

Group B, the AEDT Inputs group was presented with four questions (shown in *italics*) to answer during the March 31–April 2 workshop. A significant amount of the discussion centered on EDMS and INM inputs when compared with the time spent on the other components of AEDT. A summary of the responses is provided below in line with the original questions, which are followed by a list of the key points. Key points and new data requirements are identified in **bold**. Group B consisted of the individuals listed on the final page of this summary.

1 Questions

1. *What are the inputs required for AEDT?*
    a. *Outputs of EDS*
        i. Direct costs to airlines and manufacturers.
        ii. Inputs that match those required by the existing tools. (e.g. 3 tone-corrected points is not what is required by INM; it would be beneficial to not have to apply conversions to the data before being able to use it within AEDT).
    b. *Aircraft performance data (outside of EDS output)*
        i. Aircraft/engine combination: The most accurate way to capture the fleet would be to use the tail number for every aircraft being modeled. However, since this data is typically not captured for air carriers beyond the top 11 domestically, a less detailed data set is more practical.
        ii. Taxi speed (emissions only)
        iii. Takeoff roll (noise + emissions)
        iv. Climb
        v. Departure and arrival flight paths (noise only)
        vi. Approach
        vii. Landing roll (emissions only)
        viii. Aircraft departure weight or stage length as an input to SAE AIR-1845 methodology for estimating takeoff roll, climb, approach, and landing roll times.
        ix. The current models do not have provisions for nondefault, nonstandard takeoff settings (e.g., reduced thrust, high-density altitude, etc). This is an area that should be improved in AEDT: Suggestions included using Boeing Method 2 for emissions and having the ability to user specify the performance data rather than relying on SAE AIR-1845 for all operations.

c. *Noise and emissions data*
   i. Noise-power-distance (NPD) data available with substitution list
      1. NPD data are processed before being included in INM.
      2. Over 100 aircraft types are included in INM, with each having its own default data (NPD curves and default profiles based on weight of aircraft).
      3. Future aircraft designs may require more sophisticated noise modeling algorithms.
      4. Included should be the ability to model noise from GSE, APUs, and road traffic.
      5. Consideration should be given to emerging issues on noise and emissions; awakenings and audibility were cited as examples for noise, as were air toxics and hazardous air pollutants (HAPs) for emissions.
   ii. Emissions certification data available for engines, with airframe assignment within EDMS
      1. Currently, only some criteria pollutants (CO, HC, NO_x, and SO_x) are available for aircraft.
      2. **Speciation of other pollutants** should be considered for AEDT.
      3. Included should be the ability to model **particulate matter (PM), polycyclic aromatic hydrocarbons (PAHs), and HAPs.**
      4. Mixing height and study year are also required for emissions modeling.
   iii. EDMS uses weather and terrain data.

d. *Aircraft movements data*
   i. Runway assignment (noise + emissions).
   ii. Taxiway assignment (emissions only).
   iii. Gate assignment (emissions only).
   iv. 3-D flight trajectory.

e. *Other modes of transportation data*
   i. Emissions includes GSE, APU, on-road vehicles, stationary sources, and training fires.
   ii. Something that would be nice to have is the ability to enter background values for noise and emissions.

f. ***Economic data*** (e.g., cost-benefit and some form of common currency between noise and emissions). It is important to investigate this now because it will be required for the portfolio management tool.

g. **Alternative trajectories for the global models** (using great circle routes is insufficient).

2. *How do inputs vary according to function* (e.g., planning, research)*?*

   a. Emissions and noise impact analysis associated with proposed actions: Because these actions can affect user operations, it may be necessary to consider a means for obtaining feedback from the user's perspective in AEDT.

   b. Proposed scenarios to reduce noise and emissions: Need associated cost data.

   c. Evaluate the impact of FAA-proposed actions on capacity and operational efficiency.

NOTE: Items a, b, and c each have very different input requirements. As an example, cost inputs may be needed to evaluate the impact of imposing an emissions tax in a given region.

   d. Future aircraft and scenarios
      i. The research community will use EDS differently than the planning community will.
      ii. The ability to enter **forecast data** (such as the TAF) is necessary to accommodate this.
      iii. The ability to include additional aircraft types and categories (helicopters, military, general aviation, and future aircraft) performance for emissions and noise.

   e. General comment: There was discussion about adopting the type of engine mapping that CAEP uses. Campbell Hill has **tail-number-specific data that could be useful**, but it would likely add significantly to the cost and may not be allowed under Part 150, because that requires the use of publicly available data.
      i. It is necessary to **identify potential uses** of AEDT to make sure that those needs are met. Externally imposed requirements for input, such as CAEP forecasts and tail numbers, was cited as an example.
      ii. We need to provide a level of consistency between the inputs of the global and the local models (various levels of data aggregation).
      iii. It is important to ensure that the needs of existing users of both the noise and emissions models continue to be met and not hindered by AEDT.

3. *What are common inputs of existing noise and emissions modules?*

   a. EDMS and INM
      i. The departure and arrival profiles are common below 1,000 ft AGL.
      ii. Aircraft operations by aircraft/engine combination. However, INM has a substitution list for aircraft/engine combinations that may be inconsistent or inappropriate for emissions use.
      iii. Airport operational conditions are typically the same, but depending upon the emissions condition being evaluated, may differ.

   b. SAGE and NIRS: SAGE uses BACK and ASQP data, and NIRS uses similar traffic data.

4. *How would air traffic tools interface with AEDT?*
    a. AEDT will require a translator for a set of standard data types.
    b. Current air-space data do not always meet the needs of noise and emissions modeling, so it would be worthwhile to research alternative sources for operational data. Developing consistency among these models is important.

2 Other Issues Raised by the Group

In addition to raising the original four questions, the group raised other issues important to the AEDT inputs. Those issues are outlined below.

1. Support the current users (don't make the model so complex or costly to use that it can not be used by all existing users). Given that statement, because the current modules do not communicate with each other, AEDT may need to take a more integrated approach. **The 800+ current users of EDMS and INM must be supported** by whatever solution is provided. That is, using common input data and formats should not impose an unreasonable burden on current users.
2. How are the common inputs different**?**
    a. Airport data:
        i. EDMS requires the location of the airport reference point and the airport elevation. Users must enter the airport runway, taxiway, and gate configurations manually.
        ii. INM includes a smaller database of airports with the runway layouts.
    b. Aircraft/engine combinations: An aircraft that makes a reasonable substitution for another for noise modeling may not be appropriate as a substitution for modeling emissions. This will be a challenge to address, since it can make transparency difficult.
    c. Traffic data: 90% of the uncertainty in SAGE can be attributed to not accounting for wind and takeoff weight.
    d. Weather data: The AERMOD dispersion model requires surface and upper air weather data from AERMET with over 50 calculated parameters. The noise models are not able to use such detailed data, and it seems unreasonable to require the data's use for all cases.
    e. General: Users of the different modules may require different levels of accuracy. The impact on the **accuracy of the result should be included with the input data** so that the user can be aware of the expected precision given the input data.

Summary of Key Points

- **Existing users should continue to be supported.** There are over 800 users of INM and EDMS today. This user base must be supported by AEDT.
- **Existing databases need to be harmonized**. Similar databases are used by INM and EDMS. If possible, these databases need to be reconciled so that the same input can be used for both noise and emissions modeling; however, this will require a

substantial effort. Any assumptions made in this area should be documented to maintain transparency. AEDT should include development and maintenence of a comprehensive database required to exercise the models or toolsets, including such data as aircraft characteristics, movements, weather, terrain, trajectories, and performance. Finally, consideration of flexibility and scope of databases and international databases is required to ensure international use.

- **Existing data gaps in the current tools need to be addressed for AEDT.** These include PM, pollutant speciation, PAHs, and HAPs for emissions. In addition, the ability to model noise and emissions at other than the standard power settings and weather conditions is important. There was a discussion of moving away from SAE AIR-1845 in the future and also of incorporating Boeing Method 2.
- **Economic data are currently not included in any existing tools.** This economic data should include cost data for the airport user and the airport as well as relevant community economic data.
- **Better trajectory data are needed for the global models.** Currently, radar data are used for North and Central America and portions of Europe (about 55% global coverage), but for the remaining 45% of flights, an empirically based vertical and horizontal dispersion model is used. Of the uncertainty in SAGE, 90% can be attributed to not accounting for wind and takeoff weight.
- **Better fleet data would be useful**. The suggestion of incorporating a tail-number database was mentioned numerous times. However, traffic data related to tail number are rarely available, so the database may be of limited use. In addition, the issue of including only publicly available data was raised. Related to the fleet data is the issue of INM and EDMS using different aircraft lists.
- **Level of accuracy should be included with the inputs.** This inclusion will enable the level of precision to be tracked throughout the analysis. This ability is very important to allowing users to understand the level of accuracy to expect from their results on the basis of inputs used. This feature will allow AEDT to accommodate a wide range of potential users.
- **Potential uses of AEDT should be identified.** To fully understand the inputs required for AEDT, it is necessary to know how the tool will be applied. This knowledge should include supporting the CAEP process as well as the current uses of the existing modules.

FRIDAY–GROUP B BREAKOUT LIST
Room 206

AEDT Workshop–4/2/04 Group B Breakout List				
FRI	**First Name**	**Middle Initial**	**Last Name**	**Organization Name**
B	John	J.	Begin	Northwest Airlines
B	John	C.	Bobick	ATAC Corporation
B	Andrew		Burke	National Air Traffic Services, UK
B	James	B.	Byers	Federal Aviation Administration
B	Lawrence	W.	Craig	The Boeing Company
B	Warren		Gillette	Federal Aviation Administration
B	Curtis	A.	Holsclaw	Federal Aviation Administration
B	Michael	A.	Kenney	URS Corporation
B	Ilan		Kroo	Stanford University
B	Daniel	L.	McGregor	Boeing Commercial Airplanes
B	Thomas		Nissalke II	Hartsfield Atlanta International Airport
B	Neal	H.	Phillips	Metropolitan Washington Airports Authority
B	Jon	F.	Pietrak	Federal Aviation Administration
B	Ray		Valeika	Delta Air Lines, Inc.
B	Mary	L.	Vigilante	Synergy Consultants, Inc.
B	Jon	M.	Woodward	Landrum & Brown
B	Nancy	N.	Young	Air Transport Association of America, Inc.

Summary of Group C: Individual Assessment of Modules

Author: Dr. Ben H. Sharp, Wyle Laboratories

Group C consisted of the individuals listed on the final page of this summary.

Question 1

What are the capabilities from existing tools (e.g., INM, NIRS, EDMS, SAGE) that must transfer to the new tool?

- Existing tools (including appropriate international tools) should become modules of AEDT rather than being incorporated or hard wired into AEDT.
- All features of the existing tools should be incorporated in AEDT.
- Near-term enhancements of existing tools should be made with consideration for the future application of modules within AEDT.
- AEDT input requirements should be sufficiently flexible to accommodate other noise and emission models, such as those used by DOD (NOISEMAP, RNM), simulation models (NMSIM), and European models.

Question 2

What are the commonalities and differences of existing tools? What are redundant capabilities (i.e., common computational capabilities of INM and EDMS)?

[In the weeks preceding the Workshop, the AEDT Development Team had discussed the commonalities of the models (INM, EDMS, MAGENTA, SAGE) and developed a tabular list for attendees to work from.]

- INM and EDMS have similar inputs but different levels of detail in their respective databases and are configured differently:
  - EDMS models the whole airport, includes taxiing aircraft and ground transportation sources, has significantly more available aircraft/engine combinations, and performs calculations for discrete and peak periods but models aircraft only up to 1000 ft (and does not use flight tracks).
  - INM models TO and Approach operations, maintenance run-ups, incorporates different profiles and flight tracks, and performs calculations averaged over a year.
- Despite the different levels of detail, the common elements of the databases for INM and EDMS should be integrated where appropriate, and EDMS perhaps should have the capability to select different departure profiles using INM's dynamic profile builder.
- To provide consistency between noise and emission analyses, inputs to INM and EDMS should be configured to be similar.

- There is consistency between INM and MAGENTA, as they use the same basic airport noise model. This is not the case with EDMS and SAGE, although they use similar emissions databases.

Question 3

What capabilities are lacking, such as meteorological effects on sound absorption, noise annoyance metrics, particulate matter data and modeling, and database expansion for national parks considerations.

a. Noise

- INM should inlcude the ability to model more than just flight operations, but also taxiing , and improved modeling for run-ups.
- INM calculations should include a more comprehensive way for modeling water surfaces.
- Aircraft configuration should be taken into account. (This is planned.)
- Noise modeling can be improved by including meteorological data, possibly the data used by EDMS (hence the need to coordinate input data for INM and EDMS). However, it is not practical to model meteorological data for a complete year as is currently required in calculation of DNL, so that average yearly data must still be used. If alternate metrics, such as worst-day 24-hour DNL, were used, then daily meteorological data would be beneficial.
- AEDT should include the flexibility to input more detailed aircraft noise data than what is currently available in NPD databases.
- Airport noise contours should include the effects of off-airport, nonaviation sources.
- Alternative noise metrics, such as number of events (e.g., N70), noise-free intervals, and others, should be considered to provide the community with a more complete understanding of noise exposure. Non-average-day metrics should also be evaluated.
- There was support for increased transparency in INM outputs to provide information on how noise contours are derived (e.g., queries that provide information on noise level by event or track). (Much of the data to do this can be extracted from INM inputs and outputs, so this may be more a data-presentation issue than a change in the noise module.)
- INM needs better graphical user interfaces for inputs and outputs.
- A need exists for a what-if capability or decision tool that can be readily and rapidly implemented by the user without lengthy reruns of the noise model.

b. Emissions/Air Quality

- Should there be a global dispersion capability in SAGE? This would require full chemistry and dispersion, which are complex and would result in excessively long computer run time. This is not considered a priority, but EDMS should provide flexible outputs for complex dispersion models.

- A major priority is to enable calculation of PM and HAP.
- There should be a capability to develop some type of contouring for toxics and PM.
- EDMS needs better graphical user interfaces—for inputs and outputs—that are consistent with those required for noise analyses and presentations so that noise and emissions can be related.
- As with noise, there is a need for transparency in presenting output data.
- EDMS needs the addition of a what-if capability or decision tool so that users can quickly identify major problem areas and solutions.

Question 4

What are the existing and required levels of fidelity at module level (e.g., accuracy, resolution)?

Much of the discussion related to this question centered on the meaning of the terms “fidelity,” “accuracy,” and “resolution.” It was noted that “fidelity” should be considered as an overall term that describes the confidence in using a model and incorporates the quantitative measures of accuracy and resolution. However, most felt that use of the term “fidelity” should be discontinued.

- “Accuracy” was defined as the quantitative measure of model results compared with measured values.
- “Resolution” was defined as the fractional part of a unit of measure that can be reported by the model.
- It is possible to have more resolution than accuracy.
- Different users may require different accuracies and resolutions.

With regard to model validation:

- Decision makers do not usually question validity; the public does not understand or trust the model results and hence doubt the model’s validity.
- Validation of noise models remains a major and ongoing issue.
- The EDMS model needs to be validated for aircraft sources. The difficulty lies in there being many different pollutants. Validation is also complicated by the need to simulate jet exhaust and motion. Validation should be conducted at an isolated location where no other emissions sources are present.
- There is a lack of an emissions database for airports.
- Individual modules and their components should be validated separately in parallel and then validated together when combined in AEDT.

Question 5

What should the priorities be for developing the missing capabilities?

- For air quality, improved models for PM and HAP are the major priority.
- For noise, improved sound propagation over terrain features and water and incorporation of meteorological effects are the main priorities.
- For both, transparency is an issue but not necessarily a priority in model development because it is more of a data-presentation issue.

Question 6

What are the hardware and operating system requirements of existing tools? Are there any potential incompatibilities?

Not applicable.

Question 7

What additional issues are important for AEDT?

Other discussion points consisted largely of emphasis on issues discussed earlier.

- Should there be a single set database for INM and EDMS with different access needs for each?
- AEDT should not be limited to existing FAA models but should be sufficiently flexible to incorporate other existing and future models. It should always use best practice in available tools.
- Should SAGE and MAGENTA be linked and EDMS and INM be linked? The databases should be consistent in both cases, but there is no need to link local and global models because they have completely different users. Local models are used by planners, whereas global models are used by researchers and policy makers.
- Platform is not generally an issue, although dispersion calculations should be separated and performed on a more powerful computer.

Group C Process and Requirements (Work Plan)

- The AEDT Development Team should continue the process of identifying the commonalities among the INM, EDMS, MAGENTA, and SAGE (and perhaps the NIRS) models.
- Databases that could be common to all or a subset of the models should be identified, with the goal of uncovering a single international database for all users.
- Individual model development should continue, as should AEDT development.

- The models to accept AEDT integrated architecture should be modified, but it should be recognized that INM and EDMS will continue to be used in parallel outside the AEDT architecture.
- The first version of AEDT should incorporate just INM and EDMS with a common graphical user interface and common database.
- Validation of individual models needs to proceed in parallel. Revalidation should occur again after models are together in AEDT.

Group C Review of Group A Output

- Group A discussions propose a much more detailed set of input noise data, such as 3D hemispheres in one-third octave bands. RNM, NMSIM, and Imagine can accept these data, but INM can currently handle only NPD curves as input, so an interface processor would be necessary.
- Currently, EDMS cannot handle PM and HC speciation as proposed as output from Group A.
    - PM: The first problem is that aircraft PM emission factors for inclusion in EDMS do not exist. The second problem is that different types of particles evolve differently in the atmosphere. We do not yet fully understand how particles evolve, and AERMOD and LASPORT can disperse PM but do not consider evolution.
    - HC Speciation: The FAA should continue with its plans to speciate HC emissions and concentrations in EDMS. Better HC speciation data for aircraft need to be developed for incorporation into EDMS.

Group C Review of Group B Output

- There were no serious issues related to Group B outputs.
- Deterministic outputs would be preferred over probabilistic outputs.
- There should be consistency with other models, such as TAAM and SIMMOD.

FRIDAY–GROUP C BREAKOUT LIST
Room 202

AEDT Workshop–4/2/04 Group C Breakout List				
FRI	**First Name**	**Middle Initial/ Name**	**Last Name**	**Organization Name**
C	Steven	L.	Baughcum	The Boeing Company
C	Carrol		Bryant	Environmental Science Associates
C	Thomas	L.	Connor	Federal Aviation Administration
C	Julie		Draper	Federal Aviation Administration
C	Peter	H. C.	Hullah	EUROCONTROL Experimental Centre
C	Ian		Jopson	Civil Aviation Authority, United Kingdom
C	Sandy		Lancaster	Dallas/Fort Worth International Airport
C	Maryalice		Locke	Federal Aviation Administration
C	Robert		Mentzer	Harris, Miller, Miller & Hanson, Inc.
C	Robert		Miller	Harris, Miller, Miller & Hanson, Inc.
C	Kerry	W.	Moss	National Park Service
C	Warren	D.	Peters	U.S. Environmental Protection Agency
C	Jake	A.	Plante	Federal Aviation Administration
C	John	E.	Putnam	Kaplan Kirsch & Rockwell, LLP
C	William	A.	Russell	U.S. Army Center for Health Promotion & Preventive Medicine
C	Jacob		Schmidt	Center for Clean Air Policy
C	Kevin	P.	Shepherd	NASA Langley Research Center
C	George	W.	Siple	CDM
C	David	Gordon	Southgate	Australian Department of Transport & Regional Services
C	Donna	G.	Warren	Federal Aviation Administration
C	William	J.	Willkie	Leigh Fisher & Associates, A Division of Jacobs Consultancy

Summary of Group D: Noise/Emissions Modules Framework Architecture

Author: Stephane I. Mondoloni, CSSI, Inc.

Group D consisted of the individuals listed on the final page of this summary.

Introduction

Group D was presented with the following questions:

1. What should the overall architecture of AEDT be? How does this vary with AEDT versions identified by Group E?
2. Are there existing capabilities that can be leveraged to develop this architecture? [Use redundant capabilities tools of existing tools input from Group C (e.g., INM, EDMS, SAGE) to help refine architecture.]
3. How are interfaces of existing noise and emissions analytical tools developed?
4. What are the needs of each customer base (e.g., ease of use, robustness of data, run time, PC accessibility)?
5. How can an architecture be developed that meets the needs of various users? Would meeting a variety of needs require multiple architectures?
6. What is the ease and cost of annual or regular AEDT maintenance (e.g., database upkeep)?
7. Can steps be taken during the design stages to keep run time manageable?
8. How is a tool robust enough to grow in the future created?

An initial discussion on the questions concluded that in the time allotted this group could not even address question 1. Clarification of the items above determined that the questions were meant to provide guidance for the discussions. Group D determined that **the outcome of the discussion should be twofold:**

- **The provision of high-level requirements for the architecture framework and**
- **The provision of process requirements,** how best to proceed with the development of an AEDT architecture.

These are summarized below, with key points in bold.

1 Framework Requirements

Portability: The AEDT architecture framework must support distributed and heterogeneous platforms. This requirement states that the framework must support multiple platforms, must support applications that can operate only on specific platforms, and must support interoperability between differing platforms. However, **functions performing core calculations** *should* be platform independent. The framework must not restrict portability, and modules restricting portability should be avoided. However, many realized that platform independence cannot always be achieved because of mission or resource constraints. When this situation cannot be avoided, the reasons for it and possible design constraints on other AEDT modules must be communicated within the AEDT team. Participants stressed that short-term fixes that restrict portability can appear cheap in the short term but can be costly in the longer term.

Modularity: The AEDT architecture should be modular and capable of accommodating new data formats and updated computation modules.
The system should be reconfigurable to allow users to select different modules in any required order. The pathway through the model should not be hardwired. High levels of reconfigurability complicate the validation of the overall system. Furthermore, only certain reconfiguration options may make sense.

Input Compatibility: The architecture should support its own consistent but openly documented data formats. Data elements that are common between modules should ultimately be harmonized to the highest possible fidelity. Where possible, formats leading to duplication should be eliminated. Systems should support generally accepted standardized formats for input and output.

Output Compatibility: The architecture should provide an interface to different types of outputs to support the goal of coordinated noise and emissions analysis.
Because the current output is driven by different regulatory requirements for noise and emissions at the airport, regional, and global levels, AEDT must continue to support these differing requirements. However, current regulatory requirements could change, so the architecture must also allow output flexibility. The EDS level may have similar requirements.

Screening Tools: The architecture should support screening tools and the "tiered" analysis approach. The participants defined the need for screening tools. These are used to rapidly screen the set of possible required analyses. An air quality example would include using 1 hour of weather data (less accuracy vs. increased speed)) as opposed to a whole year of data (more accurate). For noise, contour growth has been generalized in AEM (no flight tracks or aircraft procedures) versus specific contour growth (INM with full flight tracks and specific aircraft procedures).

Scalability: The architecture should support both large-scale and small-scale studies while consistent assumptions are maintained. Examples of these include emissions studies with 10 receptors versus 100, NIRS studies with larger geographic scope, and EDS investigations that look at one aircraft or a whole fleet of aircraft.

Usability: The architecture must accommodate multiple versions for different users with differing regulatory requirements. The architecture must remain usable to the current user base. **The architecture should allow, and the programs should contain, data defaults (identified by group B) to expedite analyses when more tailored data are not required for all components. The look and feel that current users experience should be considered in the design of the system to facilitate their transition to the new**

model. Run time should meet the needs of the user. Large applications should be handled by distributed multiprocessor systems.

Interfaces to other models: The architecture should be developed to support flexible interfaces with a variety of relevant applications. For example, the architecture should support interfaces to other scientific models that support the chemistry of global emissions. Some projects will require full coordination with the EDS modules to provide the impact of aircraft design changes at the airport, regional, and global levels. Finally, these would need to be rolled up into a coordinated output to support policy analyses. The architecture should support the integration required for these projects.

Transparency: The architecture must allow the input data to be fully traceable and auditable. **However, the proprietary data may need to be protected, and metamodels might enable that protection.**

2 Process Requirements

Many participants suggested that a **steering group should be established** and a focal point identified to help guide the architecture and determine how to proceed. The AEDT addresses more analysis issues than what AEE normally undertakes (such as the interfaces with EDS). The steering group and the definition of a framework should be established as early as possible—before work is initiated, if possible. If this is not feasible, **the definition of the framework and the establishment of the steering group should be undertaken as early in the process as possible.** It is important that the steering group also include members with architecture framework expertise in addition to members capable of covering all requirements.

A plan should be developed for moving existing users toward AEDT. One recurring theme across all groups was the need to continue supporting the existing user base of noise and emissions models. This plan would address how to make the transition to the future with this existing user base.

An AEDT validation plan should be developed. The large number of modules within AEDT and the potential for complex interactions among modules will likely necessitate a continuous validation approach. The plan should address the validation of the AEDT system in response to changes in individual modules.

A prototype of merged models should be launched. Short-term deliverables and products are important for sustaining the momentum behind this project. One such deliverable would be the initiation of a prototype that would couple two environmental models using a common data set.

A survey of current commonality should be initiated. The identification of common functions within INM, EDMS, SAGE, MAGENTA and NIRS could be used in the development of a library of common modules for AEDT. *In the long run*, this approach provides ease of software maintainability and facilitates the upgrade of functionality. As this flexibility provides a long-term benefit, this task was felt to be subordinate to the prototype described above.

FRIDAY–GROUP D BREAKOUT LIST
Room 203

AEDT Workshop–4/2/04 Group D Breakout List				
FRI	**First Name**	**Middle Initial**	**Last Name**	**Organization Name**
D	Sherry	S.	Borener	Volpe Center, NASA
D	Raymond	N.	Brown III	Delta Airlines
D	Gregg	G.	Fleming	U.S. Department of Transportation, Volpe National Transportation Systems Center
D	John		Gulding	Federal Aviation Administration
D	Jonathan		Hoffman	MITRE Corporation
D	Kimberly	C.	Hughes	HNTB Corporation
D	Brian	Y.	Kim	U.S. DOT, Volpe Center Acoustics Facility
D	Dimitri	N.	Mavris	Georgia Institute of Technology
D	Stephane	I.	Mondoloni	CSSI, Inc.
D	Angel	L.	Morales	Federal Aviation Administration
D	Jeffrey	R.	Olmstead	ATAC Corporation
D	Virginia	L.	Raps	Landrum & Brown
D	Ben	H.	Sharp	Wyle Laboratories
D	Terence		Thompson	Metron Aviation, Inc.
D	Theodore	G.	Thrasher	CSSI, Inc.
D	Roger	L.	Wayson	University of Central Florida
D	George	M.	Webb	Environmental Consulting Group, LLC

Summary of Group E: Output

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Question 1

Given the expectations for AEDT applications presented by FAA, has FAA identified the right questions that AEDT should help to address? Are there additional areas that AEDT should consider?

1. AEDT development should recognize that some issues do not have a tradeoff consideration (e.g., one is or is not either compliant with the Clean Air Act) (Issue).
2. AEDT development should continue to recognize the environmental link to capacity and delay (Application).
3. AEDT development should consider a drive toward strategic noise maps (rail, highway, and other sources); that is, compatibility with worldwide practices and worldwide regulations must be considered (Application).
4. AEDT should consider implications of misuse of a public model and work to minimize misuse through proper design (Issue).
5. AEDT is a long-term model, and policy needs and hardware/software capabilities will evolve over time; AEDT should consider the evolving state of computer modeling (Issue/Application).
6. AEDT should better consider the link between local and global environmental issues. This consideration has serious implications for model fidelity and developmental versions (Issue/Application).
7. See the attached list of applications.

Question 2

FAA had identified the following potential uses of AEDT.

1. Research prioritization and resource investment guidance.
2. Support decision-making processes.
3. Compatible land-use planning.
4. Technical decision making for smaller airframers that don’t have in-house capabilities; product design support and requirements definition.
5. Interactive process between airlines and manufacturers to help define the product that will be provided.
6. Operational analyses, including airspace evaluation and assessment of proposed mitigation/abatement procedures.

7. Assess interdependencies between economics and environmental variables.
8. Business planning and decision-making, e.g., airline schedules.
9. Support litigation.
10. Perform what-if scenarios and comparative analyses.

Are these others?

Comply with legal requirements; inform policy decisions; provide information for infrastructure development; compatibility/exposure; mitigation/abatement; CAEP process; provide technical information for economic analysis using the APMT

Question 3

Who are the potential users of AEDT: government, ,manufacturers, airports, airlines, public, academia?

1. Expansion of government category: NASA, EPA, FHWA, FTA, FRA, DoT, DoD, NPS, HUD, DoE, NWS, NOAA, state and local, and airport authorities.
2. Scientific community, committees, and researchers.
3. Consultants.
4. Citizen groups/public interest groups (There was a strong concern about potential misuse within this group).
5. International organizations/governments.
6. Air navigation organizations.
7. Legal groups.

Question 4

Why would potential users not use AEDT?

1. High cost of use (either cost of AEDT or hardware costs).
2. Too difficult to use (not transparent or well documented, i.e., a black box).
3. Lack of, or inability to collect, necessary input data.
4. Not required to use it.
5. Does not provide outputs that user needs.
6. Not invented here (NIH).
7. Inadequate fidelity of output.
8. Inadequate validation (either do not agree with results or they are not satisfactory).
9. Lack of high-quality user training.
10. Lack of modular architecture (e.g., international or military users who have their own core modules need to be able to plug and play).

Question 5

Do we need various versions of AEDT? What are these versions (e.g., a planning version with a limited set of modules and a research version with the full suite of modules)?

1. AEDT should be designed around a flexible set of basic modules and an application programming interface (programmer's instructions). This ability will allow tailoring to users and their analysis needs and scope (e.g., local, regional, global, screening, etc.). It will also support maintainability. AEDT should allow for users to access only the modules they need for a particular analysis. It should be an extensible, carefully designed framework. AEDT should include a data dictionary that describes in detail how the modules interface.
2. Version control is a big issue with such a complex system.

Question 6

What should priorities be for developing various output capabilities? What are the time drivers for developing each capability (e.g., CAEP)?

1. Maintain all current capabilities of existing tools (INM, EDMS, etc.) until AEDT has been validated, released, and accepted.
2. Integrate common modules across core tools (e.g., aircraft performance module); provide a near-term deliverable to keep AEDT viable and in the forefront.
3. To the degree practical, minimize the use of proprietary data and tools.
4. Preserve and improve upon the screening capability.
5. Include economics in initial design; as a bare minimum, AEDT must support basic cost-benefit analysis.
6. Recognize the reality of the aviation life cycle (i.e., aircraft have a typical 30- to 40-year life cycle; support robust forecasting.
7. Provide for a flexible methodology to examine interdependencies among noise, emissions, and economics.
8. Provide a visual representation of emissions (like noise contours).
9. Provide a way to see impact in context (e.g., a state might speak of an airport's contributions to NO_x in terms of a more publicly understandable contributor, like a power plant).
10. Provide utility and ease of interpretation: public consumption of model output should be considered at all times.
11. Include supplemental metrics for noise, emissions, and economics.
12. Need useful analytical output synchronized with CAEP, shortly after CAEP 7 (summer/fall 2007); will miss impact if there is nothing at that time.

Question 7

What are the characteristics of useful output format (common noise contours/emissions inventories; utility and ease of interpretation; ability to interpret data in context; required overall fidelity)?

1. Diagnostic/interim output from each step in an analysis process.
2. User-friendly file output formats (e.g., ASCII or .dbf).
3. Easily repeatable results for official regulatory compliance purposes (i.e., simple input/scenario setup).
4. Automated ability to compare a baseline with alternatives.
5. Additional/supplementary metrics.
6. Population exposure to provide transparency between noise and emission concentrations.
7. Ability to interpret data in context.
8. Advanced, built-in GIS capability, including demographics.
9. Support of compliance with international standards/regulations.
10. Inclusion of a measure of goodness (e.g., uncertainty bars, with results).

Other Priorities and Considerations

1. Necessary resources should be spent on designing a flexible framework.
2. Run time is less of an issue for scientific community.
3. AEDT could be web based.
4. Potential legal issues associated with advanced flexibility should be considered.
5. An AEDT DRG should be formed to assist with development.